

The role of health promotion and education in cancer prevention

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*LEEА: Lifestyle-related Environmental Exposures to Avoid

PPT slides 1 & 2

My name is P. J. Blois and I'm here to explain

Topic : The role of health promotion and education in cancer prevention.

I'm well-positioned to speak to this topic because

- I went on to study an MEd. Leadership after my BSc.,
- I've been participating in the 2020-2021 Cancer and Evolution Symposium as well as the USC Ellison Insights in Medicine Forums,
- I've been reading and writing academic literature about advancing biology and cancer curriculum over the past few years.

The literature indicates that cancer can and should be prevented by addressing environment and lifestyle factors because they play a big role in determining our risk of cancer⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾⁽⁵⁾⁽⁶⁾⁽⁷⁾⁽⁸⁾⁽⁹⁾⁽¹⁰⁾⁽¹¹⁾⁽¹²⁾⁽¹³⁾⁽¹⁴⁾⁽¹⁵⁾⁽¹⁶⁾⁽¹⁷⁾⁽¹⁸⁾⁽¹⁹⁾⁽²⁰⁾⁽²¹⁾⁽²²⁾⁽²³⁾⁽²⁴⁾⁽²⁵⁾⁽²⁶⁾⁽²⁷⁾⁽²⁸⁾⁽²⁹⁾⁽³⁰⁾⁽³¹⁾⁽³²⁾⁽³³⁾⁽³⁴⁾⁽³⁵⁾⁽³⁶⁾⁽³⁷⁾⁽³⁸⁾⁽³⁹⁾⁽⁴⁰⁾⁽⁴¹⁾⁽⁴²⁾⁽⁴³⁾⁽⁴⁴⁾⁽⁴⁵⁾⁽⁴⁶⁾⁽⁴⁷⁾⁽⁴⁸⁾⁽⁴⁹⁾⁽⁵⁰⁾.

Despite increasing attention to this fact in recent decades, many people remain unaware of the relationship between cancer and lifestyle choices beyond the problems of smoking, pollution and pesticides⁽³³⁾, lifestyle choices, such as exercise and diet, and environmental exposures including infections determine risk of cancer⁽⁵¹⁾.

Genetics are only responsible for a small fraction of cancers whereas the majority are due to lifestyle and environmental factors⁽³³⁾⁽⁴¹⁾⁽⁴⁴⁾⁽⁴⁹⁾. Therefore: Avoid or reduce exposure to carcinogens, the “known or probable causes of cancer”⁽⁶⁾. Curb infection through vaccination, abstinence or safe sex, and safe injections⁽³⁰⁾⁽³⁶⁾.

Beware that traumatic and chronic elevated stress may cause DNA damage⁽²⁵⁾⁽³²⁾⁽³⁵⁾.

Education can help reduce cancer incidence by increasing awareness of how it can be prevented:

Blois (2022)•:

The data in this pie chart is based on an interpolation of information from multiple sources over the past decade with special consideration to recent research⁽³³⁾⁽³⁹⁾.

“Approximately 5% to 10% of cancers have a clear genetic basis” whereas “up to 80%” of Western cancer cases are due to lifestyle and “environmental factors including infectious agents”⁽⁴¹⁾⁽⁴⁴⁾⁽⁴⁹⁾.

Smoking and Heredity:

Since most people have heard about how smoking increases cancer risk, I will not

belabor that point in my presentation, nor will I focus on heredity, since today we know that the range of environmental factors that contribute to cancer risk are 10 to 20 times as important as heredity⁽³³⁾.

Infection

Beyond the ability to reduce infection through vaccination, further precautions that should reduce incidence include the practice of abstinence or safe sex, and safe injections both inside and outside of medical facilities⁽³⁰⁾⁽³⁶⁾.

Professional exposure

I would like to mention the radiation workers at nuclear power plants may face, and the importance of filtration systems and masks to prevent intake of airborne particles, but there is more to it because “at least 150 chemical and biological agents are known or probable causes of cancer”⁽⁶⁾.

Stress

An association has been found “between traumatic stress”, “Chronic exposure to elevated stress” and DNA damage⁽²⁵⁾⁽³⁵⁾.

Bereavement and loss can also increase risk of cancer through increased chances of infection⁽³²⁾.

Cell-phones, Wifi and EMFs

Finally, I’d like to mention cell-phones which use microwaves—many people do not know that it is not recommended to keep a phone right next to your skin⁽¹⁷⁾⁽²¹⁾⁽⁴⁷⁾. EMFs refers to electromagnetic fields which are found near electrical devices, the most notable of which are found near power lines.

References

- (1) Temple NJ. The war on cancer-failure of therapy and research: discussion paper. *Journal of the Royal Society of Medicine*. 1991;84(2): 95–8.
- (2) Bouker KB, Hilakivi-Clarke L. Genistein: Does It Prevent or Promote Breast Cancer? *Environmental Health Perspectives*. 2000;108(8): 701–8.
- (3) Peto J. Cancer epidemiology in the last century and the next decade. *Nature*. 2001;411(6835): 390–5.
- (4) Rothman N, Wacholder S, Caporaso NE, Garcia-Closas M, Buetow K, Fraumeni JFJ. The use of common genetic polymorphisms to enhance the epidemiologic study of environmental carcinogens. *Biochimica et Biophysica Acta*. 2001;1471(2): 1–10.
- (5) Carbone M, Klein G, Gruber J, Wong M. Modern Criteria to Establish Human Cancer Etiology. *Cancer Research*. 2004;64: 5518–5524.
- (6) World Health Organization. *Global Health Risks: Mortality and burden of disease attributable to selected major risks*. Geneva: World Health Organization; 2004.
- (7) Williams, M. T. N. G. Hord. The Role of Dietary Factors in Cancer Prevention: Beyond Fruits and Vegetables. *Nutrition in Clinical Practice*. 2005;20(4): 451–459.
- (8) Clapp RW, Howe GK, Jacob M. Environmental and Occupational Causes of Cancer Re-visited. *Journal of Public Health Policy*. 2006;27(1), 61–76.
- (9) World Health Organization. *Preventing disease through healthy environments. Towards an estimate of the environmental burden of disease*. Geneva: World Health Organization; 2006.
- (10) Sage C, Carpenter DO. Public health implications of wireless technologies. *Pathophysiology*. 2009;16(2-3): 233–246.
- (11) Weiderpass E. Lifestyle and Cancer Risk. *Journal of Preventive Medicine and Public Health*. 2010;43(6): 459–471.
- (12) Lennan E. Lifestyle and Prevention. In A. Keen and E. Lennan (eds.) *Women's Cancers, 1st Ed*. Oxford: Blackwell Publishing Ltd; 2011.
- (13) Ay S, Yanikkerem E, Çalım Sİ, Yazıcı M. Health-promoting Lifestyle Behaviour for Cancer Prevention: a Survey of Turkish University Students. *Asian Pacific*

Journal of Cancer Prevention. 2012;13(5): 2269–2277.

- (14) Biolnitiative Working Group. C. Sage D. O. Carpenter (eds.) *Biolnitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Radiation*. Biolnitiative; 2012. <https://bioinitiative.org>
- (15) Novaković B, Jovičić J, Grujičić M. Lifestyle Changes May Prevent Cancer. In Georgakilas AG (ed.) *Cancer Prevention from Mechanisms to Translational Benefits*. Croatia: IntechOpen; 2012.
- (16) Aizer A., Chen MH, McCarthy EP, Mendu ML, Koo S, Wilhite TJ, Graham PL, Choueiri TK, Hoffman KE, Martin NE, Hu JC, Nguyen PL. Marital status and survival in patients with cancer. *Journal of Clinical Oncology*. 2013;31(31): 3869–76.
- (17) Davis D. *Disconnect: The Truth About Cell Phone Radiation, What the Industry Is Doing to Hide It, and How to Protect Your Family*. New York: West 26th Street Press; 2013.
- (18) Espina C, Porta M, Schüz J, Aguado IH, Percival RV, Dora C, Slevin T, Guzman, JR, Meredith T, Landrigan PJ, Neira M. Environmental and Occupational Interventions for Primary Prevention of Cancer: A Cross-Sectorial Policy Framework. *Environmental Health Perspectives*. 2013;121(4): 420–6.
- (19) Norman RE, Carpenter DO, Scott J, Brunea MN, Sly PD. Environmental exposures: an underrecognized contribution to noncommunicable diseases. *Reviews on Environmental Health*. 2013;28(1): 59–65.
- (20) Bellis MA, Hughes K, Leckenby N, Hardcastle KA, Perkins C, Lowey H. Measuring mortality and the burden of adult disease associated with adverse childhood experiences in England: a national survey. *Journal of Public Health*. 2014;37(3): 445–454.
- (21) Blank M. *Overpowered: What Science Tells Us about the Dangers of Cell Phones and Other WiFi-Age Devices*. New York: Seven Stories Press; 2014.
- (22) Carlos S, de Irala J, Hanley M, Martínez-González MÁ. The use of expensive technologies instead of simple, sound and effective lifestyle interventions: a perpetual delusion. *Journal of Epidemiology and Community Health*. 2014;68(9): 897–904.
- (23) Dartois L, Fagherazzi G, Boutron-Ruault, MC, Mesrine S, Clavel-Chapelon F. Association between Five Lifestyle Habits and Cancer Risk: Results from the E3N Cohort. *Cancer Prevention Research*. 2014;7(5): 516–25.

- (24) Ducasse H, Arnal A, Vittecoq M, Daoust SP, Ujvari B, Jacqueline C, Tissot T, Ewald P, Gatenby RA, King KC, Bonhomme F, Brodeur J, Renaud F, Solary E, Roche B, Thomas F. Cancer: an emergent property of disturbed resource-rich environments? Ecology meets personalized medicine. *Evolutionary Applications*. John Wiley Sons Ltd; 2014.
- (25) Morath J, Moreno-Villanueva M, Hamuni G, Kolassa S, Ruf-Leuschner M, Schauer M, Elbert T, Bürkle A, Kolassa IT. Effects of Psychotherapy on DNA Strand Break Accumulation Originating from Traumatic Stress. *Psychotherapy and Psychosomatics*. 2014;83: 289–297.
- (26) Turner, KA. *Radical Remission: Surviving Cancer Against All Odds*. New York: HarperCollins; 2014.
- (27) Vineis P, Wild CP. Global cancer patterns: causes and prevention. *Lancet*. 2014;383(9916): 549–57.
- (28) Ilbawi AM, Anderson BO. Cancer in global health: How do prevention and early detection strategies relate? *Science Translational Medicine*. 2015;7(278): 1–5.
- (29) Sills J. Cancer risk: Role of environment. *Science Magazine*. 2015;347(6223): 727.
- (30) Goltz SEB, Lob-Levyt J. Cancer prevention. In Kerr DJ, Haller DG, van de Velde CJH, Baumann M (eds.) *Oxford textbook of oncology 3rd ed*. Oxford University Press; 2016.
- (31) Golubnitschaja O, Debald M, Yeghiazaryan K, Kuhn W, Pešta M, Costigliola V Grech G. Breast cancer epidemic in the early twenty-first century: evaluation of risk factors, cumulative questionnaires and recommendations for preventive measures. *Tumor Biology*. 2016;37(10): 12941–12957.
- (32) Lu D, Sundström K, Sparén P, Fall K, Sjölander A, Dillner J, Helm NY, Adami, HO, Valdimarsdóttir U, Fang F. Bereavement is associated with an increased risk of HPV infection and cervical cancer: an epidemiological study in Sweden. *Cancer Research*. 2016;76(3): 643–651.
- (33) Béliveau R, Gingras D. *Foods to Fights Cancer: What to eat to reduce your risk*. New York: Penguin Random House; 2017.
- (34) Bhatt AP, Redinbo MR, Bultman SJ. The Role of the Microbiome in Cancer Development Therapy. *Cancer Journal for Clinicians*. 2017;67(4): 326–344.

- (35) Flaherty RL, Owen M, Fagan-Murphy A, Intabli H, Healy D, Patel A, Allen M C, Patel BA, Flint MS. Glucocorticoids induce production of reactive oxygen species/reactive nitrogen species and DNA damage through an iNOS mediated pathway in breast cancer. *Breast Cancer Research*. 2017;19(35): 1–13.
- (36) Torre LA, Islami F, Siegel RL, Ward EM, Jemal A. Global Cancer in Women: Burden and Trends. *Cancer Epidemiology, Biomarkers Prevention Online*. 2017;26(4): 444–457.
- (37) Forman D, Bauld L, Bonanni B, Brenner H, Brown K, Dillner J, Kampman E, Manczuk M, Riboli E, Steindorf K, Storm H, Espina C. Wild CP. Time for a European initiative for research to prevent cancer: A manifesto for Cancer Prevention Europe. *Journal of Cancer Policy*. 2018;17: 1–21.
- (38) Gapstur SM, Brooks PJ. Alcohol and Cancer Risk. In Thun MJ, Linet MS, Cerhan JR, Haiman C, Schottenfeld D (eds.). *Schottenfeld and Fraumeni Cancer Epidemiology and Prevention 4th Ed*. Oxford University Press; 2018.
- (39) Kaleli S, Deveci A, Eskiler, GG. Which environment makes cancer? *Oncology Research and Reviews*. 2018;1(3): 1–4.
- (40) McCullough ML, Willett WC. Diet and Nutrition. In MJ. Thun MJ, Linet MS, Cerhan JR, Haiman C, Schottenfeld D (eds.). *Schottenfeld and Fraumeni Cancer Epidemiology and Prevention 4th Ed*. Oxford University Press. 2018.
- (41) Ashley AK, Kemp CJ. Chapter 9 Chemical Factors In: DeVita VT, Lawrence TS, Rosenberg SA (eds.). *DeVita, Hellman, and Rosenberg's Cancer: Principles Practice of Oncology, 11th ed*. Philadelphia: Wolters Kluwer. 2019.
- (42) Keum N, Song M, Giovannucci EL, Eliassen AH. Obesity and Body Composition. In Thun MJ, Linet MS, Cerhan JR, Haiman C, Schottenfeld D (eds.). *Schottenfeld and Fraumeni Cancer Epidemiology and Prevention 4th Ed*. Oxford University Press; 2018.
- (43) Moore SC, Matthews CE, Keadle S, Patel AV, Lee IM. Physical Activity, Sedentary Behaviors, and Risk of Cancer. In Thun MJ, Linet MS, Cerhan JR, Haiman C, Schottenfeld D (eds.). *Schottenfeld and Fraumeni Cancer Epidemiology and Prevention 4th Ed*. Oxford University Press; 2018.
- (44) Bellis MA, Hughes K, Ford K, Rodriguez GR, Sethi D, Passmore J. Life course health consequences and associated annual costs of adverse childhood experiences across Europe and North America: a systematic review and meta-analysis. *Lancet Public Health*. 2019;4(10): 517–528.

- (45) Koosha M, Raoofi A, Haghghat S, Hatefnia E. A study of lifestyle factors associated with breast cancer patients in Iran. *Ethiopian Journal of Health Development*. 2019;33(3): 160–166.
- (46) Kulhánová I, Znaor A, Shield KD, Arnold M, Vignat J, Charafeddine M, Fadhil I, Fouad H, Al-Omari A, Al-Zahrani AS, El-Basmy A, Shamseddine A, Bray F, Soerjomataram I. Proportion of cancers attributable to major lifestyle and environmental risk factors in the Eastern Mediterranean region. *International Journal of Cancer*. 2020;146(3): 646–656.
- (47) Mercola, J. *EMF*D: 5G, Wi-Fi Cell Phones: Hidden Harms and How to Protect Yourself*. New York: Hay House Inc; 2020.
- (48) Ramanathan G, Hoover BM, Fleischman AG. Impact of Host, Lifestyle and Environmental Factors in the Pathogenesis of MPN. *Cancers*. 2020;12(2038): 1–15.
- (49) American Association for Cancer Research. *Cancer Progress Report*. 2021. https://cancerprogressreport.aacr.org/aacr_cpr_2021/
- (50) Balwan WK, Kour S. Lifestyle Diseases: The Link between Modern Lifestyle and Threat to Public Health. *Saudi Journal of Medical and Pharmaceutical Sciences*. 2021;7(4): 179–184.
- (51) Myers DJ, Hoppin P, Jacobs M, Clapp R, Kriebel D. Cancer rates not explained by smoking: a county-level analysis. *Environmental Health*. 2020;19(64): 1–10. Currently, “most cancer prevention messaging focuses on reducing cigarette smoking and changing other personal behaviors with little mention of environmental chemicals, despite widespread exposure to many known carcinogens.” Instead, “cancer prevention strategies should focus not only on lifestyle changes but also the likely contributions of the full range of risk factors, including environmental/occupational carcinogens” (p. 1).

PPT slide 3: Integrated Approach

- (1) Kachuri L, Graff RE, Smith-Byrne K, Meyers TJ, Rashkin SR, Ziv E, Witte JS, Johansson M. Pan-cancer analysis demonstrates that integrating polygenic risk scores with modifiable risk factors improves risk prediction. *Nature Communications*. 2020;11(6084): 1–11.
- (2) Michels KB, Willett WC. Chapter 11 Dietary Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (3) Lee ME , Lichtenstein E, Andrews JA, Glasgow RE, Hampson SE. Radon-smoking synergy: A population-based behavioral risk reduction approach. *Preventive medicine*. 1999;29(3): 222–7.
- (4) Ljungman M. Chapter 10 Physical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (5) Gharibvand L, Shavlik D, Ghamsary M, Beeson WL, Soret S, Knutsen R, Knutsen, SF. The Association between Ambient Fine Particulate Air Pollution and Lung Cancer Incidence: Results from the AHSMOG-2 Study. *Environmental Health Perspectives*. 2017;125(3): 378–384.
- (6) Nyberg F, Gustavsson P, Lars J, Bellander T, Berglind N, Jakobsson R, Pershagen G. Urban Air Pollution and Lung Cancer in Stockholm. *Epidemiology*. 2000;11(5): 487–495.
- (7) Wu S, Zhu W, Thompson P, Hannun YA. Evaluating intrinsic and non-intrinsic cancer risk factors. *Nature Communications*. 2018;9(3490): 1–12.
Intrinsic and non-intrinsic table graphic from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6113228/bin/41467_2018_5467_Fig1_HTML.jpg
- (8) Salk JJ, Kennedy SR. Next-Generation Genotoxicology: Using Modern Sequencing Technologies to Assess Somatic Mutagenesis and Cancer Risk. *Environmental and Molecular Mutagenesis*. 2020;61(1): 135–151.
“Mutations arise as a result of repair and replication errors due to endogenous processes and environmental factors” (p. 136).
- (9) Ljungman M. Chapter 10 Physical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (10) Casey SC, Amedei A, Aquilano K, Azmi AS, Benencia F, Bhakta D, Bilsland AE,

Boosani CS, Chen S, Ciriolo MR, Crawford S, Fujii H, Georgakilas AG, Guha G, Halicka D, Helferich WG, Heneberg P, Honoki K, Keith WN, Kerkar SP, Mohammed SI, Niccolai E, Newsheen S, Rupasinghe HPV, Samadi A, Singh N, Talib WH, Venkateswaran V, Whelan RL, Yang X, Felsher DW. Cancer prevention and therapy through the modulation of the tumor microenvironment. *Seminars in Cancer Biology*. 2015;35: 199–223.

- (11) Zubair H, Khan MA, Anand S, Srivastava SK, Singh S, Singha AP. Modulation of the tumor microenvironment by natural agents: implications for cancer prevention and therapy. *Seminars in Cancer Biology*. 2021: 1–42.

Figure: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7688484/figure/F2/>

- (12) Brenner DE, Lippman SM. Chapter 35 Cancer Risk-Reducing Agents In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

- (13) Dominiak A, Chełstowska B, Olejarz W, Nowicka G. Communication in the Cancer Microenvironment as a Target for Therapeutic Interventions. *Cancers*. 2020;12(1232): 1–24.

- (14) Riol A, Cervera J, Levin M, Mafe S. Cell Systems Bioelectricity: How Different Intercellular Gap Junctions Could Regionalize a Multicellular Aggregate. *Cancers*. 13(5300): 1–23.

- (15) Tripathi A, Kashyap A, Tripathi G, Yadav J, Bibban R, Aggarwal N, Thakur K, Chhokar A, Jadli M, Sah AK, Verma Y, Zayed H, Husain A, Bharti AC, Kashyap MK. Tumor reversion: a dream or a reality. *Biomarker Research*. 2021;9(31): 1–27.

- (16) Green MD, Zou W. Chapter 8 Inflammation In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

- (17) Eltzschig HK, Carmeliet P. Hypoxia and Inflammation. *The New England Journal of Medicine*. 2011;364(7): 656–665.

- (18) Biddlestone J, Bandarra D and Rocha S. The role of hypoxia in inflammatory disease. *International Journal of Molecular Medicine*. 2015;35: 859-869.

- (19) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.

One myelodysplastic patient “went from being considered for a five-organ transplant as she lay in the ICU, deathly ill, to being managed by aspirin alone”

(p. 104).

- (20) Brenner DE, Lippman SM. Chapter 35 Cancer Risk-Reducing Agents In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (21) Bibbins-Domingo K, on behalf of the U.S. Preventive Services Task Force. Aspirin Use for the Primary Prevention of Cardiovascular Disease and Colorectal Cancer. *Annals of Internal Medicine.* 2016;164: 836–845.
- (22) Chubak J, Kamineni A, Buist DSM, Anderson ML, Whitlock EP. Aspirin Use for the Prevention of Colorectal Cancer: An Updated Systematic Evidence Review for the U.S. Preventive Services Task Force. *Evidence Syntheses.* 2015;133: 1–127.
- (23) Hatfield SM, Kjaergaard J, Lukashev D, Schreiber TH, Belikoff B, Abbott R, Sethumadhavan S, Philbrook P, Ko K, Cannici R, Thayer M, Rodig S, Kutok JL, Jackson EK, Karger B, Podack ER, Ohta A, Sitkovsky MV. Immunological mechanisms of the antitumor effects of supplemental oxygenation. *Science Translational Medicine.* 2015;7(277): 1–23.
- (24) Marrone O, Bonsignore M. Obstructive sleep apnea and cancer: a complex relationship. *Current Opinion in Pulmonary Medicine.* 2020;26(6): 657–667.
Obstructive sleep apnea (OSA) has been recognized as a risk factor for cancer mainly through hypoxia: “Time spent with oxygen saturation below 90% ... strongly associated with unfavorable effects on cancer. Experimental studies support the role of hypoxia as an important risk factor for cancer growth and aggressiveness ... largely mediated by the hypoxia-inducible factor, which controls the synthesis of molecules with effects on inflammation, immune surveillance and cell proliferation. Sleep fragmentation” thus increases cancer risk (p. 657).
- (25) Boedtkjer E, Pedersen SF. The Acidic Tumor Microenvironment as a Driver of Cancer. *Annual Review of Physiology.* 2020;82(1): 103–126.
(cf. pp. 103–106)
- (26) Andreucci E, Peppicelli S, Ruzzolini J, Bianchini F, Biagioni A, Papucci L, Magnelli L, Mazzanti B, Stecca B, Calorini L. The acidic tumor microenvironment drives a stem-like phenotype in melanoma cells. *Journal of Molecular Medicine.* 2020;98: 1431–1446.

PPT slide 4: Prevention is Vital: Late-stage cancer is difficult to treat effectively

Problem 1: The majority of cancer therapeutic drugs harm patients without improving overall survival⁽¹⁾.

- (1) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
“The 5 percent of drugs that reach [FDA] approval might as well have failed, since they prolong survival of patients by no more than a few months at best.
“Since 2005, 70 percent of [FDA] approved drugs have shown zero improvement in survival rates while up to 70 percent have been actually harmful to patients”
(p. 11).
- (2) Hess LM, Brnabic A, Mason O, Lee P, Barker S. Relationship between Progression-free Survival and Overall Survival in Randomized Clinical Trials of Targeted and Biologic Agents in Oncology. *Journal of Cancer*. 2019;10(16): 3717–3727.
(cf. pp. 3722–3)
- (3) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
(cf. p. 109)

Problem 2: New therapies often only offer a short improvement on previous therapies⁽⁴⁾.

- (4) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
(cf. p. 14)
- (5) Szabo L. Dozens Of New Cancer Drugs Do Little To Improve Survival, Frustrating Patients. Kaiser Family Foundation. [Internet]. 2017 Feb 9 [cited 2022 Jan 2]. News. Available from: <https://khn.org/news/dozens-of-new-cancer-drugs-do-little-to-improve-survival-frustrating-patients/>
- (6) Foster CC, Sher DJ, Rusthoven CG, Verma V, Spiotto MT, Weichselbaum RR, Koshy M. Overall survival according to immunotherapy and radiation treatment for metastatic non-small-cell lung cancer: a National Cancer Database analysis. *Radiation Oncology*. 2019;14(18): 1–13.
Stereotactic radiotherapy (SRT) + immunotherapy = 18.2 month OS,
whereas SRT + chemotherapy = 14.3 month OS (p.1).

- (7) Park S, Lee SY, Kim D, Sim SU, Ryu J-S, Choi J, Lee SH, Ryu YJ, Lee JH, Chang JH. Comparison of epidermal growth factor receptor tyrosine kinase inhibitors for patients with lung adenocarcinoma harboring different epidermal growth factor receptor mutation types. *BioMed Central Cancer*. 2021;21:52: 1–9.
Gefitinib 48.4 months OS compared to afatinib 39.1 months OS in handling patients with L858R mutation, but performed worse in handling uncommon mutations (p. 1).
- (8) Ito K, Morise M, Wakuda K, Hataji O, Shimokawaji T, Takahashi K, Furuya N, Takeyama Y, Goto Y, Abe T, Kato T, Ozone S, Ikeda S, Kogure Y, Yokoyama T, Kimura M, Yoshioka H, Murotani K, Kondo M, Saka H. A multicenter cohort study of osimertinib compared with afatinib as first-line treatment for EGFR-mutated non-small-cell lung cancer from practical dataset: CJLSG1903. *European Society for Medical Oncology Open*. 2021;6(3): 1–8.
- (9) Chau CH, Figg WD. Chapter 28 Antiangiogenesis Agents. In DeVita VT, Lawrence TS, Rosenberg SA. *DeVita, Hellman & Rosenberg's Cancer: Principles and Practice of Oncology, 10th ed.* 2015.

Problem 3: Surgery and radiation are unlikely to cure cancer which has spread beyond what may be excised or irradiated⁽¹⁰⁾⁽¹¹⁾.

- (10) Mukherjee S. *The Emperor of All Maladies: A Biography of Cancer*. London: Fourth Estate; 2011.
“Surgery and radiation ... fail when cancer cells have spread beyond the limits of what can be surgically removed or irradiated” (p. 406).
- (11) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
Approximately 90% of cancer mortality is due to advanced disease - metastases (p. 52)

Problem 4: Therapeutics which target cell growth may cause illness or death before cure is achieved⁽¹⁰⁾⁽¹²⁾.

- (10) Mukherjee S. *The Emperor of All Maladies: A Biography of Cancer*. London: Fourth Estate; 2011.
“Targeting cellular growth also hits a biological ceiling because normal cells must grow as well” (p. 406)
- (12) Walko CM, McLeod HL. Chapter 19 Pharmacogenomics In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer:*

Principles & Practice of Oncology, 11th ed. Philadelphia: Wolters Kluwer. 2019.

Issue 1: Chemotherapy can weaken our immune system which fights cancer, and is carcinogenic, along with radiotherapy (RT)⁽¹³⁾⁽¹⁴⁾⁽¹⁵⁾⁽¹⁶⁾.

(13) Park DS, Robertson-Tessi M, Luddy KA, Maini PK, Bonsall MB, Gatenby RA, Anderson ARA. The Goldilocks Window of Personalized Chemotherapy: Getting the immune response just right. *Cancer Research*. 2019;79(20): 5302–15.

“High-dose chemotherapy, however, depletes memory cells faster and leads to declining CTL responses and concurrent tumor escape” (p. 5307).

(14) Fung C, Bhatia S, Allan JM, Oeffinger KC, Ng A, Travis, LB. Chapter 135 Second Cancers In: *DeVita VT, Lawrence TS, Rosenberg SA. (eds.) DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

(15) Ljungman M. Chapter 10 Physical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

(16) Ashley AK, Kemp CJ. Chapter 9 Chemical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

Some chemotherapeutics are more carcinogenic than others.

For example, watch out for chlorambucil, cyclophosphamide, etoposide, melphalan, “MOPP and other combined chemotherapy including alkylating agents”, tamoxifen, thiotepa, treosulfan

Issue 2: Cancer often presents as heterogeneous, more so in metastatic late-stage disease, and genome chaos, chromothripsis, exacerbates diversity⁽¹⁷⁾⁽¹⁸⁾⁽¹⁹⁾⁽²⁰⁾⁽²¹⁾⁽²²⁾.

(17) Heng HH. *Debating Cancer: The paradox in cancer research*. London: World Scientific Publishing. 2016.

(cf. p.254)

(18) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.

“the evolving, expanding, transforming, invading, regressing, recovering, transmuting population of malignant cells in vivo” is vastly heterogenous

(p. 232)

Diversity seems likely given the large number of cells present in a late-stage presentation:

Whereas early presentation might be 0.1 cubic mm, “approximately three hundred thousand malignant cells”, or even 1 cubic mm, “three million cells”, 1 cubic cm of “tumor contains roughly three billion cells”!
(p. 233)

- (19) Heng HH. *Genome Chaos: Rethinking genetics, evolution and molecular medicine*. London: Academic Press. 2019.

(cf. p.44)

Book cover picture edited from Amazon: <https://www.amazon.com/>

Genome-Chaos-Rethinking-Evolution-Molecular-ebook/dp/B07SB52V5D

- (20) Cortés-Ciriano I, Lee JJ-K, Xi R, Jain D, Jung YL, Yang L, Gordenin D, Klimczak LJ, Zhang C-Z, Pellman DS, PCAWG Structural Variation Working Group, Park PJ, PCAWG Consortium. Comprehensive analysis of chromothripsis in 2,658 human cancers using whole-genome sequencing. *Nature Genetics*. 2020;52: 331–341.

“Chromothripsis events are pervasive across cancers, with a frequency of more than 50% in several cancer types” (p. 1).

- (21) Ye CJ, Liu G, Heng HH. Chapter 21 Experimental Induction of Genome Chaos In F Pellestor (ed.) *Chromothripsis: Methods and Protocols*. New York: Humana Press.

“Various chaotic genomes were detected within nearly all types of cancers”

(p. 338).

Book picture from <https://www.amazon.com/Chromothripsis>

-Methods-Protocols-Molecular-Biology -dp-1493977792/dp/1493977792

- (22) Shorokhova M, Nikolsky N, Grinchuk, T. Chromothripsis—Explosion in Genetic Science. *Cells*. 2021;10(1102): 1–15.

Issue 3: Chemotherapy may not eliminate every cancerous cell, adapted clonal subpopulations survive and regrow, so targeted therapies often fail⁽²³⁾⁽²⁴⁾⁽²⁵⁾⁽²⁶⁾.

- (23) Vendramin R, Litchfield K, Swanton C. *Cancer evolution: Darwin and beyond*. European Molecular Biology Organization Journal. 2021;40: e108389.

Graphs extracted from their figure: [https://www.embopress.org/cms/asset/](https://www.embopress.org/cms/asset/05bf5e92-0d80-455a-8e57-a64e60a9ed49/embj2021108389-fig-0001-m.jpg)

05bf5e92-0d80-455a-8e57-a64e60a9ed49/embj2021108389-fig-0001-m.jpg

- (24) Cabanos HF, Hata AN. Emerging Insights into Targeted Therapy-Tolerant Persister Cells in Cancer. *Cancers*. 2021;13(2666): 1–26.

- (25) Pasha N, Turner NC. Understanding and overcoming tumor heterogeneity in metastatic breast cancer treatment. *Nature Cancer*. 2021;2: 680–692.

- (26) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
(cf. p.112)

Issue 4: Cancer therapy may induce genome chaos, increasing genetic change⁽²⁷⁾⁽²⁸⁾⁽²⁹⁾.

- (27) Heng HH. *Genome Chaos: Rethinking genetics, evolution and molecular medicine*. London: Academic Press. 2019.
(cf. pp. 153, 181, and the discussion throughout)
- (28) Ye JC, Horne S, Zhang JZ, Jackson L, Heng HH. Therapy Induced Genome Chaos: A Novel Mechanism of Rapid Cancer Drug Resistance. *Frontiers in Cell and Developmental Biology*. 2021; 9: 676344.
- (29) Heng E, Moy A, Liu G, Heng HH, Zhang K. ER Stress and Micronuclei Cluster: Stress Response Contributes to Genome Chaos in Cancer. *Frontiers in Cell and Developmental Biology*. 2021; 9:673188.

Issue 5: Polyploid giant cancer cells (PGCCs) may cause cancer, are stress induced, and might survive chemotherapy and RT⁽³⁰⁾⁽³¹⁾⁽³²⁾.

- (30) Kuczler MD, Olseen AM, Pienta KJ, Amend SR. ROS-induced cell cycle arrest as a mechanism of resistance in polyan euploid cancer cells (PACCs). *Progress in Biophysics and Molecular Biology*. 2021;165 (2021): 3–7.
- (31) Song Y, Zhao Y, Deng Z, Zhao R, Huang Q. Stress-Induced Polyploid Giant Cancer Cells: Unique Way of Formation and Non-Negligible Characteristics. *Frontiers in Oncology*. 2021;11(724781): 1–13.
- (32) Liu J. The "life code": A theory that unifies the human life cycle and the origin of human tumors. *Seminars in Cancer Biology*. 2020;60: 380–397.
- (33) Virchow R. (1860). *Cellular Pathology, as Based upon Physiological and Pathological Histology, 7th ed*. New York, NY: Robert M. De Witt.

Issue 6: RT and chemotherapy tissue impact may exacerbate cancer⁽³⁴⁾⁽³⁵⁾⁽³⁶⁾⁽³⁷⁾.

- (34) Sonnenschein C, Soto A. Carcinogenesis explained within the context of a theory of organisms. *Progress in Biophysics and Molecular Biology*. 2016;122(1): 1–8.

- (cf. p. 6)
- (35) Bejarano L, Jordao MJC, Joyce JA. Therapeutic Targeting of the Tumor Microenvironment. *Cancer Discovery*. 2021;11: 933–59.
“Radiotherapy and chemotherapies can increase the presence of immunosuppressive TAMs in tumors, protecting the cancer cells from therapy-induced cell death, which may ultimately lead to tumor recurrence” (p. 934).
- (36) Green MD, Zou W. Chapter 8 Inflammation In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (37) Jordan CT, Guzman ML, Noble M. Mechanisms of Disease: Cancer stem cells. *The New England Journal of Medicine*. 2006;355(12): 1253–1261.
(cf. p. 1258)
- (38) Zhang DY, Monteiro MJ, Liu JP, Gu WY. Mechanisms of cancer stem cell senescence: Current understanding and future perspectives. *Clinical and Experimental Pharmacology and Physiology*. 2021;48: 1185–1202.
Zhang et al. note that PGCCs were “detected in about 37%” of human tumors, and go on to describe evidence suggesting that chemotherapeutics and RT induce senescence which results in the generation of cancer stem cells (CSC) (p. 1192).
Their illustration (cf. p. 1193) was edited from their powerpoint.
<https://onlinelibrary.wiley.com/action/downloadFigures?id=cep13528-fig-0001&doi=10.1111%2F1440-1681.13528>
- (39) Samanta D, Gilkes DM, Chaturvedi P, Xiang L, Semenza GL. Hypoxia-inducible factors are required for chemotherapy resistance of breast cancer stem cells. *The Proceedings of the National Academy of Sciences*. 2014;111(50): 5429–543.
- (40) He-Ming Zhou HM, Zhang JG, Zhang X, Li Q. Targeting cancer stem cells for reversing therapy resistance: mechanism, signaling, and prospective agents. *Signal Transduction and Targeted Therapy*. 2021;6(62): 1–17.
- (41) Malik B, Nie D. Cancer stem cells and resistance to chemo and radiotherapy. *Frontiers in Bioscience*. 2012;1(4): 2142–9.
- (42) Dawood S, Austin L, Cristofanilli M. Cancer stem cells: Implications for cancer therapy. *Oncology*. 2014;28(12): 1101–1110.
- (43) Jiang W, Peng J, Zhang Y, Cho WCS, Jin K. The implications of cancer stem cells for cancer therapy. *International Journal of Molecular Sciences*. 2012;13(12): 16636–57.

PPT slide 5: Positive Reasons to Embrace Prevention: Success stories

- (1) World Health Organization. *Guide to cancer early diagnosis*. Geneva: World Health Organization; 2017.
“Prevention is the most cost-effective public health strategy in NCD control”
(p. 6).
- (2) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
Screening and early detection in recent decades has reduced overall US cancer mortality by 25% or more.
(cf. p. 236)
- (3) Prevent Cancer Foundation. *Cervical Cancer: A Prevention Success Story*
January 12, 2011. Accessible at: <https://www.preventcancer.org/2011/01/cervical-cancer-a-prevention-success-story/>
“Cervical cancer has become the ultimate preventable cancer success story. The Pap test, developed in the late 1920s and first widely used in the 1940s, was adopted as an essential screening tool for early detection and treatment, and in turn lowered the cervical cancer mortality rate by over 70%. More recently, another leap in cervical cancer prevention was made possible with the development of the HPV vaccine.”
- (4) Roser M. Cigarette sales and lung cancer mortality in the US. OurWorldinData.
<https://ourworldindata.org/smoking-big-problem-in-brief>
Picture retrieved from <https://ourworldindata.org/uploads/2021/07/Smoking-and-lung-cancer-mortality-US-only.png>

PPT slide 6: Overview of Prevention

- (1) World Health Organization. *Guide to cancer early diagnosis*. Geneva: World Health Organization; 2017.
Figure from p. 9.
- (2) Brenner DE, Lippman SM. Chapter 35 Cancer Risk-Reducing Agents In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (3) World Health Organization. *Global Action Plan for the Prevention and Control of NCDs 2013-2020*. Geneva: World Health Organization; 2013.
<https://apps.who.int/iris/rest/bitstreams/442296/retrieve>
“While deaths from noncommunicable diseases mainly occur in adulthood, exposure to risk factors begins in childhood and builds up throughout life...”
(p. 29).
- (4) Salk JJ, Kennedy SR. Next-Generation Genotoxicology: Using Modern Sequencing Technologies to Assess Somatic Mutagenesis and Cancer Risk. *Environmental and Molecular Mutagenesis*. 2020;61(1): 135–151.
Picture accessible at: <https://www.researchgate.net/publication/336364848/figure/fig1/AS:857797839294464@1581526350184/The-genesis-of-cancer-Cancer-exists-on-a-continuum-Mutations-arise-as-a-result-of.png>,
Also available at: <https://onlinelibrary.wiley.com/action/downloadFigures?id=em22342-fig-0001&doi=10.1002%2Fem.22342>
- (5) Raza A. *The First Cell And the Human Costs of Pursuing Cancer to the Last*. New York: Basic Books; 2020.
(cf. pp. 14 & 236–243)

**PPT slide 7: Lifestyle-related Environmental Exposures to Avoid:
Chemical Carcinogenic Factors⁽¹⁾**

- (1) Ashley AK, Kemp CJ. Chapter 9 Chemical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) Warren G, Simmons VN. Chapter 33 Tobacco Use and the Cancer Patient In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (3) U.S. Food and Drug Administration. FDA Permits Marketing of E-Cigarette Products, Marking First Authorization of Its Kind by the Agency: Agency Also Denies Applications for Flavored Products for Failing to Demonstrate that Marketing of These Products Would Be Appropriate for the Protection of Public Health. FDA News Release. [October 12, 2021] Accessible at: <https://www.fda.gov/news-events/press-announcements/fda-permits-marketing-e-cigarette-products-marking-first-authorization-its-kind-agency>
- (4) Ljungman M. Chapter 10 Physical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (5) World Health Organization. *Prevention (Cancer control: knowledge into action)*. Geneva: World Health Organization; 2017.
universal infant HBV immunization recommended
(p. 30)
- (6) US Environmental Protection Agency Office of Pesticide Programs. *Chemicals Evaluated for Carcinogenic Potential Annual Cancer Report 2020*. Accessible at: http://npic.orst.edu/chemicals_evaluated.pdf
There is suggestive, probable or likely "evidence of carcinogenic potential" of:
Acetochlor, Acifluorfen sodium, Alachlor, Ametryn, Amisulbrom, Amitraz, Anthraquinone, Benalaxyl-M, Benfluralin, Benthiavalicarb-isopropyl, Bicyclopyrone, Bioallethrin, Boscalid, Buprofezin, Butachlor, Captafol, Captan, Carbaryl, Chlordimeform, Chlorfenapyr, (p-)Chloroaniline, Chlorothalonil, Clodinafop-propargyl, CMNP (Pyrazachlor), Cocamide Diethanolamine, Cumyluron, Cyflufenamid, Cyflumetofen, Daminozide, Dichlorvos, Diclofop-methyl, Dicloran, Dicrotophos, Diethofencarb, Difenconazole, Dimethoxane, Dithianon, Diuron, Epoxiconazole, Esbiothrin, Ethaboxam, Ethiprole, Ethoprop, Ethylene thiourea (ETU), Fenoxaprop-ethyl, Fenoxycarb, Fenpicoxamid (XDE-777), Fenpropidin, Ferbam, Flonicamid, Fluazinam,

Fluensulfone, Fluthiacet methyl, Furfural, Furfuryl Alcohol, Furilazole (MON 13900), Furmecyclox, Haloxyfop-methyl, Hexavalent Chromium (CrVI), Hexythiazox, Imazalil, Imazalil sulfate, Iprodione, Iprovalicarb, Isopyrazam, Isoxaben, Isoxaflutole, Kresoxim-methyl, Lactofen, Lindane, Malathion, Mancozeb, Maneb, Mecoprop-P, Mepanipyrim, Metaldehyde, Metam sodium, Methyl isothiocyanate (MITC), Metiram, Metrafenone, Molinate, MON 4660, Noviflumuron, Orthosulfamuron, Oryzalin, Oxadiazon, Oxyfluorfen, Oxythioquinox, Paraformaldehyde, Penflufen, Penoxulam, Pentachlorophenol, Penthioopyrad, Permethrin, Pethoxamid, PHMB, Phosmet, Picoxystrobin, Pirimicarb, Potassium dichromate, Procymidone, Propachlor, Propanil, Propargite, Propineb, Propoxur, Propylene Oxide, Proquinazid, Pymetrozine, Pyraflufen ethyl, Pyrasulfotole, Resmethrin, S-Bioallethrin, Sedaxane, Solatenol, Spirodiclofen, Sulfoxaflor, Tebufenpyrad, Teflubenzuron, Telone, Tembotrione, Terrazole, Tetrachlorvinphos, Thiabendazole, Thiacloprid, Thiazopyr (MON 13200), Thiodicarb, Thiophanate-methyl, Tolpyralate, Tolyfluanid, Tralkoxydim, Tribufos, Trichlorfon, Triforine, Triphenyltin hydroxide (TPTH), UDMH, Ziram

Many more chemicals are possible or have not yet been well-evaluated.

**PPT slide 8: Lifestyle-related Environmental Exposures to Avoid:
Biological Carcinogenic Factors**

- (1) Buck CB, Ratner L, Tosato G. Chapter 7 Oncogenic Viruses In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) World Health Organization. *Comprehensive Cervical Cancer Control: A guide to essential practice 2nd ed.* Geneva: World Health Organization; 2014.
Cervical cancer can be prevented through HPV vaccination (esp. girls 9-13), sexual education, condom promotion and provision, and circumcision, and HPV testing of women over 30 can help identify those at risk (p. 52).
- (3) World Health Organization. *Prevention (Cancer control: knowledge into action).* Geneva: World Health Organization; 2017.
universal infant HBV immunization recommended
(p. 30, cf. p. 38)
- (4) Ashley AK, Kemp CJ. Chapter 9 Chemical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (5) Isaguliantz M, Bayurova E, Avdoshina D, Kondrashova A, Chiodi F, Palefsky JM. Oncogenic Effects of HIV-1 Proteins, Mechanisms Behind. *Cancers.* 2021;13(305): 1–23.
- (6) Mawa PA, Kincaid-Smith J, Tukahebwa EM, Webster JP, Wilson S. Schistosomiasis Morbidity Hotspots: Roles of the Human Host, the Parasite and Their Interface in the Development of Severe Morbidity. *Frontiers in Immunology.* 2021;12(635869): 1–21.
- (7) Global Health, Division of Parasitic Diseases and Malaria. Schistosomiasis Parasites: Prevention & Control. U.S. Department of Health & Human Services: Centers for Disease Control and Prevention; 2020.
<https://www.cdc.gov/parasites/schistosomiasis/prevent.html>
- (8) Mukherjee S. *The Emperor of All Maladies: A Biography of Cancer.* London: Fourth Estate; 2011.
(cf. pp. 281–284).

**PPT slide 9: Lifestyle-related Environmental Exposures to Avoid:
Physical Carcinogenic Factors⁽¹⁾**

- (1) Ljungman M. Chapter 10 Physical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) World Health Organization. *Prevention (Cancer control: knowledge into action)*. Geneva: World Health Organization; 2017.
(p. 43)
- (3) Ashley AK, Kemp CJ. Chapter 9 Chemical Factors In: *DeVita VT, Lawrence TS, Rosenberg SA. (eds.) DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (4) Michels KB, Willett WC. Chapter 11 Dietary Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (5) Lantz PM, Mendez D, Philbert MA. Radon, Smoking, and Lung Cancer: The Need to Refocus Radon Control Policy. *American Journal of Public Health*. 2013; 103(3): 443–447.
- (6) Agency for Toxic Substances and Disease Registry. *Toxicological Profile for Radon*. U.S. Department of Health and Human Services; 2012. https://www.ncbi.nlm.nih.gov/books/NBK158784/pdf/Bookshelf_NBK158784.pdf
The advantage of carbon detection is low-cost, whereas radon alpha track detector can be reused (p. 150).
- (7) Agency for Toxic Substances and Disease Registry. *Case Studies in Environmental Medicine: Radon Toxicity*. U.S. Department of Health & Human Services: Centers for Disease Control and Prevention; 2010. <https://www.atsdr.cdc.gov/csem/radon/radon.pdf>
Radon is the second leading cause of lung cancer (p. 14)
Radon is a radioactive gas which releases from “rock, soil, water, and building materials” (p. 13).
“Because radon is a noble gas, it is colorless, odorless, tasteless, and imperceptible to the senses” (p. 12).
“Under most conditions, the indoor radon concentration increase is in direct proportion to the ventilation rate decrease” (p. 83).
“Other factors found to predispose homes to increased levels of radon include
 - Building ventilation rates,

- Entry points for soil gas,
- Foundation type,
- Location,
- Soil porosity,
- Source of water supply, and
- Type of building materials used" (p. 83).

(8) Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ. Heavy Metals Toxicity and the Environment. *Experientia Supplementa*. 2012; 101: 133–164.

Heavy metals’ “multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment; raising concerns over their potential effects on human health and the environment. Their toxicity depends on several factors including the dose, route of exposure, and chemical species.... Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority” public health (p. 103).

Beware electromagnetic fields (EMFs) near electronics. Ex. phone kept on skin⁽⁹⁾⁽¹⁰⁾⁽¹¹⁾.

(9) Davis, D. (2013). *Disconnect: The Truth About Cell Phone Radiation, What the Industry Is Doing to Hide It, and How to Protect Your Family*. West 26th Street Press.

(10) Blank, M. (2014). *Overpowered: What Science Tells Us about the Dangers of Cell Phones and Other WiFi-Age Devices*. Seven Stories Press.

(11) Mercola, J. (2020). *EMF*D: 5G, Wi-Fi & Cell Phones: Hidden Harms and How to Protect Yourself*. Hay House Inc.

PPT slide 10: Lifestyle-related Environmental Exposures to Avoid: Dietary Carcinogenic Factors⁽¹⁾

- (1) Michels KB, Willett WC. Chapter 11 Dietary Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) Brown JC, Meyerhardt JA, Ligibel JA. Chapter 12 Obesity and Physical Activity In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (3) Ashley AK, Kemp CJ. Chapter 9 Chemical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (4) World Health Organization. *Global Action Plan for the Prevention and Control of NCDs 2013-2020.* Geneva: World Health Organization; 2013.
<https://apps.who.int/iris/rest/bitstreams/442296/retrieve>
Health education is vital to prevent “harmful use of alcohol and to protect children from adverse impacts of marketing” (p. 29)
- (5) World Health Organization. *Prevention (Cancer control: knowledge into action).* Geneva: World Health Organization; 2017.
“Promote educational and information campaigns about reducing salt, sugar and fat consumption and eliminating cooking and preservation methods known to increase cancer risk, for example aflatoxins” (p. 29).
- (6) Kumar P, Mahato DK, Kamle M, Mohanta TK, Kang SG. Aflatoxins: A Global Concern for Food Safety, Human Health and Their Management. *Frontiers in Microbiology.* 2017;7(2170): 1–10.
“Aflatoxin producing fungi ... have severely contaminated food supplies”, usually cereals, wheat, corn and nuts, “in the field, or during harvest, transport and storage” and aflatoxins in feedstuff can result in contaminated eggs, milk and meat products (p. 4).
- (7) National Cancer Institute. Aflatoxins. U.S. Department of Health and Human Services. [December 28, 2018] Accessible at: <https://www.cancer.gov/about-cancer/causes-prevention/risk/substances/aflatoxins>
- (8) Turner, K. A. (2014). *Radical Remission: Surviving Cancer Against All Odds.* HarperCollins.

Drink filtered water.
(cf. pp. 28-33).

- (9) Evans S, Campbell C, Naidenko OV. Cumulative risk analysis of carcinogenic contaminants in United States drinking water. *Heliyon*. 2019;5(2314): 1-9.
Drinking water may contain “arsenic, disinfection byproducts and radioactive contaminants” responsible for an estimated 100,000 US cancer cases.
- (10) Vemuri SB, Rao CS, Darsi R, Reddy H, Aruna M, Ramesh B, Swarupa S. Methods for Removal of Pesticide Residues in Tomato. *Food Science and Technology*. 2014;2(5): 64-68.
- (11) Rani GB, Sri CNS, Rishita Y, Saikia N, Rao CS. Domestic methods for the removal of pesticide residues in chilies. *Journal of Pharmacognosy and Phytochemistry*. 2019;8(4): 2690-3.
- (12) Reddy SS, Reddy CN, Reddy AA, Rao AM, Reddy SN. Risk mitigation methods for different pesticides on Indian bean for food safety. *Journal of Entomology and Zoology Studies* 2020; 8(6): 2010-2017.
Improvement on the 2% saline method: 4% Acetic Acid = typical vinegar
+ 0.1% NaHCO₃ = 1.0g/L baking soda + 1 lemon/L
- (13) Alcohol and Drug Foundation. Betel nut. Alcohol and Drug Foundation; 2021.
Accessible at: <https://adf.org.au/drug-facts/betel-nut/>
Betel nut, “also known as areca nut” is a stimulant with many side effects.
- (14) Athukorala IA, Tilakaratne WM, Jayasinghe RD. Areca Nut Chewing: Initiation, Addiction, and Harmful Effects Emphasizing the Barriers and Importance of Cessation. *Journal of Addiction*. 2021;2021(9967097): 1–9.
Areca is “a highly addictive substance with carcinogenic properties” (p. 1).
- (15) Bedi R, Scully C. Tropical Oral Health In Farrar J, Hotez, PJ, Junghanss T, Kang G, Lalloo D, White NJ (Eds.) *Manson's Tropical Infectious Diseases 23rd Ed.*, 2014: 1073–1083.
Areca chewing is “the fourth most common addiction globally following tobacco, alcohol and caffeine” (p. 1076).
- (16) Cox S, Ullah M, Zoellner H. Chapter 78 Oral and Systemic Health Effects of Compulsive Areca Nut Use. *Neuropathology of Drug Addictions and Substance Misuse Vol. 3: General Processes and Mechanisms, Prescription Medications, Caffeine and Areca, Polydrug Misuse, Emerging Addictions and Non-Drug Addictions*. *Academic Press*; 2016: 785-793.
Areca is “the fourth most used drug after nicotine, alcohol, and caffeine”

- (17) Sui C, Lacey A. Asia's deadly secret: The scourge of the betel nut. 2015
 BBC Health Check. BBC News [22 March 2015]
<https://www.bbc.com/news/health-31921207>
 Areca is “used by almost a tenth of the world’s population.”
- (18) Athukorala IA, Tilakaratne WM, Jayasinghe RD. Areca Nut Chewing: Initiation, Addiction, and Harmful Effects Emphasizing the Barriers and Importance of Cessation. *Journal of Addiction*. 2021;2021(9967097): 1–9.
 Betel chewing alters oral pH, causing inflammation leading to oral cancer and contributing to esophageal, liver, pancreatic, laryngeal and lung cancer (p. 2).
 Lack of education regarding harmful effects has been an obstacle to cessation (p. 3).
- (19) Pankaj C. Areca Nut or Betel Nut Control is Mandatory if India Wants to Reduce the Burden of Cancer Especially Cancer of the Oral Cavity. *International Journal of Head and Neck Surgery*, January-April 2010;1(1):17–20.
 Several reports linked the areca nut “with hepatocellular carcinoma, cholangiocarcinoma, cancers of the larynx, stomach, lung and cervix” (p. 18).
- (20) Fraser GE, Jaceldo-Siegl K, Orlich M, Mashchak A, Sirirat R, Knutsen S.
 Dairy, soy, and risk of breast cancer: those confounded milks. *International Journal of Epidemiology*. 2020;49(5): 1526–1537.
- (21) Lê MG, Moulton LH, Hill C, Kramar A. Consumption of Dairy Produce and Alcohol in a Case-Control Study of Breast Cancer. *Journal of the National Cancer Institute*. 1986;77(3): 633–636.
 “The risk of breast cancer was found to be positively associated with frequency of cheese consumption and the level of fat in the milk consumed” (p. 633).
- (22) Mobarakeh ZS, Mirzaei K, Hatmi N, Ebrahimi M, Dabiran S, Sotoudeh G.
 Dietary habits contributing to breast cancer risk among Iranian women. *Asian Pacific Journal of Cancer Prevention*. 2014;15(21): 9543-7.
- (23) Turner, K. A. (2014). *Radical Remission: Surviving Cancer Against All Odds*. HarperCollins.
 (cf. pp. 17-19).
- (24) McCann SE, Hays J, Baumgart CW, Weiss EH, Yao S, Ambrosone CB. Usual Consumption of Specific Dairy Foods Is Associated with Breast Cancer in the Roswell Park Cancer Institute Data Bank and BioRepository. *Current Developments in Nutrition*. 2017;1(3): 1-6.
- (25) Ljungman M. Chapter 10 Physical Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles &*

Practice of Oncology, 11th ed. Philadelphia: Wolters Kluwer. 2019.

PPT slide 11: “Cancer Risk-Reducing Agents”⁽¹⁾

- (1) Brenner DE, Lippman SM. Chapter 35 Cancer Risk-Reducing Agents In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) Cunha JP. Vitamin A. RxList; 2021. [19 August 2021]
https://www.rxlist.com/consumer_vitamin_a_retinol/drugs-condition.htm
“Brand Name: Retinol”
Based on the conversion of “300 mcg/day retinol activity equivalent (1,000 units per day)”, retinol units are divided by 3.33 to determine mcg.
- (3) Michels KB, Willett WC. Chapter 11 Dietary Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (4) Mukherjee S. *The Emperor of All Maladies: A Biography of Cancer.* London: Fourth Estate; 2011.
(cf. pp. 29–36).
- (5) Vettenranta A, Murtola TJ, Raitanen J, Raitinen P, Talala K, Taari K, Stenman UH, Tammela TL, Auvinen A. Outcomes of Screening for Prostate Cancer Among Men Who Use Statins. *Journal of the American Medical Association Oncology.* 2022;8(1): 61–68.
“Incidence of low-risk (Gleason score 6) and localized tumors was lower among statin users.”
- (6) Alfaqih MA, Allott EH, Hamilton RJ, Freeman MR, Freedland SJ. The current evidence on statin use and prostate cancer prevention: are we there yet? *Nature Reviews Urology.* 2017;14(2): 107–19.
“An increasing amount of data supports an inverse association between statin use and cancer risk. ... Use of these agents seems to also be associated with improved prostate-cancer-specific survival, particularly in men undergoing radiotherapy, suggesting usefulness of statins in secondary and tertiary prevention” (p. 107).
- (7) Babcook MA, Joshi A, Montellano JA, Shankar E, Gupta S. Statin Use in Prostate Cancer: An update. *Nutrition and Metabolic Insights.* 2016;9: 43–50.
“Accumulating clinical evidence suggests that statin use may be beneficial in the prevention and/or treatment of prostate cancer” (p. 43).

- (8) US Preventive Service Task Force. Statin Use for the Primary Prevention of Cardiovascular Disease in Adults: Preventive Medication. *Journal of the American Medical Association*. 2016;316(19): 1997–2007.
Statins should become common since a regular “low- to moderate-dose” is recommended for cardiovascular disease (CVD) risk-reduction in adults 40–75 with no CVD history, risk factor(s) and 10 year risk of at least 10% (p. 2000).
- (9) Guillem JG, Berchuck A, Norton JA, Subhedar P, Seastedt KP, Untch BR. Chapter 34 Role of Surgery in Cancer Prevention In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

PPT slide 12: Lifestyle Recommendations: Healthy Diet

- (1) Brenner DE, Lippman SM. Chapter 35 Cancer Risk-Reducing Agents In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) Béliveau R, Gingras D. *Foods to Fights Cancer: What to eat to reduce your risk.* London: Penguin Random House; 2017.
- (3) National Center for Biotechnology Information. PubChem Compound Summary for CID 5280961, Genistein. Available from: <https://pubchem.ncbi.nlm.nih.gov/compound/Genistein>. [Accessed 20th Jan 2022].
- (3) Michels KB, Willett WC. Chapter 11 Dietary Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

PPT slide 13: Lifestyle Recommendations: Exercise & Healthy Weight

- (1) Brown JC, Meyerhardt JA, Ligibel JA. Chapter 12 Obesity and Physical Activity In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (2) Jay. 2020. How Many Calories Should I Eat A Day To Lose Weight or Gain Muscle? Available at:
<https://www.aworkoutroutine.com/how-many-calories-should-i-eat-a-day/>
Picture retrieved from: <https://www.aworkoutroutine.com/wp-content/uploads/2017/08/caloric-surplus.jpg>
- (3) World Health Organization. *Prevention (Cancer control: knowledge into action)*. Geneva: World Health Organization; 2017.
(cf. p. 29)
- (4) Michels KB, Willett WC. Chapter 11 Dietary Factors In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
- (5) US Preventive Service Task Force. Weight Loss to Prevent Obesity-Related Morbidity and Mortality in Adults: Behavioral Interventions. *Journal of the American Medical Association*. 2018;320(11): 1163–1171.
“The USPSTF recommends that clinicians offer or refer adults with a body mass index (BMI) of 30 or higher (calculated as” (weight in kg)/(height in meters)² “to intensive, multicomponent behavioral interventions” (p. 1163).
- (6) US Preventive Service Task Force. Obesity in Children and Adolescents: Screening. *Journal of the American Medical Association*. 2017;317(23): 2417–2426.
“The USPSTF recommends that clinicians screen for obesity in children and adolescents 6 years and older and offer or refer them to comprehensive, intensive behavioral interventions to promote improvements in weight status” (p. 2417).
- (7) Venturini E, Iannuzzo G, Andrea AD, Pacileo M, Tarantini L, Canale ML, Gentile M, Vitale G, Sarullo FM, Vastarella R, Lorenzo AD, Testa C, Parlato A, Vigorito C, Giallauria F. Oncology and Cardiac Rehabilitation: An Underrated Relationship. *Journal of Clinical Medicine*. 2020;9(1810): 1–26.
“Many observational studies link an increase in physical activity to a reduction in either the development or progression of cancer, as well as to a reduction in risk in cardiovascular diseases.... Exercise is an effective tool for improving cardio-respiratory fitness, quality of life, [and] it can counteract the toxic effects of cancer therapy” (p. 1).

PPT slide 14: “Role of Surgery in Cancer Prevention”⁽¹⁾

- (1) Guillem JG, Berchuck A, Norton JA, Subhedar P, Seastedt KP, Untch BR. Chapter 34 Role of Surgery in Cancer Prevention In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

- (2) Brown JC, Meyerhardt JA, Ligibel JA. Chapter 12 Obesity and Physical Activity In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.
Bariatric surgery may reduce risk (by 27 to 59%) of obesity-related cancer.

- (3) World Health Organization. *Comprehensive Cervical Cancer Control: A guide to essential practice 2nd ed.* Geneva: World Health Organization; 2014.
Cervical pre-cancer: cryotherapy, loop electrosurgical excision procedure, cold knife conization
(cf. 155–160).

PPT slide 15: Conclusion: Highlights

- (1) Pallin ND, Beeken RJ, Pritchard-Jones K, Charlesworth L, Woznitza N, Fisher A. Therapeutic radiographers' delivery of health behaviour change advice to those living with and beyond cancer: a qualitative study. *British Medical Journal Open*. 2020 Aug 1;10(39909): 1–8.
Few therapeutic radiographers advise patients on healthy physical activity, eating, weight, or help with smoking cessation and reduced alcohol consumption, and need for resources and training identified (p. 5).
- (2) World Health Organization. Ways to Reduce Cancer Risk. Graphic resource retrieved from <https://www.who.int/images/default-source/infographics/cancer/cancer-infographic.png>
- (3) Béliveau R, Gingras D. *Foods to Fights Cancer: What to eat to reduce your risk*. London: Penguin Random House; 2017.
(cf. pp. 15–24)
- (4) Faguet G. Environmental Carcinogens. In *The Conquest of Cancer: A distant goal*. Dordrecht: Springer; 2015.
- (5) US Preventive Service Task Force. Weight Loss to Prevent Obesity-Related Morbidity and Mortality in Adults: Behavioral Interventions. *Journal of the American Medical Association*. 2018;320(11): 1163–1171.
“The USPSTF recommends that clinicians offer or refer adults with a body mass index (BMI) of 30 or higher (calculated as $(\text{weight in kg})/(\text{height in meters})^2$ “to intensive, multicomponent behavioral interventions” (p. 1163).
- (6) US Preventive Service Task Force. Interventions for Tobacco Smoking Cessation in Adults, Including Pregnant Persons: US Preventive Services Task Force Recommendation Statement. *Journal of the American Medical Association*. 2021;325(3): 265–279.
“The USPSTF recommends that clinicians ask all adults about tobacco use, advise them to stop using tobacco, and provide behavioral interventions and FDA-approved pharmacotherapy for cessation to nonpregnant adults who use tobacco” (p. 265).
- (7) US Preventive Service Task Force. Screening and Behavioral Counseling Interventions to Reduce Unhealthy Alcohol Use in Adolescents and Adults: US Preventive Services Task Force Recommendation Statement. *Journal of the American Medical Association*. 2018;320(18): 1899–1909.
“The USPSTF recommends screening for unhealthy alcohol use in primary care settings in adults 18 years or older, including pregnant women, and providing persons engaged in risky or hazardous drinking with brief behavioral counseling

interventions to reduce unhealthy alcohol use” (p. 1899).

- (8) US Preventive Services Task Force Recommendation Statement. Screening for Unhealthy Drug Use. *Journal of the American Medical Association*. 2020;323(22): 2301–2309.

“The USPSTF recommends screening by asking questions about unhealthy drug use in adults age 18 years or older ... and appropriate care can be offered or referred” (p. 2301).

- (9) World Health Organization. *Comprehensive Cervical Cancer Control: A guide to essential practice 2nd ed*. Geneva: World Health Organization; 2014.

Comprehensive cervical cancer control: a guide to essential practice, 2nd ed
Pap screen women aged 30–49 to identify and treat pre-cancerous cervical lesions (pp. 53, 149).

- (10) US Preventive Service Task Force. Screening for Cervical Cancer: U.S. Preventive Services Task Force Recommendation Statement. *Journal of the American Medical Association*. 2018;320(7): 674–686.

“The USPSTF recommends screening for cervical cancer every 3 years with cervical cytology alone in women aged 21 to 29 years”, and from 30 to 65 “recommends screening every 3 years with cervical cytology alone, every 5 years with hrHPV testing alone, or every 5 years with hrHPV testing in combination with cytology (cotesting)” (p. 674).

- (11) US Preventive Service Task Force. Screening for Colorectal Cancer: U.S. Preventive Services Task Force Recommendation Statement. *Journal of the American Medical Association*. 2021;325(19): 1965–1977.

“The USPSTF recommends screening for colorectal cancer in adults aged 45 to” 75 years of age (p. 1966).

- (12) US Preventive Service Task Force. Screening for Breast Cancer: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2016;164(4): 279–297.

“The USPSTF concludes that while there are harms of mammography, the benefit of screening mammography outweighs the harms by at least a moderate amount from age 50 to 74 years and is greatest for women in their 60s” (p. 282).

- (13) US Preventive Service Task Force. Screening for Lung Cancer: U.S. Preventive Services Task Force Recommendation Statement. *Journal of the American Medical Association*. 2021;325(10): 962–970.

“The USPSTF recommends annual screening for lung cancer with low-dose computed tomography (LDCT) in adults aged 50 to 80 years who have a 20 pack-year smoking history and currently smoke or have quit within the past 15 years” unless they have “a health problem that substantially limits life expectancy

or the ability or willingness to have curative lung surgery” (p. 962).

- (14) US Preventive Service Task Force. Risk Assessment, Genetic Counseling, and Genetic Testing for BRCA-Related Cancer. *Journal of the American Medical Association*. 2019;322(7): 652–665.

“The USPSTF recommends that primary care clinicians assess women with a personal or family history of breast, ovarian, tubal, or peritoneal cancer or who have an ancestry associated with breast cancer susceptibility 1 and 2 (BRCA1/2) gene mutations with an appropriate brief familial risk assessment tool. Women with a positive result on the risk assessment tool should receive genetic counseling and, if indicated after counseling, genetic testing” (p. 652).

- (15) Guillem JG, Berchuck A, Norton JA, Subhedar P, Seastedt KP, Untch BR. Chapter 34 Role of Surgery in Cancer Prevention In: DeVita VT, Lawrence TS, Rosenberg SA. (eds.) *DeVita, Hellman, and Rosenberg's Cancer: Principles & Practice of Oncology, 11th ed.* Philadelphia: Wolters Kluwer. 2019.

- (16) Keane MG, Horsfall L, Rait G, Pereira P. A case–control study comparing the incidence of early symptoms in pancreatic and biliary tract cancer. *British Medical Journal Open*. 2014;4(5720): 1–8.

Ex. weight loss, pain, nausea, diabetes, itching, fatigue, dysphagia, mass