Curing Cancer - Part 2 - Adult versus childhood tumors
15 December 2020

This is my second essay about curing cancer. See also **Curing cancer, Part 1 – Reductionism vs. Complexity**.

The top 10 causes of US cancer death for all ages are listed below, including the projected number of deaths in 2020 and the 5 year relative survival rate (see **Cancer Facts & Figures 2020** for all cancer related statistics). The 5 year relative survival rate is the number of patients alive at 5 years after diagnosis, with or without cancer, divided by the number of patients of a similar age expected to be alive who do not have cancer, based on normal life expectancy. Note that 5 year survival is not necessarily a cure - some patients may relapse.

#1 Lung cancer, 135,720 deaths, 5 year survival 19%
#2 Colon cancer, 53,200 deaths, 5 year survival 64%
#3 Pancreatic cancer, 47,050 deaths, 5 year survival 9%
#4 Breast cancer, 42,690 deaths, 5 year survival 90%
#5 Prostate cancer, 33,330 deaths, 5 year survival 98%
#6 Liver cancer, 30,160 deaths, 5 year survival 18%
#7 Non Hodgkin lymphoma, 19,940 deaths, 5 year survival 72%
#8 Central nervous system cancer, 18,020 deaths, 5 year survival 34%
#9 Bladder cancer, 17,980 deaths, 5 year survival 77%
#10 Esophageal cancer, 16,170 deaths, 5 year survival 20%

These top 10 cancers are projected to cause 414,260 deaths or 68.3% of the total projected US cancer deaths in 2020.

Cancer in children differs from cancer in adults. Children have far fewer cases (11,050 versus 1.8 million), fewer deaths (1,190 versus 606,520), different histologic (microscopic) types and higher rates of 5 year survival:

Central nervous system cancer, 74%
Ewing sarcoma, 76%
Hodgkin lymphoma, 98%
Leukemia, 87% (91% for acute lymphocytic leukemia, 66% for acute myeloid leukemia)
Neuroblastoma, 81%
Non Hodgkin lymphoma, 91%
Osteosarcoma, 69%
Retinoblastoma, 96%
Rhabdomyosarcoma, 71%
Testicular lymphoma, 95%
Wilms tumor, 93%

Cancer survival rates are higher in children than adults because their tumors have different origins and because clinical trials are more commonly used.

Childhood tumors are typically caused by inherited or constitutional cancer predisposition or developmental mutations (**Kentsis 2020**), are not age related and show no “field effects” (large areas affected by premalignant or malignant change). In contrast, adult tumors are caused by risk factors acting over decades, including tobacco use and exposure to other carcinogens, alcohol use, excess weight, Western diet (high fat, few vegetables), microorganisms and parasites, constant hormonal exposure and immune system dysfunction. Adult tumors are associated with older age and show prominent field effects. For example, the average age for lung cancer patients is 70 years and many of these patients have premalignant and malignant

lesions throughout their lungs because cigarette smoke damages cells throughout the respiratory tract.

Second, there is a strong emphasis on enrolling every child with cancer in a clinical trial to compare current standard therapy for a particular risk group with a potentially better treatment that may improve survival or reduce treatment side effects. As a result, children with leukemia are sorted into different risk categories and treatment plans based on age, gender, weight, race / ethnicity, central nervous system involvement, testicular involvement, white blood cell count, characteristics of leukemic cells and genomic alterations (**NCI: Childhood Acute Lymphoblastic Leukemia Treatment (PDQ®)–Health Professional Version**, accessed 6Dec20).

Curing childhood tumors requires combining multiple effective treatments with different mechanisms of action (**Mukherjee: The Emperor of All Maladies 2010**). Often, “combinations of combinations” of treatment are needed to kill all tumor cells, even though these tumors may originate from just one mutation in one cell. Combining treatments is necessary because biologic pathways are weblike, not linear. This means that treatment directed at stopping one dangerous pathway may be ineffective because the tumor uses alternative pathways on the biologic “web” to achieve a similar function (**Nollmann 2020**).

To cure adult tumors, more combinations may be required than for childhood tumors because adult tumors originate from many mutations in many cells, due to multiple risk factors acting over long periods of time. Clinical trials are important because human physiology follows the principles of self-organized criticality, which indicate that we cannot easily predict the impact of treatment combinations. This is analogous to the difficulty in predicting changes in a sandpile as grains of sand are added (**Bak, How Nature Works 1999**, **Pernick 2017**). The only way to effectively test whether treatment combinations are effective and tolerable in different patient groups is with clinical trials.

It is also important to address the many systemic changes related to adult tumors that occur in the decades it takes for the tumor to arise. This will be discussed in a future essay.