David L. Wilson

Chapter 2 Where Are We Headed Without a Breakthrough?

It is said that two things can't be avoided: death and taxes. However, there are ways to delay taxes and there are ways to delay death. As described in the previous chapter, life expectancy has shown a gradual increase in most developed countries over the last couple of centuries. Can we expect that average life expectancy will continue to increase in this new century without a breakthrough of the kind that I am proposing? Certainly, there is a good possibility that medical research will continue to make progress in combating the major killers—heart disease, cancer, stroke, etc. Success there will lengthen life expectancies a little more. However, there are counteracting trends that are emerging, and it appears quite possible that life expectancies for identifiable subpopulations of humans might decline, while others increase, because of factors that are beginning to tug in opposite directions. Not all of us are living healthy lifestyles, not all of us have health insurance, and there are reasons to be concerned about the possibility of a return to an era of deadly infectious diseases. In less-developed countries there also continue to be a variety of life-shortening events, from famine to war, that kill many individuals. Finally, some view us as being near the end of an extended era of "cheap" energy as we begin to peak in our production of oil and natural gas, which will produce substantial hardships for many. The consequence of the high cost of energy will be many—more stress for everyone, hardships in less developed nations--leading to higher mortality rates.

Lifestyles of the middle-class and not-so-famous

Some of us fortunate enough to live in developed countries are engaged in behaviors that will reduce life expectancy. Some are not getting adequate exercise, some have improper diets, and some engage in such risky behaviors as smoking, excess alcohol consumption, and high-stress life styles. Even among those who are taking action to try to extend their healthy life expectancy, some individuals are tinkering with herbals, unprotected by the usual controls of the Food and Drug Administration due to a law passed by Congress in the mid-1990s. Some believe they are helping themselves by taking hormones with unknown long-term effects, perhaps misled by exploitative or misguided physicians into thinking there is good evidence that these have been shown to be helpful. In addition, smoking has increased among women in the last couple of generations, and recent reports indicate that women are at an even higher risk for developing lung cancer from smoking than are men. That decision by women is beginning to impact on their death rates not only due to increased rates of lung cancer, which is an especially deadly cancer, but also because smokers have a substantially increased risk of heart disorders and cardiovascular problems that contributes to the early deaths of many more of them than does lung cancer. Deaths in the U.S. today due to smoking are at about 400,000 per year. These individuals are dying at younger ages than they would if they had not smoked, and some die considerably younger. As males in the U.S. have dropped their rates of smoking, their death rates from lung cancer have declined, but female death rates from lung cancer continue to increase due to choices that they made 20-40 years ago.

Thus, some actions and lifestyle decisions by individuals contribute to shortened life expectancy. Without a breakthrough, there is no assurance that the normal progress made by medical research in fighting the disorders related to aging will be enough to allow for continued increases in life expectancy--the advances may be overshadowed if enough individuals make poor lifestyle decisions. Without some kind of intervention, a possible scenario for life expectancy in the U.S. is a split population, with some of us living healthier lifestyles and living longer, while others make unwise choices and experience earlier disabilities and live shorter lives.

Fat chance of a longer lifespan

One example of a growing problem (literally!) is the increase in disabilities and deaths due to obesity-related disorders in the United States. A 1998 study found that over half of the U.S. population was either overweight or obese, and that number may have increased to two-thirds of Americans in 2004 (Abelson and Kennedy, 2004). Recent reports of rising rates of high blood pressure and adult-onset diabetes among younger individuals demonstrate that we have a significant problem that will impact on quality of life for many, and life expectancy for at least some of them, especially those who are overweight due to improper diet and lack of exercise. Diets high in fats and refined sugars seem to be a special risk, as is the shift among the young in recent years from time spent in physical activity to that spent watching television and playing sedentary video games. Busy working couples and single parents seem to be relying on less healthy, fast food for their families all too often. Many of us need to limit our intake of fat and refined, simple sugars, while exercising more. In Chapter 10, we will see that, even for those of normal weight, reducing, rather than increasing, calories consumed might contribute, under appropriate conditions, to longer life.

Diet and exercise often are linked when discussing lifestyles, and to some extent such a linkage is appropriate. Unhealthy weight gain is a consequence of long-term differences between calories 'in' and calories 'out.' The calories 'out' are influenced greatly by one's level of exercise. While exercise provides other positive benefits—strengthening muscles, enhancing cardiovascular functioning, and increasing HDL cholesterol among other things—it also helps one to control weight.

The view that excess weight contributes in a major way to premature death has been challenged recently, but few doubt the risks of obesity. Evidence suggesting that being overweight causes as many as 400,000 premature deaths a year in the U.S. has been challenged as mistaken. Some put the number at less than one-tenth that. In fact, for some years, there have been conflicting results among studies on what effect being overweight has on mortality. Some studies do indicate that, for those over (about) age 80, being overweight no longer raises one's risk of mortality (Stevens et al, 1998). The trick is getting there! Those who make it may lack some of the risk factors, including genotypes which can lead to death at younger ages for those carrying too many pounds of fat.

Oversimplified research studies do not take proper account of the relationships among body-mass index, exercise, and diet. Some overweight individuals do get considerable exercise and eat healthy foods. Part of the problem may come from attempting to classify who is over weight by using Body Mass Index (BMI). BMI is weight in kilograms divided by the square of height in meters. If you wish to determine

your BMI, and you are used to feet/inches and pounds, you will need to do a couple of conversions. Begin with your height in feet and inches. Divide the inches by 12 and add that fraction to the number of feet. Then multiply the result by 0.3048 (that gives you your height in meters). Multiply your height in meters by itself (square it). Divide it into your weight in pounds, and divide that result by 2.2, to adjust from pounds to kilograms. The result is your BMI. A BMI under 19-20 is considered very thin, and one above about 30 is considered obese. Do keep in mind that these numbers do not take body types into account, nor do they account for the different proportions of lean body weight and fat possible in individuals with the same BMI.

Here is a specific example of the calculation for someone who is 5 feet 10 inches tall and weighs 150 pounds: 5 + 10/12 = 5.833 feet. 5.833 x 0.3048 = 1.778 meters. $(1.778)^2 = 3.16$. 150/3.16 = 47.47. 47.47/2.2 = 21.6, which is the BMI for someone 5' 10" tall and weighing 150 pounds.

BMI alone may not be an adequate measure for determining who is at risk because individuals with the same BMI can still vary in their ratio of fat to muscle. Some exercise while others do not. Also, there are different body types, and individuals who are "big-boned" may well be able to carry a higher BMI without undue added risk. Some suggest that comparing one's waist and hip diameters is a better way. It was said that, for males, the ratio waist/hip should be 0.95 or less; for females, 0.8 or less, to reduce the risk of cardiovascular problems, but I haven't seen those numbers confirmed. While BMI alone may not be a completely accurate predictor of premature death, there is no question that obesity contributes to increasing morbidity and disability, including adult onset diabetes and a higher risk of joint and back problems. Carrying excess fat, especially in the belly as opposed to hips, seems to predispose one to cardiovascular problems.

Perhaps equally important, some of the studies of the effect of body mass index on mortality have not corrected for those who were underweight at the beginning of the research study because of existing health problems, and other studies did not adjust for smokers, who tend to be of lower weight and higher risk. Of course, one cannot do an adequate study if some of the participants who are listed as being slim have recently lost weight due to preexisting illnesses, such as cancer. Some studies that do take account of such individuals seem to indicate that being slightly underweight is an advantage, while others show a rather flat relationship between BMI and longevity until one reaches higher, obese, levels (Manson et al, 1995). Some have suggested that being thin can be an advantage in one's 50s and 60s, but a few extra pounds might help those in their 80s. Of course, by then, most who were carrying too many extra pounds have died. So, the issue of what is the best BMI remains with us, and perhaps will ultimately be viewed as too simple a question, given the variety of factors that influence both BMI and mortality. However, what is clear from all of the studies is that those who are more than just overweight--who are obese and relatively sedentary--experience a significantly higher health risk and mortality risk. At the very least, those whose diets are poor and who are overweight enhance their risk of developing a number of disorders that produce late life morbidity and reduced quality of life. Diet and exercise are among the major factors that are dividing the population in terms of lifestyle choices.

Exercising the option of living longer

The lifestyles of all too many in developed nations seem designed to avoid any kind of regular physical activity—automobiles are used rather than feet, even to travel distances less than a mile; too many suburbs seem designed to discourage foot travel or cycling; television and computer games have replaced after-school or after-work sports; and many of those who can afford it employ household help and gardeners, further reducing the opportunity for exercise. Fortunately, workout gyms, combining exercising with the possibility of socializing, have made exercise more attractive to some. But, especially in middle age, the demands of children and jobs put a squeeze on time, and exercise seems too low on the list of priorities for many.

There is little or no controversy about the need to exercise. The health-related benefits of exercise are great—enhanced physical strength and reduced frailty, reduced cardiovascular risks, reduced diabetes risk, reduced osteoporosis, increased maximum workload, reduced stress, etc. Many age-related disorders appear to be delayed, at least, by regular exercise. Both morbidity and mortality are decreased by exercise. Most individuals know of the importance of regular exercise, but only some are getting it. This is another major factor that is dividing the population in terms of lifestyle choices.

Health Insurance and the Distribution of Wealth

In the U.S. there is another at-risk group--those lacking universal health insurance. The numbers of such individuals are growing, and include not just the unemployed, but also many workers whose employers do not offer health insurance and who cannot afford it on their own. These individuals, because they cannot afford otherwise, tend to see doctors only when health problems have become more advanced, and their delays can lead to earlier mortality due to cancers, undetected and uncontrolled high blood pressure or LDL cholesterol levels leading to cardiovascular problems, reduced responsiveness to insulin leading to diabetes, etc.

Numerous studies identify socioeconomic status as a factor that influences life expectancy. Poverty contributes to early death, and this could worsen, especially in a country like the United States, with its growing gulf between the rich and poor, the insurance haves and have-nots. Unfortunately, many in the lower socioeconomic class make poor lifestyle choices on top of their limited resources. A higher fraction of working class individuals are smokers than are those in the middle or upper class. But the lack of health insurance becomes a confounding factor that impacts on the quality of their lives, no matter their lifestyle choices.

The impact of large income range and lack of universal health insurance on mortality rates in the U.S. is shown by comparing the U.S. with other developed nations that have universal health care coverage and less extreme income deviations. The United States is behind many other developed countries in terms of life expectancy. The United States (in 1999) shows an average life expectancy of 77 years. In contrast, our neighbor to the north, Canada (1996) has managed 78 years, Norway (2000) and France (2001) are at 79 years, Sweden has achieved 80 (2002), and Japan (1999) is tops in the world with nearly 81 years [In each case, the year used is the most recent currently available in the Human Mortality Database (ref)]. Females in Japan live an average of 84 years, another record. Compared to other countries, while our overall health care expenditures per person are higher, they are much less uniform among our citizens, with some either left

out of the system or relying on trips to the emergency room when an untreated problem becomes a crisis. With any luck, the U.S. will join most other developed nations and offer universal health insurance or care in the near future. Otherwise, the most likely way our life expectancy will reach those in other developed nations is if some of them reduce theirs by adopting some of our more unhealthy lifestyles.

While some indulge in sedentary living and bad habits, others are intentionally taking advantage of growing knowledge of what contributes to a healthy lifestyle, and, even without a breakthrough, are likely to experience longer than average life expectancy, especially as they take advantage of future medical advances against specific diseases and disorders. We can conclude that, for developed nations, without a breakthrough, the chances of continuing to increase average life expectancy may rest as much with a combination of social policies and individual life style choices as with medical progress in treating age-related disorders. It is not impossible that we are heading toward two separable groups in the U.S.--one experiencing increased life expectancy over the next several decades, while the other experiences a plateau or drop.

Concrete Example of Declining Life Expectancy

For those who may not believe that declines in life expectancies are likely in these more modern times, the recent lesson from the former Soviet Union is telling. Consider Russia, perhaps the most developed region within the Soviet Union. After the collapse of Soviet Communism, along with all of the good things that resulted, there was a decline in safety nets--inflation ate away at fixed pensions, benefits such as universal health care disappeared, and alcohol consumption increased. Within a year of the collapse and the initiation of a rather raw capitalistic system in Russia, average life expectancy dropped by several years! In 1999, males had dropped from nearly 65 years to just under 60 on average. It does not take much to destroy a system of health care and social support, and, clearly, raw capitalism has its limits. The U.S. gave up on it gradually during the 20th century, but, instead of reflecting our own experience with more raw forms of capitalism, our government supported a rapid conversion from communism to capitalism in Russia, despite the human cost. A transition to social capitalism could have been done in a manner that would not have had such detrimental consequences for so many individuals in the former Soviet Union.

Fortunately, things can go the opposite way as well. Before the Berlin wall came down, and East and West Germany were reunited, death rates were considerably higher in the East. Over the next few years, life expectancy for former East Germans rose to almost equal those of West Germans because of medical and social improvements for the East Germans. This was true even for those already in their 80s at the time of the merger (Scholz and Maier, 2003). The examples of Russia and East Germany show that, even at rather late ages, death rates can change, for better or for worse, depending on environmental factors. At older ages we are quite vulnerable to many different kinds of stress, and we have already recognized how such stress can increase IMR in the Gompertz model of mortality rates, raising mortality across the age spectrum. Increasing or decreasing stress can quickly result in altered mortality rates. In a later chapter we will see that this vulnerability rises as our organ system reserves decline with age.

Environmental Factors and Resource Limitations

Environmental factors could play a larger role in life expectancies in the future due to a combination of environmental degradation and non-sustainable resource use. Impacts will be both local in some cases, and global in others. During the 19th and early 20th century, we experienced a decline in quality of air and water in the U.S., followed by a partial reversed due to governmental regulations impacting on polluters. Due to such policies, we now have cleaner air in many cities, and many lakes and rivers have reducing levels of pollution even with growing populations nearby. Such pollution is known to increase certain kinds of cancers, to contribute to toxic metal (mercury, lead, etc.) poisonings, and to contribute to lung disorders. Today, pregnant women are told not to eat fish caught in the Everglades more than once a week because of mercury poisoning, which also may be a problem in some farm-raised fish because of contamination of feed. So there still are some problems remaining.

I still remember irritated eyes and lungs on the many smog-alert days that Los Angeles experienced in the late 1960s. At that time, some of the Great Lakes were fast becoming wastewaters. Fortunately, there have been improvements, but areas such as the Chesapeake Bay currently are showing continuing problems from pollution. So, there has been widespread, partial deterioration of the environment, but, at least in many industrialized societies, the problems have begun to be addressed.

However, as costs and pressures from polluting industries rise, and political winds shift, the decisions being made today point to a declining interest in doing more than reducing pollution to "acceptable" levels, and what is acceptable seem to depend on who is running the show in Washington. In addition, there are ominous signs that the renewal efforts might soon end, and pollution begin to grow once again, as I discuss below.

Some nations are not willing to recognize growing problems of a global nature that could ultimately impact on life expectancy as well as on quality of life. Among these problems is global warming. Three large nations refused to sign the Kyoto agreement to limit the production of greenhouse gases—China, India, and the United States. China and India have two of the world's fastest growing economies, with China's double-digit growth rate beginning to strain the world's supplies of many natural resources. The U.S. already consumes more resources per capita than any other nation, but has, up to now, failed to take adequate action to reduce the risks associated with the continuing rise of carbon dioxide in the atmosphere as a result of emissions from tailpipes and smokestacks. The ones who end up paying the price for increased warming of the atmosphere will not only be those in the countries refusing to participate in maintaining or lowering emission levels. Melting polar ice will raise sea levels everywhere, and the poor in low-lying areas of Bangladesh will be among the first who suffer death for the sins of others. Warming oceans also could cause dramatic changes in ocean currents and weather patterns, including hurricane intensities. We can hope that some adjustments will be made soon, but it may already be late in the game.

The more general use of resources at unsustainable rates will eventually, inevitably, contribute to decreases in life expectancy world wide. As the resources are depleted, our ability to replace such resources with new technologies will likely be limited and more expensive. It is hard to predict exactly what we will not be able to replace, but there will be hardships that are bound to occur during the next couple of centuries, and they could start within the next decade or two, as we exhaust the easily

available stores of a number of raw materials. Further deaths could come from wars over remaining resources.

We already are beginning to feel the impact of the end of cheap oil and natural gas. I had once thought that problems would occur only when we actually ran out of oil and so viewed that as being many decades away. However, what has now become clear is that the problems will start as world oil production begins to peak. This is because of supply-and-demand issues.

With China and India developing, their demand for oil is growing, while the world's production rate is widely predicted to be close to its peak. Meanwhile, in some developed nations, we remain very inefficient in the use of petroleum products, with gas-guzzling SUVs transporting people from home to work, with products being transported over long distances related to our global marketplaces, and with coal-burning power plants generating higher levels of pollutants and CO_2 than other forms of energy. With demand being greater than supply, we can expect prices for oil and gas to continue to rise, with a few ups and downs, but generally up, and we may already be seeing impacts on our lives. As everything from transportation to electricity and heating rises in cost, will we continue to be able to afford air conditioning, plentiful fruits and vegetables imported from a far, and long commutes from home to work?

There could be more major disruptions that will impact on life expectancies in the world just about at the time that I am predicting a breakthough in longevity to occur. Without similar breakthroughs in energy supplies and new technologies, we may be doomed to suffer much shorter life expectancies because of the very different conditions in a society adjusting from plenty to want. Books such as James Kunstler's (2005) may exaggerate somewhat, but they make some good points about what is likely to happen when our non-sustainable use of natural resources catches up with us. At the very least I would expect the stresses of resource depletion to impact on the underprivileged among us, further stretching the differences in life expectancy between "haves" and "have-nots."

I suspect that, as oil production declines, reserves of coal will stave off the more radical reworking of society that will be required when we have depleted all types of fossil fuels, but there will be large prices to pay in terms of environmental degradation and increased costs for energy in the shorter term. Already there are calls for a return to building new nuclear power plants, but we are still without a long-term solution to the problem of storing nuclear waste. As the cost of oil rises, it will make feasible the production of synthetic fuels, including heating oil and gasoline, from coal, as was done in Germany when it had insufficient oil during Hitler's Third Reich. Coal already is being used in power plants, but there will be temptations to reduce the pollution controls on "dirty" coal as prices rise, and carbon dioxide production will inevitably continue to rise, as more of it is generated per BTU produced from coal than from oil, along with global temperatures. Most imaginable agreements, such as that from Kyoto, merely reduce the rate at which we dump the carbon dioxide into the atmosphere. There appears little chance that we will not eventually deplete all the fossil fuels we can in the name of economic progress, and the long-term consequences will appear to many to be worth the price for the short-term gains, which eventually will include the ability to continue to support the billions of humans on earth for a few more decades.

We have painted ourselves into a corner with the current size of our world population and our chosen lifestyles. Our non-sustainable use of natural resources has

allowed us a period of excess that will come to an end, and that could impact greatly on all that I am predicting here about increases in life expectancy, which is based upon the expectation of continuing social and economic support for everything from health care and medical research to air conditioning.

Early Death in Less Developed Countries

I use the phrase "less developed" intentionally. I know that this phrase may be considered by some to be politically incorrect, but at least it does not hide a prediction of the future the way that the more popular phrase "developing countries" does—not all less-developed countries will experience development in the near future, and some are showing signs of the opposite at present. In a number of less-developed countries there are immediate, dire issues of famine, war, and growing numbers of individuals with Acquired Immunodeficiency Syndrome (AIDS) that are causing reduced life expectancy. Most of the countries in the southern half of Africa are now experiencing dramatic reductions in life expectancies because of AIDS. In some African nations, the Human Immunodeficiency Virus (HIV) that causes AIDS now infects more than one in four individuals, and access to drugs to slow the progression of the disease is very limited. These countries are selectively losing the demographic group that normally is most productive in a society. The tragedy certainly will multiply as both young and old are left behind, with too few in the middle to provide care and support. If this level of death and human misery were occurring in developed nations, it would be splashed across the front pages of newspapers and make T.V. in lead news stories on a daily basis. Instead, we have had delays in recognizing and dealing with the problem in some nations, in part because of denial or active suppression of information about infection rates, as well as a national leader who, at one point, even denied the obvious causes of AIDS, leading to diminished use of condoms to control of the spread of the disorder. Some of the policies of the U.S. with respect to what kind of birth control information it is willing to support with its funds also contributes to more infections and deaths.

AIDS, of course, is but one illness, and there are peoples, mostly in less-developed countries, who are impacted by malaria, hepatitis, rotavirus, papillomavirus, tuberculosis, influenza, and diarrhea, with high morbidity and mortality consequences. Worldwide, millions die each year from these disorders. Up to now, little has been done in developed countries to attempt to find a cure or treatment for a number of disorders that cause much suffering and death only in the less developed regions of the world. There has been little monetary incentive for the big pharmaceutical companies to get involved in identifying and producing cures because the victims cannot afford expensive medicines, as we have seen with AIDS treatments. Even the National Institutes of Health, the major U.S. government source of funding for basic research into health, has put little money toward trying to find cures to disorders that impact tens-of-millions of people who do not live in the U.S. There may be no easy way to ask U.S. taxpayers if they might be willing to have a small fraction of their health research dollars go to fighting world scourges, but fortunately we have some international organizations, including the United Nations and the World Health Organization, that do care, and some individuals with substantial resources, such as Bill and Melinda Gates, who have, through foundations, begun to recognize the magnitude of these world health problems and are investing in solutions for the betterment of all humankind.

Without changes in human behavior and some social systems, there are reasons to be pessimistic about what is coming in the way of life expectancy for the vast majority of humans now on earth, not only those who live in less developed regions of the world, but also many in developed countries who experience poverty and lack of health insurance or make unhealthy life style choices. Those in less-developed countries will not be helped much by the expensive kinds of cures, or partial solutions, to age-related diseases and disorders now being sought by most in the biomedical and pharmaceutical communities. Coronary bypass surgery and expensive chemotherapy are not the kind of advances likely to be exported to large numbers of the world's poor anytime soon, and many continue to die before needing help with age-related disorders. And, if we are as close as some think to peaking in the world's production of oil and gas, time will run out on those nations that have not yet developed, as the cost of energy goes through the roof.

It may be worth noting that the above analysis of emerging risks and life-style choices is not the reason for the "boxed-in" hypothesis described in the last chapter. Gerontologists who hold the view of a coming plateau in average life expectancy for humans do so because they view us as being very close to a biological limit on human life expectancy. They believe that humans cannot go much beyond 80-85 years average, no matter what the advances in ordinary medicine and life styles. The caveats that I have described above are not related to this concern but to the limits on our current civilization's ability to extract resources and solve health-related problems.

When Dreams Become Nightmares

There are newly emerging viral disorders, beyond HIV, that could become more general problems that contribute to a general rise in mortality rates. These viruses have not yet caused a large number of deaths, but might evolve to do so in the future. They include the hemorrhagic fever viruses, for which Ebola serves as a good example. Ebola kills about 90% of those who are infected, and it does so through general bleeding. Individuals die while hemorrhaging and exuding virus from every possible body orifice. As painful as it is to say, and as tragic as the disorder has been for some in Zaire and Uganda in Western Africa, the most fortunate thing for the rest of us about Ebola is that it kills fast. Death usually occurs within two weeks of infection. The reason this can be viewed as a blessing of sorts is that it reduces the likelihood of a widespread outbreak. Thus far, typically, those in a village or two will be infected, and perhaps a few hospital workers who first come in contact with them, but as soon as the nature of the illness is recognized, precautions are taken and the outbreak subsides. If there were a longer incubation period, or especially if Ebola were to spread without the need for direct contact with body fluids from an infected individual, we would have a major epidemic on our hands. Anyone who has seen the Dustin Hoffman movie *Outbreak* has some idea of the challenge that would confront us should the Ebola virus mutate into an airborne infectious agent. The solution found at the end of that movie made for a nice story but was not a realistic one, unfortunately. Certainly, if such a new virus were to appear, all bets would be off about the future of human life expectancy.

In fact, in 1989, there was an instance where an airborne version of Ebola appeared to be present—monkeys in one room caught the virus from monkeys in an adjacent room, with the only contact seeming to be the air ventilation system. Fortunately, this particular variant of the virus seemed not to have been transmissible to

humans—a good thing, since the incident was in a group of research animals in Reston, Virginia, just outside of Washington, D.C. (Preston, 1994).

Of course, we don't have to imagine the possibility of a deadly virus causing widespread deaths--we already have an example in AIDS. A possible source for new agents will be in central Africa, the location from which Ebola outbreaks have started. In the Congo, Zaire, Cameroon, and elsewhere, there is continued contact, through hunting and habitat overlap, with our close relatives, other primates. Infectious agents will continue to evolve and emerge as we contact such organisms and develop practices and behaviors that allow for the spread of such agents. As humans take over more and more of the planet, there could yet be more revenge coming from Mother Nature.

Another possible risk for deadly viruses comes from an old enemy, influenza. In 1918, in the middle of World War I, millions died during the influenza pandemic, and we are overdue for another one. Infectious disease experts currently are concerned about the possibility of bird flu in Asia mutating and spreading to humans as the initiation point for another pandemic like that of 1918. We are overdue for one, it appears.

A Return to Yesteryear? The Possible Rise of Old Enemies

We also are beginning to see a decline in the effectiveness of antibiotics against some bacteria, which is producing resistant strains. The result could be the return to conditions in the early 1900s, when infections were a leading cause of deaths, even in developed countries.

One of the ways that bacteria can develop resistance to our antibiotics makes an interesting story. I first learned about it in the 1960s, when I was a graduate student doing research on bacteria. There are small, circular pieces of DNA, called plasmids, within some bacteria. Plasmids are separate pieces of genetic material, not usually a part of the main bacterial chromosome, but still get copied and inherited by each daughter cell that forms when bacteria divide.

Bacteria also can distribute such plasmids to other bacteria by a couple of different mechanisms. The simplest of these arises from the ability of a bacterium to take up pieces of DNA from its environment. If one bacterium containing a plasmid dies, and the plasmid is freed and floating around, another bacterium can simply take it up and begin to produce the gene products specified by the plasmid's genes. A second mechanism involves the ability of some plasmids to form mating bridges between bacteria, allowing for the direct transfer of plasmid genes from one bacterium to another.

Some of these plasmids contain genes conferring resistance to antibiotics, and a single plasmid can contain a half dozen or more such antibiotic resistance genes. The bacterium receiving such a plasmid can gain resistance to almost all common antibiotics in an instant. Especially since we have been overusing antibiotics, evolution through natural selection, has assured that these antibiotic-resistant genes on plasmids have become more commonly found in bacteria. They are found in abundance in bacteria in hospitals, where antibiotics are frequently used—a very unfortunate circumstance, since ill patients can be hit especially hard if they pick up an antibiotic-resistant infection.

Antibiotics are used in farm animals because the animals grow a bit larger and grow faster, more than paying for the farmer's antibiotic investment. Physicians often prescribe antibiotics when individuals have viral infections, sometimes because patients demand them. Antibiotics do not work against viral infections. Unlike bacteria, viruses

use our own cell's machinery to multiply. Antibiotics target the special aspects and structures involved in bacterial metabolism. Finally, some who are prescribed antibiotics also will not always complete the course of therapy, and a partial use may only enhance the chances of developing a resistant strain. The overuse and misuse of antibiotics is shortening the time before these "wonder drugs" become useless. We soon will need a new set of antibiotics, or we may revert to the days when many died of infections. Creating new antibiotics is something that the government now is encouraging pharmaceutical companies to do. If we are successful in generating new ones, hopefully we will be wiser in their usage.

We can see the growing risk of antibiotic resistance in AIDS patients, who, being at high risk of infection due to their compromised immune systems, harbor both common and rare infections, and it appears that a number of antibiotic-resistant strains, including tuberculosis, are spreading in AIDS patients, especially in those who do not complete a full course of antibiotic therapy. Tuberculosis was a potent killer a hundred years ago, until effective treatments were developed. It is one among a number of infective agents that we fear could make a comeback.

The Good News

I have painted some grim aspects of what might be ahead without emphasizing the other side—modern medicine is advancing at a rapid pace, and ideas for the treatment of many of today's major killers are being tested every day. We already have seen a decline in deaths due to heart disease by more than 25% from their peak in the 1950s and 60s, and we continue to advance new treatments.

We have seen rises in the cure rates for a number of common cancers thanks to earlier detection, chemotherapy, radiation therapy, and surgery. Overall death rates from cancers in the U.S. have declined slightly in the last couple of years. Much of this is because of men smoking less, but there are other cancers for which we have better prevention, detection, or treatment. The PSA test for prostate cancer is allowing males to detect the cancer at an earlier stage, increasing the likelihood of a total cure. There now is a vaccine that will prevent several of the most common kinds of cervical cancer in women.

There now are several approaches to treatments for stroke. For those who get to the hospital quickly after first symptoms of a stroke, genetically-engineered TPA (tissue plasminogen activator) can dissolve clots in the brain and allow the stroke patient to avoid permanent damage. The need for quick treatment limits the use of TPA, as does the need to determine if the stroke is due to a clot or a burst blood vessel. If the latter, TPA can make matters worse, so it is important to do a quick brain scan on stroke victims before administering the drug. While TPA has found only limited use because of delays in diagnosis, other treatments are being developed as we learn more about what actually kills nerve cells deprived of oxygen.

Beyond the big three of heart disease, cancer, and stroke, there is continued progress against other killers of the aged. We now have a vaccine for certain forms of pneumonia, and the elderly can take annual influenza shots to reduce the risk of that killer. The only foreseeable end to modern medical and biomedical advances seems to be the cost—are we approaching the point where we no longer can afford to deliver all of the treatments to those who need them? Health care costs continue to rise much faster

than inflation, eating a larger piece of the whole pie each year. We need to focus on less expensive solutions and need to accept that there are times when aggressive attempts to resuscitate are futile. It has been estimated that 25% of the total health care expenditure for individuals in the U.S. occurs in their last year of life.

Looming large among the still unsolved disorders, especially with the current aging population, we still have the challenge of Alzheimer's disease, a disorder that strikes one-quarter to one-half of all who reach 85 years of age. We'll discuss this particular disorder in Chapter 8, when we consider possible issues with a "first draft" solution to the problem of aging. The good news here is that we are beginning to understand the causes of Alzheimers, and that may allow us to glimpse possible solutions to this major disorder. Treatments so far just work on symptoms, and do not slow the progression of the disorder, but we can hope for better in the future.

It should not go unmentioned that I have listed a number of age-related disorders above. The current model in medical science is to work hard at finding a cure for each one of these, individually. What is not emphasized as often as it perhaps should be, is that any treatment that produces a delay of aging in humans is likely to result in a delay in most of these age-related diseases. While we (via our tax dollars spent by the NIH and other government funders of medical research) are spending billions trying to cure individual disorders, the investment we make in trying to solve all of these problems at once, through research in the biology of aging, is relatively underfunded, especially given the bigger possible payoff.

In Summary

A period of uncertainty awaits us when it comes to future life expectancy. Those who can afford care for themselves, if they also make healthy life style choices, can look forward to gradually increasing life expectancy, on average, even without a breakthrough. Those who are poor, or who make bad lifestyle choices, even in developed countries, could experience shorter lives, on average, than their parents—a dramatic change from the longevity trends of a century ago. For these individuals, even a breakthrough may not help prevent an early demise. Whatever state their bodies are in at the time the breakthrough becomes available, assuming that it will work on adults at all, will be what they will have to live with, for whatever extended period the breakthrough might bring. All of this, and this entire book, is predicated on the continuation of society and civilization as we know it, and there is the risk that a rising, world-wide cost of energy could cause a total reconsideration of everything. While no one has a clear crystal ball with which to view the future, I will try a most optimistic assumption in the next chapter, and consider an extreme view of humans without senescence—life without any aging.