Chapter 1

Aging and Health: Challenges and Opportunities

An Age Wave Heads to Shore

Social scientists have been monitoring with great interest an approaching tidal wave that may well overwhelm the resources of the United States and many other countries if we don't carefully plan for it. This wave will nearly double the number of Americans 65 and older from about 38 million today to over 71 million by 2030.[1] And it carries with it a whole collection of age-related health concerns.

Increased longevity is a success story with many heroes, but the trend poses tremendous challenges. Innovations in healthcare delivery, housing, land-use planning, transportation, agriculture, food distribution, and other societal activities will attempt to respond to the demographic shift, competing with other needs of the 21st century. Ethical questions concerning how and where elders fit into society and our responsibilities to them as well as future generations will take on new dimensions.

The boomers' history of tackling thorny challenges and reinventing themselves regularly as they move through life could presage widespread innovation in approaches to healthy aging. Enormous benefits could accrue to societies when this huge former labor pool becomes available for volunteerism. Intergenerational relationship building could once again expand. Indeed, many are hoping that the generation responsible for many dynamic technological advances will help develop new ways to address looming age-related health concerns.

THE ONCOMING AGE WAVE is fueled in part by the "baby boom" generation (Americans born between 1946 and 1964). In 2000, people over 65 represented a little over 12 percent of the population and this is expected to grow to nearly 20 percent by 2030. The census bureau predicts that the over-85 age group alone will almost double from nearly five million in 2003 to nearly ten million by 2030. This continues a dramatic demographic transformation that has doubled the older population in the U.S. every 30 years since 1900.[2]

This trend is also underway not only in other industrialized countries but also in the "global South" (less industrialized countries), where over half (59 percent) of the world's elderly (65 and over) lived in 2000. That proportion is expected to increase to over 70 percent or 686 million older people in developing nations by 2030. Older age groups will also continue to be a growing portion of the population in these Southern countries.[3]

The turtle image is a symbol of longevity in Native American cultures.

In the best of all worlds, a relatively healthy older population would actively continue to contribute to society while placing minimal additional demands on healthcare and care-taking resources. Setting this goal would prompt us to identify age-associated disorders that might be prevented or delayed, thereby compressing the illness burden into a shorter period of time near the age of death.

Thus, the pathway to healthy aging is lined with healthy pregnancies, infants, children, and adults.

The optimum aging scenario, says Andrew Weil MD, a pioneer in integrative medicine, is to remain as healthy as possible until we approach death, and then rapidly decline: "I don't subscribe to the concept of 'anti-aging' or the view that we can reverse the physical changes that come with growing older. However, I do believe we can age with grace, and that we should do everything in our power to delay the onset of age-related disease, discomfort and loss of vigor."[4] Peter J. Whitehouse MD, PhD, a geriatric neurologist at Case University and noted expert on Alzheimer's disease, agrees. He adds, "A lot of people are making money out of convincing people aging is a disease. It is not."[5]

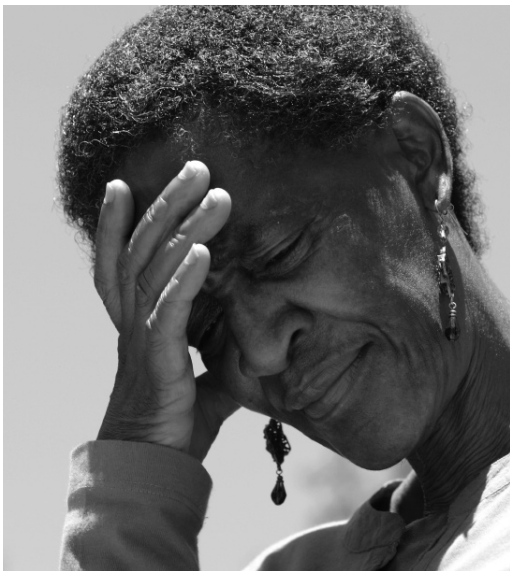
The Origins of Chronic, Degenerative Diseases

The material developed in this report stems from our long-term interest in the relationships connecting human health and the environment. By environment we mean the entire physical, biological, social, and cultural context in which we are conceived, born, grow, age, and die. In recent years, influences of chemical exposures, inadequate or inappropriate nutrition, and socioeconomic stress on children's health have received much-needed attention as critical components of the environment. Scientists tell us about the unique vulnerability of the developing child to each of these.

We have also wondered how these variables might influence the health of older people. This, too, is a vulnerable stage of life. As it turns out, we now know that environmental influences beginning in the womb and continuing throughout life are strong determinants of health decades later. That is, health in older age is, to a large extent, a reflection of health throughout life, beginning with conception. Thus, the pathway to healthy aging is lined with healthy pregnancies, infants, children, and adults.

The challenges in assessing the impacts of chemical exposures, diet, social status, and other environmental factors on health in later years are unique. Children grow, develop, and

acquire functions and skills. Older people lose many of them. Normograms of child development, which help parents and clinicians track growth and acquisition of age-appropriate skills, do not have their counterpart in the aged. But, like delayed or slowed child development, combinations of early onset or accelerated progression of functional decline in older people are more likely to draw medical attention. Still, the line differentiating normal aging from disease is often indistinct. Where it is drawn can be determined as much by social convention as by biology. And where it is drawn helps to set the stage for individual or societal responses.



Over time, disease patterns change. Fewer infants and children now die of infectious diseases than at the beginning of the 20th century, but more are afflicted with birth defects, asthma, cancer, diabetes, and obesity. Among adults, cardiovascular disease, cancer, and diabetes are now leading causes of morbidity and mortality. But why do some people live relatively healthy lives until close to the time of their deaths, while others suffer with often debilitating chronic disease as adults? Can this be explained by genetics, personal behavioral patterns, and luck? Are there also features of the shared environment beyond individual control that help to explain these disparities as well as disease patterns?

Because health in the later years of life strongly depends on health in earlier years, this project is a logical extension of our 2000 report, *In Harm's Way: Toxic Threats to Child Development*. There we focused primarily on the impacts of toxic chemical exposures on the developing brain. Later we wondered if brain function might similarly be affected later in life and decided to focus primarily on the two most common neurodegenerative diseases—Alzheimer's disease and Parkinson's disease. These are chronic diseases that profoundly affect individuals, families, communities, and society. People with dementia have lost more than their cognitive ability. They have lost their personhood before losing their lives. People with Parkinson's disease live with more than shaking limbs and a stiff, unsteady walk. When they can no longer express their emotions on their faces they have lost essential ways of communicating with lovers, families, friends, and others.

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The discussion in this report is relevant to a number of other diseases as well. It also speaks volumes about the state of the environment. In essence, we identify direct connections between the health of people and the health of the planet. From a public health perspective, much abnormal loss of neurological function in older people, as well as many increasingly common chronic diseases, is

PORTRAITS *of* AGING

It's morning in the Alzheimer's unit of the local nursing home. Behind the locked doors, the volume in the hallway begins to rise. One woman sings the refrain of a Christmas carol over and over, although the month is July. A man repeatedly shouts from his bed, "Where's my ticket?" Another complains that someone has stolen his cows. A night shift nurse, finishing up her paperwork, warns a morning nurse about the new patient in 3B. He was agitated all night and tried to kick his window out again. Claiming to be a prisoner of war, he appears delusional.

Out in the day room, two men, heads bowed, shuffle back and forth in the gait characteristic of Parkinson's disease. A woman bangs her wheelchair over and over into the corner of the wall. She will do this until someone turns her chair around. And then she will roll to the opposite corner of the room and bang some more.

The staff prepare cups of "thickened water" for residents who are losing their ability to swallow. This helps prevent aspiration. A room at the end of the hall is being prepared for the long-time resident in 9A. She has lost her swallowing reflexes altogether. Her grown children have been summoned and, once they arrive, they will be ushered into the new, quieter room to await the inevitable.

Taped to each door along the hallway is a photograph of the occupant and a brief biography that includes former hobbies and the names of family members both living and dead. The photos are intended to help residents find their rooms after meals. The biographies help the staff to converse with and calm the patients. Many occupations are represented among the residents: farmer, college professor, ballroom dancer, church organist, machinist, banker.

After his breakfast, the former banker wanders down the hallway. He stops to examine one of the photos. It is a picture of himself. He scowls and jabs his finger at the image. "Who is that guy?" he demands to know. "Who is that guy?"

These are not portraits of normal aging.

Contributed by Sandra Steingraber

Alzheimer's and other forms of dementia are major contributors to the rapid increase in demand for long-term care services.

linked to the profound changes brought about by humans in ecosystems throughout the world. The good news is that restorative win-win alternatives could lead to long-term sustainable health for both people and the planet.

Alzheimer's Disease and Parkinson's Disease

Changes in cognitive abilities, including attention, memory, and executive function, are common in normal aging. Healthy individuals are able to adapt by recruiting the services of other areas of the brain and are generally able to maintain adequate functional status. Yet, in some people, more rapid decline in the function of certain areas of the brain results in symptoms that ultimately lead to a diagnosis of Alzheimer's disease or Parkinson's disease. Although advancing age is the largest risk factor for each, their debilitating symptoms are not an inevitable feature of normal aging.[6]

The most prominent symptoms of Alzheimer's disease result from involvement of parts of the brain that control thought, memory, and language. Ultimately a person with Alzheimer's disease is unable to carry out daily activities independently. Functional decline accelerates, progressing to death. The disease usually becomes apparent after age 60, although it may have its origins many years before. Earlier onset of symptoms occurs but is uncommon. The risk of Alzheimer's disease increases with age. About 5 percent of all men and women ages 65–74 have Alzheimer's disease, while nearly half of those age 85 and older may have the disease.[7] Alzheimer's disease is estimated to affect nearly 4.5 million people in the U.S. This is expected to nearly triple by mid-century to over 13 million.[8] Worldwide, according to a 2007 World Health Organization report, Alzheimer's disease affects 24 million people.[9]

US-wide Initiatives on Aging

Below is a brief historical timeline of important initiatives on aging and health:

1945 - Harry Truman asks Congress for legislation that would establish a national health insurance plan. The issue is debated for twenty years, with opponents warning of the dangers of "socialized medicine."[1]

1958 - Dr. Ethel Percy Andrus, a retired high school principal, founds AARP. This evolved from the National Retired Teachers Association (NRTA), which Dr. Andrus had established in 1947 to promote her philosophy of "productive aging," and in response to the need of retired teachers for health insurance.[2]

1965 – President Lyndon Johnson as part of his "Great Society" enacts Medicare, providing health benefits for the first time to those over 65. Ex-president Truman is the first to enroll in Medicare. [3]

1985 – Environmental Protection Agency (EPA) and National Institute of Environmental Health Sciences (NIEHS) ask National Academy of Sciences (NAS) to investigate effects of the environment on elders.

1987 – NAS publishes *Aging in Today's Environment.*

2002 – EPA sponsors forum at the NAS, "Differential Susceptibility of Older Persons to Environmental Hazards."

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Parkinson's disease is a progressive disorder that includes combinations of tremors, stiffness, and emotional changes that ultimately lead to severe disability. About 50,000 new cases of Parkinson's disease are reported annually in the U.S. alone.[10] The number of individuals with Parkinson's disease over age 50 in the world's 10 most populous countries in 2005 is estimated at over 4 million. Prevalence of Parkinson's is expected to double by 2030.[11] These are estimates, as no comprehensive Parkinson's disease registries currently exist.

Socio-Economic Implications

The Alzheimer's Association estimates that national direct and indirect annual costs of caring for individuals with Alzheimer's disease are nearly $150 billion.[12] According to a recent study, the cost of caring for a person with Alzheimer's disease more than doubles over four years of care.[13] The cost of Parkinson's disease in the U.S. alone is estimated to be $13–28.5 billion per year.[14] Patients with both dementia and Parkinson's disease have significantly higher annual direct costs than patients with Alzheimer's disease alone.[15]

Alzheimer's and other forms of dementia are major contributors to the rapid increase in demand for long-term care services. Alzheimer's disease also dramatically affects the quality of life of family caregivers.[16] The majority of dementia-related deaths in the United States occurred in nursing homes (66.9 percent). In contrast, older persons with cancer mostly died at home (37.8 percent) or in the hospital (35.4 percent). The hospital was the most common site of death for all other conditions (52.2 percent).[17]

The World Health Organization's 2007 report on the global burden of neurological disorders shows that Alzheimer's disease and Parkinson's disease are more prevalent in higher income regions and account for a larger fraction of the disease burden. For example, Alzheimer's disease and other dementias constitute 1.47 percent and 2.04 percent of projected healthy years lost due to disease or disability in the Americas and Europe, respectively, compared to the African (0.10 percent) and Southeast Asian (0.26 percent) regions.[18] Even if much of this difference is attributable to more limited case ascertainment and higher prevalence of other diseases in some countries, it is dramatic. We examine cross-cultural studies more fully later.

A New Framework—An Ecological Approach to the Western Disease Cluster

Our interest in the origins and patterns of Alzheimer's disease and Parkinson's disease led us into expansive terrain encompassing many aspects of the natural, built, and social environments. It became clear that we needed to consider these diseases in a social, cultural, and historical framework while trying to understand their biological underpinnings. We also found links to a cluster of other diseases and conditions and, therefore, needed to examine broader disease patterns and even the way that we name and classify diseases.

Disease patterns change in response to historical forces, including interconnected environmental conditions and many kinds of human activity. These patterns can change slowly or more rapidly as may happen during times of war, famine, natural disaster, economic collapse, or epidemic infectious disease.

While looking at the macro level, we also turned to the micro level of cells, cellular signaling pathways, and sub-cellular organelles. The chapters that follow attempt to lay out how these various pieces fit together. Briefly, historically rapid and accelerating changes in virtually all aspects of socioeconomic life in the U.S. and most other countries of the world over the past 50–100 years created the conditions for new disease patterns. We can see the impacts of these changing conditions in communities, individuals, tissues, cells, and DNA.

An expanding collection of research tools has enabled scientists to describe in some detail biologic processes at the micro level that are set in motion by human-environmental interactions. These processes include, for example, gene mutation, enzyme induction, oxidative stress, inflammation, changes in membrane permeability or cell-to-cell signaling properties, and hormone disruption. We have learned just how much our health or risk of disease depends on our biologic responses to what we eat, drink, and breathe; exposures to industrial and other chemicals; social circumstances; interactions with other biological organisms; and many other aspects of our environment.

In this document we frequently emphasize, among the many potential responses to environmental stimuli, the role of inflammation and oxidative stress in the origins of many diseases. From the outset we stress that these are natural biologic processes

2002 – EPA launches Aging Initiative to examine, among other things, environmental hazards the elderly may face—and to shape a planned National Agenda for the Environment and the Aging.

2003 – EPA Aging Initiative conducts public "listening session" forums around the country to solicit input on environmental issues of importance to elders.

2007 – The U.S. National Academies *Keck Futures Initiative* convenes *The Future of Human Healthspan: Demography, Evolution, Medicine and Bioengineering* conference to provide a forum for interdisciplinary exploration of a wide range of challenges related to aging, and to propose innovative solutions.

Note: EPA references from Adler T. Aging research: the future face of environmental health. EHP. 2003 Nov; 111(14):A760-5 and Hood E. Toward a new understanding of aging. EHP. 2003 Nov; 111(14):A756-9.

1 Senior Journal. Available at: http://www.seniorjournal.com/NEWS/2000%20Files/Aug%2000/FTR-08-04-00MedCarHistry.htm. Accessed June 18, 2007.

2 AARP. Available at: http://www.aarp.org/about_aarp/aarp_overview/a2003-01-13-aarphistory.html. Accessed June 18, 2007.

3 Senior Journal 2000 op cit.

In a time of resource constraints, an overburdened healthcare system, and an approaching wave of age-related disease, preventing entire clusters of chronic debilitating illnesses should be a high priority.

that play essential roles in maintaining health. However, toxic chemical exposures, certain kinds of diets, and social stress, among other factors, can chronically up-regulate inflammation and oxidative stress so that they become initiators or promoters of disease. Indeed, as we will show, a coherent and compelling narrative links a number of environmental trends with abnormal up-regulation of these micro-level biologic processes. Moreover, inflammation and oxidative stress are key players not only in Alzheimer's disease and Parkinson's disease, but also in diabetes, cardiovascular disease, the metabolic syndrome, lipid disorders, obesity, asthma, and cancer. We do not mean to suggest that abnormal inflammation and oxidative stress are the only pathological processes of concern. But they are major pathways through which numerous environmental factors are integrated and contribute to a variety of chronic diseases. We will discuss this in some detail.

A Closer Look

Oxidative Stress

Oxidative stress occurs in the presence of highly reactive oxygen-containing compounds called "free radicals". Free radicals are an inevitable consequence of living in an oxygen-rich atmosphere and using oxygen to generate cellular energy. In fact, appropriate levels of free radical production are essential for health. But when free radical production is excessive or prolonged, oxidative stress is linked to the origins or progression of many diseases. (see chapter 6)

We call diabetes, cardiovascular disease, the metabolic syndrome, lipid disorders, and obesity the "Western disease cluster" because of their emergence as major public health concerns in Western society, their tendency to co-occur in individuals and populations, and their overlapping origins. We also note that this same cluster of conditions is becoming increasingly prominent in other countries, for example in India, as they modernize along pathways similar to the West.[19] We identify determinants of this cluster at every level from the societal to the sub-cellular and argue that those determinants play a role in the origins of Alzheimer's disease and Parkinson's disease. Asthma and some kinds of cancer undoubtedly belong in this cluster as well. Asthma has a large inflammatory component and pro-inflammatory triggers commonly provoke asthma attacks.

The initiation, promotion, and growth of many kinds of cancer are also fueled by excessive oxidative stress and a pro-inflammatory state.[20] [21] In order to limit the scope of this document, however, we will not include further discussion of asthma or cancer but hypothesize that their trends, too, would be favorably influenced by interventions designed to address the Western disease cluster.

We want to avoid being overly simplistic. Of course many factors are involved and we acknowledge areas of uncertainty, data gaps, and debate. Even within groups of individuals with the same disease, the origins of conditions will vary. In most of them, the disease will arise from a mixture of contributing causes. In some, genetic influences will play a more prominent role. In others, exposures to a toxic chemical or dietary pattern will be relatively more important. We emphasize that whatever causes individual cases of a disease is unlikely to be identical to what causes disease incidence and patterns in a population. However, from a medical, public health, and policy perspective, we think that it is useful to identify disease patterns and common origins where they exist. Then thoughtful interventions at many levels—individual, community, and societal—can help to prevent or mitigate several problems simultaneously. In a time of resource constraints, an overburdened healthcare system, and an approaching wave of age-related disease, preventing entire clusters of chronic debilitating illnesses should be a high priority.

Elder health is a key indicator of quality of life throughout the lifecycle, as well as an important issue in its own right.

Ours is a public health perspective with an emphasis on prevention. Our curiosity does not arise out of an anti-aging agenda with a primary goal of prolonging life but rather out of an interest in the quality of life of elders. Moreover, elder health is a key indicator of quality of life throughout the lifecycle, as well as an important issue in its own right. The narrative that emerges from the material that follows has decisive implications for public policy. These diseases are not just a matter of bad luck, individual responsibility, or personal choice. We argue that they are, in large measure, diseases of civilization and must, therefore, be addressed in that way. So, before turning to the diseases themselves, we first describe a number of relevant trends that have unfolded in the U.S. over the past 50–100 years. This lays out the context in which our discussion of diseases and disease patterns will begin.

Endnotes

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