1 TOXICS IN PERSPECTIVE

We begin with a chapter that addresses one of the most perplexing questions concerning toxics: How much should one worry about toxic substances when there are so many other things to deal with in life? We approach this question by first exploring the meaning of risk. We highlight some of the more common confusions that arise when people talk about risk, and we try to make the reader feel more at home thinking about this easily misused notion. We then look at the changing patterns of death and disease in the United States. Here the reader will find out what the most common causes of death are and which health threats are on the rise. This information provides a useful perspective for understanding the threat of toxics.

A. Thinking about Risk

Public attitudes toward risk are varied. In response to a warning of exposure to some hazardous substance, most readers have likely heard replies such as these:

"Well, you have to die of something."

"Why should I worry, when more people get killed in car crashes than from using this chemical spray?"

"You tell me that one in a million people using that product will get cancer, but you're just telling me about odds—I'm interested in what will happen to me."

"Uncle Harry used the stuff all his life and lived to the age of 101—Why should I worry?"

"I don't want to be subject to any risk when I drink my tap water."

These quotes reflect serious and commonly encountered misunderstandings about the nature of risk. This chapter will try to clarify some of the more confusing aspects of the subject.

Risk is expressed in terms of probability, and this is what causes much of the public's confusion about risk. Risk must be expressed in terms of probability, in part because human beings are not identical and therefore do not respond in the same way to similar exposures. Even the mice used as test animals in laboratories differ from one another in their response to a given exposure. Thus, the data available from laboratory tests and from human health records will always have to be in the form of statements such as "If one million individuals drink all their water for one year from this contaminated source, then the odds are that ten of them will develop cancer as a result." The specific individuals from a group of one million who will develop cancer as a result of the contamination cannot be predicted. Nor can you even be sure that exactly ten members of the group will really develop the cancer; a hundred might or none might.

In addition, few people resemble the fictitious "average person" that scientists often refer to in expressing risk estimates. For any given hazard there are usually groups of people that are far more at risk than others. This can occur because of individual differences in age and the ways our bodies work (see Chapter 4, Section B) and because of differences in where we live and in our daily habits (which can affect the dose we receive and our response to it). Two different people can use the same product from a spray can and inhale very different levels of the toxic ingredients. Their exposures could differ because they use the spray can in places having different ventilation and because they may hold the can differently. Air pollution levels can vary widely along a single block in a polluted city, and water pollutants may not be uniformly mixed within a reservoir. At best, average levels of exposure from average everyday activities can be estimated, and even these are poorly known in many cases.

For a person who is a member of a group that is especially vulnerable to a particular hazard (or especially invulnerable), a statement about average risk is misleading. For many toxics, only the members of especially vulnerable groups need be concerned about the risk, and so throughout this book we try to characterize those who are most at risk whenever the information exists.

Even when it is understood why risk estimates are based on probability, confusion often lingers. This is illustrated by the previous quote about the greater risk of dying in a car crash than from some chemical. To understand the confusion, let's look at the dual concepts of risk and benefit. There are many situations in which we expose ourselves to some environmental hazard because we also reap some benefit in doing so. Thus, we might expose ourselves to the fumes from a paint remover to accomplish a desired goal—the removal of paint. We may live in a polluted city because it would cost us more to live elsewhere or because it is where our job is or where our friends live. Sometimes the benefit is not merely a convenience, but instead is health promoting. We add preservatives to food (which carries some risk to health) to retard the formation of molds that might pose an even greater risk.

When we compare the risk of a toxic exposure to that of other unrelated activities, we can easily be fooled into thinking that the risk of practically any exposure to a toxic is insignificant. After all, with the exception of cigarette smoking, no single activity or toxic discussed in this book causes as many deaths each year in the United States as do automobile accidents (and most cause far, far less). But this risk comparison is no reason for a car driver to continue exposure to a toxic. Rather, it is a reason for the person to ask, "Am I getting enough benefit from exposure to the toxic to make the health risk acceptable to me?" (By the same token, we might ask ourselves whether driving is worth the risk of dying in a car crash.) By comparing each risky activity with the benefits of that activity, rather than with the risks of some unrelated activity, we can be most certain that our actions match our priorities.

Risk–benefit comparisons also help make us aware of alternative ways of deriving the same benefit. True, it is practically impossible to enjoy many of life's benefits today without exposing ourselves to the risk of car accidents. But we may be able to avoid using a toxic chemical and still get comparable benefits by using some safer alternative product. Or we might decide that the benefits of using a certain toxic simply aren't worth the risk of toxic exposure and instead find something else to do to enrich our lives.

Pursuing this theme of risk and benefit, we encounter another important subtlety: the people who benefit from a particular activity may not be the same ones who must endure the risk of harm. For example, those who benefit from a new chemical may be the consumers using it and the stockholders of the company manufacturing it, while the factory workers producing it may suffer the consequences of its toxicity. Or one group of consumers may enjoy the benefits and endure the risk, while another group may only endure the risk. The two groups may not even be alive at the same time, for the present generation may enjoy the benefit of a new chemical, while our descendants may inherit the risk. For example, some of the *nuclear wastes*[1] produced by present-day nuclear power plants remain harmful for hundreds or thousands of years and will pose a risk to our great-grandchildren long after we, the generation that enjoyed the electricity, are gone. Toxic metals (see Chapter 12) such as the **lead**[2] released into the environment

[1]Technical terms italicized throughout the book are listed in the Glossary.

[2]Toxics that are boldfaced throughout the book are listed as entries in Part II, "A Guide to Commonly Encountered Toxics."

from lead-based paints or lead additives in gasoline persist in the environment as well.

The implications of such gaps between the winners and the losers are profound. The precept "take responsibility for your own actions" is firmly implanted in our ethics, yet it is increasingly difficult to obey this in our industrial society. How far into the future should we look when we count up the people who may die of cancer because of a long-lived waste product? Will new technologies come along that will eventually permit total removal of the waste? Will a cure for cancer eventually be found? Are benefits of the product to the present generation also benefits to future ones? (For example, the use of nuclear power today leaves more oil in the ground for future generations.) These are not easy questions, yet when we evaluate the costs and benefits of a new industrial product, we must at least be aware of these issues lest we become addicts of instant technological gratification.

Further complexity surrounds the subject of risk because of the wide range of hazards associated with various activities. Some toxic substances have a high probability of harming us, but the harm is not terribly great. Perhaps we are told that temporary dizziness and a tired feeling are the worst we can expect, but we are very likely to experience these symptoms if exposed to a normal dose of the product. In contrast, suppose normal use of another product leads to a very low probability of harm, but that harm is very severe. Perhaps normal use of this second product carries the risk of developing a fatal cancer, but the probability of getting that cancer is only 1 in 100,000. Which product should we use if they both produce the same benefit?

No one can answer that question for anyone else; the choice depends on how one weighs the odds. Some people view a 1 in 100,000 chance of developing a fatal cancer as so small that it can be ignored. They would take those odds rather than accept nearly certain but temporary dizziness and fatigue. Others, however, might reason that such a chance of a fatal cancer (that is, suffering and death) is an unacceptable risk and opt for the other product. So, risk has two dimensions: probability and magnitude. Probability tells us how likely we are to respond in a certain way to the chemical. Magnitude tells us how severe that response will be. Individuals must make up their own minds about the relative importance they attach to these two aspects of risk.

The subject of risk is also complicated by the fact that some risky activities are more subject to our control than others. It is natural to fear more those risks associated with activities that are beyond our control. For example, most people fear flying more than driving, even though, per passenger mile, the odds of dying in a car crash are greater than the odds of dying in a commercial airline accident. The perception of toxic risks is no different. Suppose that by some objective measure of risk, the odds of getting a fatal cancer from the **aflatoxin** in peanut butter (at the rate you normally eat that product) and from the aerial spraying of pesticides on agricultural fields near your home were publicized as being the same. You would probably direct more outrage and fear at the spraying. The reason is that you have some control over your peanut butter consumption—you can try shopping around for brands that are made with the best preservation techniques and you can cut down on your intake if you want to. In contrast, the spraying is out of your control. The decision to spray is imposed upon you by someone else, and you may not even know it has been made.

Some scientists and public officials argue that the regulatory process ought to deal only with the objective risks associated with various activities, not with subjective issues such as people's feeling of control over exposure. They say that each regulatory dollar should be spent to get the maximum benefit in terms of increased lifespans or other objective measures of public health. Others argue that this misses the point and that public welfare should not be measured solely in terms of objective measures such as life-span. Instead, they argue, public welfare is diminished if people are fearful because they lack control over their exposure to chemicals. Hence, regulations designed to enhance public welfare must reflect such subjective perceptions of risk. Both sides, however, can agree that in a democracy, perceptions of risk will inevitably influence regulations, and that it will be up to those who believe that the present public perceptions of risk are somehow "wrong" to work to change these perceptions.

We have seen that the notion of risk is complex and subtle, with aspects that are highly subjective and dependent on one's own perceptions. Whether you are listening to a debate over chemical hazards or are just thinking about the consequences of your own actions, it is useful to keep these lessons in mind.

B. Causes of Death and Disease

About two million people die in the United States each year: 37% from heart attacks, 22% from cancer, 7% from strokes, and the remaining 34% from a variety of afflictions listed in Table 1. The average life expectancy at birth for white women is now 79 years, for white men 72 years, for black women 74 years, and for black men 65 years. This reflects a far different picture of our overall health than that at the turn of the century. In 1900, white life expectancy in the United States was slightly less than 50 years, and black life expectancy was about 34 years. Five of the ten leading causes of death were infectious diseases, with tuberculosis, pneumonia/influenza, and diarrhea/enteritis being the top three. Today only pneumonia/influenza remains in the top ten (sixth). What accounts for this changing pattern of health and disease and how it relates to toxic substances is the subject of this section.

The most important factor in the improvement of lifespan has been the control of infectious diseases. Prevention of disease by improved sanitation, housing, vaccines, and nutrition, as well as treatment with antibiotics, are largely responsible for the decline in the high rate of infant and childhood mortality that marked the turn of the century. In more recent years, improved treatment for the chronic diseases of old age has also added to the average lifespan.

Cardiovascular Diseases

Cardiovascular diseases (including heart disease, stroke, and high blood pressure) are the leading cause of death, together accounting for just under half of all deaths. The underlying cause of cardiovascular disease in 85% of the cases is a progressively deteriorating condition of the arteries known as *atherosclerosis*. Atherosclerosis begins in childhood with the laying down of fatty deposits on the interior lining of the arteries. By the fourth and fifth decades of life, the deposits have grown to the point where significant narrowing of the artery has taken place. The site of accumulation begins to harden, scar tissue starts to form, and the arterial wall loses its elasticity and becomes brittle. At this point, the artery is significantly weakened and is subject to rupture, hemorrhage, or *aneurysm*. Alternatively, and especially in the case of the coronary arteries, the hardened deposit may break loose from the arterial wall and travel downstream to a narrower portion of the artery where it partially or completely blocks the flow of blood (coronary thrombosis). This is what typically happens in a heart attack.

The exact causes of atherosclerosis are not known, but various risk factors have been identified. Various nationalities of the world, such as the Japanese, have a low incidence of atherosclerosis, but when they migrate to the United States, they develop the local incidence within one generation. This points strongly to environmental or lifestyle causes. Chief among the suspected factors is the high proportion of saturated fat in the U.S. diet; also related are cigarette smoking, high blood

TABLE 1 Leading Causes of Death in the United States—1988

Rank	Cause of Death	Number of Deaths	Percent of Deaths
	All causes	2,167,999	100.0
1	Heart diseases	765,156	35.3
2	Cancer	485,048	22.4
3	Stroke	150,517	6.9
4	Accidents	97,100	4.5
	(motor vehicle	49,078	2.3)
5	Chronic obstructive lung diseases	82,853	3.8
6	Pneumonia and influenza	77,662	3.6
7	Diabetes mellitus	40,368	1.9
8	Suicide	30,407	1.4
9	All other infectious and parasitic diseases (including AIDS)	27,168	1.3
10	Chronic liver disease and cirrhosis	26,409	1.2
11	Nephritis, nephrotic syndrome, and nephrosis	22,392	1.0
12	Atherosclerosis	22,086	1.0
13	Homocide	22,032	1.0
14	Septicemia	20,925	1.0
15	Diseases of infancy	18,220	0.8
	Other and ill-defined	276,623	12.8

Source: National Center for Health Statistics. 1990. "Advance report of final mortality statistics, 1988." *Monthly Vital Statistics Report.* Vol. 39, no. 7, supplement. Hyattsville, MD: U.S. Public Health Service.

pressure, and the level of cholesterol circulating in the blood. It is unclear whether cholesterol in the diet actually determines the level of circulating blood cholesterol or whether that level is controlled by other factors. People at elevated risk for heart disease are well advised to reduce their cholesterol and fat consumption in case dietary cholesterol proves to be a controlling factor.

Regular vigorous exercise can apparently slow the atherosclerotic process by raising the proportion of so-called high-density lipoproteins (HDLs) in the blood, which actually seem to be able to scour the arteries of deposited fat. A sedentary lifestyle raises the proportion of low-density lipoproteins (LDLs), which carry cholesterol to the point of deposit. Three hours per week of vigorous exercise probably provides the maximum benefit. Moderate alcohol consumption and use of aspirin are also apparently protective against cardiovascular disease. Daily intake of aspirin is now recommended for individuals at high risk of heart disease. However, the side effects of aspirin, including the possibility of increased risk of stroke, make it unsuitable for low-risk individuals to take on a daily basis. Alcohol is associated with certain cancers (particularly among smokers) and is not recommended for the prevention of heart disease. Fish and fish oil may also protect against the disease.

The good news about cardiovascular disease is that the death rate is dropping quite rapidly. Since 1950, the number of cardiovascular deaths per 100,000 persons per year has been nearly halved (from 396 to 213). One reason for this striking decline is the identification and modification of behavior that increased the risk, leading, for example, to a reduction in dietary fat, a reduction in smoking, and an increase in exercise by many people. Another reason is improvements in medical diagnosis and treatment, including better treatment of *hypertension,* hospital coronary care units, cardio-pulmonary resuscitation (CPR), coronary by-pass surgery, and new and effective drugs. As prevention is given increased attention and as improvements in medical technology continue, we can look forward to further declines in the nation's number one killer.

Cancer

Cancer is the cause of death most people think of as associated with exposure to toxics. Currently, nearly 500,000 people die each year from cancer in the United States (nearly one in four deaths), and a million new cases are diagnosed annually. Unfortunately, in contrast to the decline in cardiovascular disease, several forms of cancer are increasing (due in large measure to cigarette smoking), leading to a rise in the overall death rate from cancer. Between 1950 and 1985 the annual incidence of reported new cancer cases rose about 1% per year (36.5% overall). The death rate from cancer rose a much smaller 0.2% per year, which partially reflects better treatment. This disparity between the incidence rate and death rate reflects better diagnosis and reporting of new cases, which makes the reported incidence rate much greater.

Most of the increase in the overall cancer rate is from lung cancer. If lung cancer is separated from the statistics, the death rate from all other cancers actually decreased by 13.3% since 1950. This overall decrease in nonrespiratory cancer deaths, however, is not uniform. It is made up of some cancers that declined markedly (such as stomach cancer) and others (such as the often fatal skin cancer melanoma) that rose, but not as much. Some of the cancers that have increased are discussed in the following sections.

The cure rate for most cancers has not improved significantly since 1950, with the important exceptions of childhood leukemia and Hodgkin's disease. The five-year survival rate (that is, the percentage of patients surviving for at least five years after a diagnosis of cancer has been made) has improved to 50%, from 39% in 1950. But much of this apparent improvement is due to earlier detection, thus lengthening the time to eventual death, rather than to more effective treatment.

The good news about cancer is that it is largely preventable. Not that all the important causes of cancer have been determined, but a comparison of the patterns of cancer among different nationalities, between migrant populations and their countries of origin, and of the changes over time within a country all show that most cancers have an environmental and/or behavioral origin. Environment and behavior in this context, however, do not only mean exposures to toxics but include all external factors over which people do or can exert control: man-made and natural toxics, viral infections, nutritional deficiencies or excesses, reproductive activities, and so on. Research on the specific causes of various cancers has begun to show that the large majority of human cancers (perhaps as much as 80 or 90%) can be avoided by suitable changes in environment or behavior.

How cancers get started is not fully understood. Several steps or stages are believed to be involved. In the first stage, called initiation, a change occurs in the genetic material (DNA) of a cell. The change can be caused by a chemical, a virus, or radiation, and it primes the cell for the next stage, called promotion. Promotion involves a second change to the genetic material that causes the cell to begin multiplying, forming a tumor. The third and final stage is called proliferation, in which some cells break away from the tumor, enter the bloodstream or lymphatic system, and colonize other tissues. This process is called metastasis, and the original tumor is referred to as being malignant. (Benign tumors do not metastasize.) Cancer becomes fatal only after metastasis has occurred. How agents alter cells to produce the various stages of cancer is not known. Some such as radiation are capable of causing both initiation and promotion (complete carcinogens) whereas others only initiate, and a second agent called a promoter must act for a tumor to form. What starts metastasis is even less well understood. There can be a long time interval between the several stages of cancer production, which is referred to as the latency period.

In our discussions of individual cancers, the currently suspected risk factors are mentioned so that individuals can take practical actions now in the hope of reducing the risk of cancer. Keep in mind, however, that only in a few cases have these risk factors been conclusively established as the most important causative agents.

Lung Cancer Lung cancer, colon and rectal cancers, and breast cancer together account for half of all U.S. cancer deaths today. Table 2 shows the number of cancer cases, the number of deaths, and the percentage of deaths from each type for the year 1985. Lung cancer is the leading fatal cancer in both sexes, having recently overtaken breast cancer as the leading fatal cancer among women. In 1985, lung cancer caused 122,000 deaths (26.5% of all cancer deaths; 6% of deaths from all causes). The rate of new lung cancer cases among men has leveled off after rising steadily throughout this century, owing to a decrease in smoking among younger men. For women, the rate of new cases is still rising rapidly, reflecting the large increase in cigarette smoking by women since the 1950s. Lung cancer is nearly always fatal, usually within five years.

Cigarette smoking is without a doubt the major cause of lung cancer, responsible for an estimated 85% of lung cancer deaths. That tobacco smoke should cause cancer is not surprising since it contains numerous substances that, individually, are known to cause cancer, such as tars, **benzo[*a*]pyrenes, nitrosamines, arsenic,** and **cadmium**). In addition to lung cancer, cigarette smoking is implicated in many other cancers, as well as in cardiovascular diseases (see Chapter 5, Section B). If we add up the deaths from all these cancers, tobacco is responsible for about one-third of all cancer deaths.

Other known causes of lung cancer include **asbestos, radon, arsenic,** environmental tobacco smoke, and other, mainly occupational chemicals. Exactly what proportion of lung cancers among nonsmoking members of the general population is due to these substances, many of which are components of air pollution, is the subject of vigorous debate by knowledgeable experts. The U.S. Office of Technology Assessment and the EPA estimate that approximately 10% of all lung cancers are produced by environmental pollution, including naturally occurring radon gas. What everyone does agree on is that tobacco smoke multiplies the inherent risk of each of these substances, so that smokers are always at a much greater risk of dying from lung cancer than are nonsmokers exposed to similar environmental conditions. Quitting smoking (and to a lesser extent, avoiding the smoky air produced by smokers) is clearly the single most important thing one can do to avoid developing cancer.

Colon and Rectal Cancers Colon and rectal cancers together are the second leading fatal cancers, causing 12.5% of all cancer deaths (nearly 58,000 deaths in 1985). The incidence rate has been rising gradually over the past 35 years, whereas the death rate has declined slightly. The percentage of patients surviving for five years after an initial diagnosis has improved to just over 50% from about 40% in 1950.

Dietary factors are strongly implicated as causes of colon and rectal cancers, as might be expected for cancers of the digestive tract. A high calorie intake, particularly in the form of animal fat, appears to increase the chances of these cancers; consumption of whole grains, cereals, fruits, and vegetables lessens the risk. Dietary fiber in particular appears to be protective. Stomach cancer, the leading fatal cancer in the 1930s, has declined markedly and is now responsible for only about 3% of cancer deaths. The reasons for this decline are not well understood, but may be related to the widespread use of refrigeration to preserve foods and the consequent

TABLE 2 Cancer Statistics for the United States—1985

Primary Site	Number of Estimated Cases	Number of Actual Deaths	Percentage of Cancer Deaths
All sites	910,000	461,520	100.0
Lung and bronchus	144,000	122,395	26.5
Males	98,000	83,754	
Females	46,000	38,641	
Colon and rectum	138,000	57,586	12.5
Colon	96,000	49,726	
Rectum	42,000	7,860	
Breast	119,000	40,090	8.7
Prostate gland	86,000	25,940	5.6
Pancreas		23,099	5.0
Leukemia	24,600	17,449	3.8
Non-Hodgkin's lymphoma	26,500	15,358	3.3
Stomach	24,700	13,949	3.0
Ovary	18,500	11,357	2.5
Brain and nervous system		10,265	2.2
Urinary bladder	40,000	9,785	2.1
Kidney	19,700	8,660	1.9
Esophagus		8,612	1.9
Oral and pharynx		8,290	1.8
Multiple myeloma		7,819	1.7
Uteris	37,000	5,959	1.3
Liver		5,952	1.3
Skin melanoma	22,000	5,529	1.2
Cervix	15,000	4,508	1.0
Larynx	11,500	3,501	0.8
Childhood cancers	6,000	1,840	0.4
Hodgkin's disease	6,900	1,778	0.4
Thyroid gland		957	0.2
Testis	5,000	425	0.1

Source: U.S. Department of Health and Human Services, National Institutes of Health. *1987 Annual Cancer Statistics Review*. NIH Publication No. 88–2789. Bethesda, MD: National Cancer Institute.

reduction of salting, pickling, and smoking for preservation, all of which are suspected causes of stomach cancer. The increased consumption of fresh fruits and vegetables may also have helped because of their protective effects.

Breast Cancer Breast cancer is the second leading fatal cancer among women, having just been surpassed by lung cancer. New cases are diagnosed in about 130,000 women every year; over 40,000 women die annually from the disease. The percentage of women surviving for five years after a diagnosis of breast cancer is approximately 75%. The incidence of breast cancer appears to be rising slightly, although this may be due in part to better detection and thus to more cases being reported. The causes of breast cancer are not known, but hormonal factors are strongly suspected. Factors that appear to increase the risk include no pregnancy or late age at first pregnancy, early onset of menstruation, late menopause, and a family history of breast cancer. Conversely, some protection appears to result from an early age at first childbirth, breast-feeding, late onset of menstruation and early menopause (in other words, a shorter menstrual history lessens risk, presumably by reducing the total time breast tissue is in contact with hormonal stimulus). Dietary fat consumption (particularly milk fat) correlates strongly with breast cancer, and this and other dietary factors, such as alcohol consumption, are currently receiving much study. Radiation exposure is also a risk factor.

Oral contraceptives (the "pill") for a long time were not believed to influence the development of breast cancer. The latest studies, however, are showing some linkage. At the present time, the data are difficult to interpret and further studies are under way. Experts are not recommending any change in pill use until the results of the new studies are in. One thing to keep in mind is that the dosages during the early period of pill use were much greater than the dosages prescribed today. Any cancers showing up now would be associated with these higher hormone levels in the early pills.

Other female reproductive cancers, including cancers of the cervix, uterus, and ovary, have been declining gradually among younger women, with cancer of the cervix showing a marked decline. Early diagnosis of precancerous lesions by pap smear followed by treatment is the main reason for the large decrease of cervical cancer.

Other Cancers Prostate cancer, the third leading fatal cancer among men (86,000 cases in 1985 and about 26,000 deaths), has been increasing steadily, but this, too, may reflect better detection and reporting rather than an actual increase in development of the disease. The survival rate has improved substantially so that 75% of newly diagnosed patients survive at least five years. Little is known about the causes of prostate cancer. The amount of sexual activity, the level of male hormones, the intake of dietary fat, and occupational exposures to **cadmium** have all been suggested as playing roles in development of the disease.

Leukemia and some cancers of the urinary bladder, kidney, and pancreas have all been associated with carcinogens of the workplace, and the first three, also with cigarette smoking. Cancer of the pancreas is the fourth leading fatal cancer in both sexes. Most of the current cases of cancer in this group are attributed to smoking, although there appears to be a slightly elevated risk of bladder cancer in the general population from *trihalomethanes* produced by water chlorination.

Skin cancer is by far the most common cancer, but the overwhelming majority of cases are nonfatal, easily treated, and therefore generally not reported in cancer statistics. These are the basal cell carcinomas and squamous cell carcinomas. Melanoma of the skin is the often fatal form of skin cancer, and its incidence is among the most rapidly rising of all cancers. Exposure to **ultraviolet radiation** is the main cause of melanoma. If ultraviolet radiation increases because of stratospheric ozone depletion (see Chapter 11, Section B), further increases in the incidence of fatal skin cancer are to be expected.

Toxic Substances and Cancer After reviewing the common forms of cancer and their suspected causes, we can now ask, What portion of them is due to exposure to toxics? Tobacco smoke is easily the largest single cause of all fatal human cancers, and it is composed of many toxic substances. So in one sense, a large portion of human cancers is due to toxic substances. But other than tobacco smoke, do toxic substances cause a large proportion of human cancers? The answer is unclear and vigorously debated. At one extreme, there are some experts who argue that as many as 30% of human cancers stem from exposure to toxics (including occupational exposures) other than tobacco smoke. At the other extreme are experts who claim a negligible fraction are caused by toxics. The main U.S. agencies involved in this field, including the EPA, OTA, and NIH, take the middle ground, suggesting that about 10% of cancers result from toxic exposures other than tobacco.

One important feature of the debate is that current cancer statistics only indicate past exposures. Numerous substances have been introduced in large quantities in the past 20 to 30 years whose *latency periods* (the time between exposure and effect) are only now being exceeded. Some of these materials may significantly increase future cancer rates. In the face of uncertainty about the implications of recently developed substances and the possibility that they might interact with existing carcinogens, we as a society need to carefully control the release of new chemical materials.

Other Causes of Death

Accidents are the fourth leading cause of deaths in the United States, responsible for about 100,000 fatalities, or 5% of all deaths. Motor vehicle accidents account for half of those fatalities. Other significant causes of death related to toxic substances include chronic obstructive lung diseases (fifth leading cause, 3.4% of deaths, caused by smoking, industrial exposures, and air pollution); cirrhosis of the liver (ninth leading cause, 1.3% of deaths, caused by alcohol consumption); and kidney disease (eleventh leading cause, 1% of deaths, some cases caused by exposure to toxic chemicals).

Further Reading

BAILAR, J., and WILSON, E. 1986. Progress Against Cancer? *New England Journal of Medicine* 314:1226–1232.

COHEN, LEONARD A. 1987. Diet and Cancer. *Scientific American* 257:42–48.

FEINLEIB, MANNING, and WILSON , RONALD W. 1985. Trends in Health in the United States. *Environmental Health Perspectives* 62:267–276.

TRIBE, L. H., SCHELLING, C. S., and VOSS, J., editors. 1976. *When Values Conflict: Essays on Environmental Analysis, Discourse, and Decision.* Cambridge, MA: Ballinger.

U.S. Office of Technology Assessment. 1981. *Assessment of Technologies for Determining Cancer Risks from the Environment.* Washington, D.C.

WILSON, R., and CROUCH, E. 1982. *Risk/Benefit Analysis.* Cambridge, MA: Ballinger.