CHAPTER 1
NUCLEAR JAGUARS

In the dark, all cats are jaguars.

—*Anonymous Proverb*

As a rule, men worry more about what they can't see than about what they can.

—*Julius Caesar*

The common denominator of most radiation exposure scenarios is fear. Just mention the word radiation, and you instill fear—a perfectly understandable response given the images of mushroom clouds and cancerous tumors that immediately come to mind. Those images would justifiably cause anyone to be anxious. Nevertheless, some people have also become highly afraid of diagnostic x-rays, luggage scanners, cell phones, and microwave ovens. This extreme level of anxiety is unwarranted, and potentially dangerous.

When people are fearful, they tend to exaggerate risk. Research has shown that people's perception of risk is tightly linked to their fear level.[1] They tend to overestimate the risk of hazards that they fear, while underestimating the risk of hazards they identify as being less scary. Often their risk perception has little to do with the facts, and the facts might not even be of interest to them. For ex-

ample, many Americans are terrified of black widow spiders, which are found throughout the United States. They are uninterested in the reality that fewer than two people die from black widow bites each year, while over 1,000 people suffer serious illness and death annually from mosquito bites. Mosquitoes are just too commonplace to worry about. Likewise, the risk of commercial airplane crashes is tiny compared to motorcycle crashes, but many a biker is afraid to fly.

The point is that risk perception drives our decision making, and these perceptions often do not correspond to the real risk levels, because irrational fear is taking our brains hostage. When irrational fear enters the picture, it is difficult to objectively weigh risks. Ironically, health decisions driven by fear may actually cause us to make choices that increase, rather than decrease, our risks.

Fear of radiation is particularly problematic considering the trend in radiation exposures. Since 1980, the background radiation exposure level for Americans has doubled, and is likely to continue to climb.[2] Similar patterns are occurring in all of the developed and developing countries. This increase in background radiation is almost entirely due to the expanding use of radiation procedures in medicine. The benefits of diagnostic radiology in identifying disease and monitoring treatment progress have been significant; however, radiation has also been overused in many circumstances, conveying little or no benefits to patients while still subjecting them to increased risks. Furthermore, medical radiation is not distributed evenly across the population. While some people are getting no medical radiation exposure at all, others are receiving substantial doses. Under such circumstances, the "average" background radiation level means little to the individual. People need to be aware of their personal radiation exposures and weigh the risks and benefits before agreeing to subject themselves to medical radiation procedures.

In addition to the medical exposures, people receive radiation doses from a variety of consumer products, commercial radiation activities, and natural radioactivity sources in our environment. Some of these exposures are low level and low risk, while others can be at a high level and potentially hazardous. People need to be

aware of these different radiation exposure hazards, and protect themselves when necessary.

In the pages that follow, we will explore the story of radiation with a specific focus on health. We will investigate what we know about radiation, and how we know it. We will weigh the risks and the benefits and characterize the uncertainties. We will identify the information needed to make rational health decisions about radiation, and we will uncover the limits of that information.

Since we typically cannot see radiation, we tend to be both intrigued by and afraid of it. We have endowed radiation with magical transformative powers that produce the superheroes of our comic books, such as the Incredible Hulk (exposed to gamma rays), Spider-Man (bitten by a radioactive spider), and the Teenage Mutant Ninja Turtles (overexposure to radiation). Yet, even superheroes are ambivalent about radiation. Superman is thankful for his x-ray vision, but scared to death of kryptonite (a fictional radioactive element).

In the end, we don't know what to think. Nevertheless, we have practical decisions facing us at the individual, community, state, national, and international levels. Questions range from whether one should agree to have a dental x-ray today, to whether more nuclear power plants should be built for energy needs 20 years from now. Such questions must be answered both individually and collectively, and answered now. We cannot postpone our decisions until more data are accumulated or more research is done, and we cannot relegate the responsibility to scientists or politicians. These decisions must be made by the electorate and the stakeholders; that is, by every person in our society.

The problem is that there are different types of radiation, and they are not all equally dangerous. Regrettably, most types are invisible, and we tend to fear things that we cannot see. Furthermore, we've lumped the invisible ones all together as equally hazardous. They are not, and we need to be able to tell the difference. All cats are not jaguars.

Which types of radiation should be feared? People must decide that for themselves. But that decision needs to be based on the facts. Although some things remain unknown, obscure, or uncer-

tain, we cannot pretend that we know nothing about radiation and its health effects. The scientific and medical communities know a great deal about the effects of exposure after more than a century of experience with radiation. In fact, we know more about radiation than any other environmental hazard.

Although seeing is believing, not seeing shouldn't mean not believing. This is particularly true for radiation, since most forms cannot be seen directly. There is, however, one type of radiation that can be seen. This is light. Fortunately, light possesses many of the same properties as the invisible types of radiation. So we can overcome at least one barrier to understanding radiation by starting with the kind that we all can see, and then moving on from there to the invisible types that lurk ominously in the dark. We'll begin our radiation journey by looking under the lamppost, where reality is revealed . . . and where jaguars dare not roam.