

Predicting the Future of Human Health

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Are futurists becoming myopic? Charles Galton Darwin's predictions for the future, published in 1952, were called *The Next Million Years*. Then came the Delphi studies of the 1960s, when industrial prophets used to forecast development over the next half-century or so. Now, as the millennium approaches, nobody wants to look more than five years ahead.

Let's reverse the trend and look at what the health-care industry will be doing in the medium-term future (biologically speaking). A few thousand years from now, I suggest, the great 20th century story of the conquest of infectious diseases will be a mere footnote. By then, humankind will be living in harmony with microorganisms and indeed using them as symbiotic aids to good health.

Five strands of thinking underpin this conclusion. First, while the advent of modern drugs and vaccines had a substantial impact on infections such as tuberculosis and diphtheria, it did not have the spectacular, unprecedented effect that is often imagined. Over a much longer period, improvements in nutrition and sanitation were far more effective in reducing the toll of communicable diseases.

Well-nourished, and given decent hygiene, we can live with countless organisms that in other circumstances cause trouble. By this criterion, all pathogens are opportunists. A recent outbreak of pneumonia in a Houston jail (C.W. Hodge et al., *New England Journal of Medicine* 331: 643, 1994) illustrates the point perfectly. It was caused not by a new hot virus or a multiply resistant "superbug," it was caused by overcrowding.

Second, the undoubted successes achieved with antimicrobial drugs have encouraged their overuse and hence the burgeoning of insensitive strains to a point where many of them are literally useless. New discovery strategies and firm action to minimize resistance will help, of course. But over the time-scale we are considering here, an alternative approach is not just desirable. It is essential.

Third, microbes and humans are coevolving toward mutual tolerance anyway. As the Australian Nobel Prize-winning immunologist Macfarlane Burnet pointed out 50 years ago, it is in the long-term interests of pathogens to become less, rather than more, virulent with time. The one caveat is that we

must not open new doors for opportunists, whether by imprudent changes in food preparation or by unecological shifts in agricultural practice.

Fourth, there are signs that the crusade to eliminate infections, from the late 19th century onward, has not been wholly beneficial. One indication, discussed recently in the *British Medical Journal* (310:1482, 1995) by Anthony Wilson and Gordon Duff of the Royal Hallamshire Hospital (Sheffield, U.K.), is the increasing evidence that autoimmunity is the penalty we pay for obliterating communicable diseases.

Consider the apparent protection from autoimmune conditions enjoyed by people in parts of West Africa where malaria is endemic—in contrast to the high incidence of one of those diseases, systemic lupus erythematosus (SLE), among Afro-American populations, who are mostly of West African descent. This has prompted suggestions that high concentrations of tumor necrosis factor- α induced by malaria in West Africa, confers protection against SLE. In support of this idea, Wilson and Duff cite evidence that the development of an SLE-like condition in a mouse model of the disease is impaired both by recombinant tumor necrosis factor- α and by infection with the parasite of mouse malaria.

My fifth argument is that the use of microorganisms to control infections has had such a respectable history—though one apparently rendered irrelevant by the arrival of antibiotics—that it is now worth reexamining. Milton Wainwright of the University of Sheffield, U.K., argues the case in *Biocontrol Science and Technology* (4:123, 1995). One of his many examples is some British work during World War I in which the proteolytic "Reading bacillus" killed pathogenic organisms and destroyed dead tissue when introduced into infected wounds.

Extrapolate these five themes forward and what do we see? Not a sterile world, free of disease, in which polio, measles, and many more microbes have followed smallpox into extinction while others are vanquished by the superdrugs of tomorrow. Nor one in which microbial resistance has finally defeated the pharmaceutical industry, and the great plagues of the past determine the course of history once more. We see instead harmonious coexistence between humans and microorganisms—to the lasting benefit of both. ///