The future of public health

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Public health deals with the health and well-being of the population as a whole and its achievements over the past century, especially in the richer countries, have been truly impressive. What direction should public health take in the future?

It is an astonishing fact that half of all the increases in life expectancy in recorded history have occurred within this century and that most occurred in the first half of the century, before the introduction of modern drugs and vaccines. Life expectancy in the United States, for example, has risen from 47 years in 1900 to 78 years in 1995. It is interesting to analyse changes in life expectancy across different countries in this century as a function of *per capita* income (Fig. 1). In addition to the obvious increases in life expectancy globally over time, two additional points are worth mentioning.

First, when people are poor, they die young, and miniscule increases in *per capita* incomes can have a major impact on life expectancy. Second, even if you were enormously wealthy in 1900, there were 25 years of life expectancy you could not buy, which in 1990 could be gained even at relatively modest incomes. That which could not be bought in 1900 is, I believe, knowledge of public health in the broad sense. The major gains in health in this century have been attributable largely to the impact of public health and disease prevention, rather than to medical interventions.

Advances in public health

Public health is best distinguished from clinical medicine by its emphasis on preventing disease rather than curing it, and its focus on populations and communities rather than the individual patient. Perhaps because of this emphasis on large numbers of people, the achievements of public health in this century are truly impressive. In the industrialized world we take clean water for granted. It is only the occasional lapses in water quality, such as the outbreak of cryptosporidiosis (caused by the protozoan *Cryptosporidium*) which sickened 440,000 people in Milwaukee in 1993, that remind us how important safe water is to our collective health. In much of the developing world, however, simply drinking water is a high-risk behaviour.

In the past two decades, deaths from heart attacks and stroke in the United States have dropped by 30–50 per cent¹, in part by behaviour changes, in part by primary prevention with medications. Smoking, which is estimated to be responsible for about 20 per cent of all deaths in the United States², has declined from 42 per cent to 25 per cent of adults over 30 years in the United States

(although it has increased ominously to 36 per cent of US teenagers and is still rising). Another contribution to cancer prevention on a large scale was made when tamoxifen, a drug used to treat cancer, was found to reduce the incidence of breast cancer by 45 per cent in women at high risk. This is an example of a drug thought of as a therapeutic in clinical medicine becoming a public health tool in 'primary prevention', that is, preventing disease in individuals already known to be at risk.

Whereas population growth in the industrialized world has reached almost steady-state levels, infant mortality in the United States has declined by 26 per cent in the past decade and is at the lowest levels ever. And even these impressive figures leave the United States ranked at only twenty-fifth worldwide.

Perhaps most dramatic of all is the impact of immunization. Vaccines have eliminated smallpox from the world and polio from the Northern Hemisphere, and have reduced measles, rubella, tetanus, diphtheria and meningitis in many countries to a handful of cases each year, at a saving of millions of lives and billions of dollars. Vaccines remain the most cost-effective intervention known for preventing death and disease. Indeed, such is the success of immunization that this year, for the first time, infectious diseases are no longer the largest cause of death worldwide³.

Figure 1 Life expectancy and income *per capita* for selected countries and periods. Figure adapted from ref. 6. The income data, expressed in international dollars, are an estimation of purchasing power and derive from data in ref. 7 and World Bank data.

Disparities remain

The bad news is that the benefits of biomedical science and public health have not been made available to everyone. The disparities are striking. The country with the highest life expectancy is Japan, where people live on average to the age of 80 years; Sierra Leone has the lowest, just 37 years in 1998. And the disparities are not just between countries. Most people believe that in industrialized countries everyone can expect a relatively long life and that the major health issues centre on the quality of life and health care rather than the quantity of life. It is a shock, therefore, to learn that people born in particular rural counties of Minnesota, Colorado, Iowa or Wisconsin on average will live 25 years longer than those born in four counties in South Dakota, 23 years longer than in 12 counties in Mississippi and Alabama, and 22 years longer than people born in Washington, DC, or Baltimore, Maryland⁴. The variance in life expectancy in the United States between women of Japanese extraction in Bergen County, New Jersey, and Bennett County, South Dakota, is 41 years. Overall, disparities in life expectancy between different parts of the United States are greater than for any other nation in the world.

Curiously, the reasons underlying the disparities in the United States are by no means clear, as in many counties the correlation between *per capita* incomes and life expectancy is not particularly good. For example, *per capita* income is significantly higher in the county of Washington, DC, than in several counties along the Texas–Mexico border, yet life expectancy is significantly lower, by about 15 years, in Washington. Understanding and then reducing disparities in health and life expectancy, within and between countries, has to be an important issue on the public health agenda for the next century.

Directions for public health policy

The major thrust of epidemiology in the twentieth century was to analyse the risk factors that contribute to illness and disease. This effort was so successful that we probably now know all the major risk factors. But this is just the beginning. There are four areas in which I believe public health will have an increasingly important role.

First, we need to develop more sensitive

Figure 2 Traffic accidents are becoming a major killer in developing countries.

epidemiological approaches that can identify the many additional risk factors of smaller effect. Also, we need to design better randomized trials so that the biases that prevent us from establishing causation can be eliminated. Second, epidemiological surveillance is needed not only to trace emerging infections but, more generally, systematically to ascertain the burden of disease (that is, the years of healthy life lost because of each disease). Together with analysis of the economic costs of those diseases to individuals and society, and the costs of the interventions available to prevent or treat them, this will enable us to set rational priorities for public spending on research. Such research should be aimed, for example, at establishing where effective interventions are lacking or too expensive to be widely used, and where resource allocations for treatment can result in the most years of healthy life per unit of health expenditure.

While an analysis of cost-effectiveness will be helpful, it will have to go hand in hand with an assessment of the quality of health care and health-care systems in order to set rational priorities in health spending. In the United States alone, a trillion dollars is spent on health care — half of the entire global expenditure on health. Thus, the third area in which public health should have a growing role is in understanding the burdens and costs of interventions, and improving the quality and efficiency of the health service.

Finally, one of the myths of the modern world is that health is determined largely by individual choice and is therefore a matter of individual responsibility. In fact, most behaviour is socially patterned and reinforced in groups. Just providing health information to people is not an effective way to change their behaviour. To make a difference in conditions that we know can be prevented (such as those due to smoking, alcohol and drug abuse, and obesity, hypertension and sexually transmitted diseases) it is essential that we develop a public health approach that will protect populations and establish prevention strategies for groups, not just for individuals.

There are, in fact, some strategies that have made a difference at the population level, with the saving of millions of lives. Local and national decisions have been made to protect the public's health by controlling the environments that cause disease: laws and standards have been adopted that protect us from health hazards in water, food, milk, alcohol and the workplace, and public policies on vaccination have been developed. Now we require a greater understanding of human behaviour, and must learn to develop more effective strategies for changing harmful behaviour. Whereas cigarettes are currently advertised in every country of the world, no one is spending billions of dollars to advertise the pleasures of salmonella or cryptosporidium contamination of the water! The challenge is to change behaviour in the face of massive advertising of tobacco, unhealthy foods and alcohol (which do indeed impart pleasure, at least in the short term). As many health-damaging behaviours are cumulative, we need to reduce unhealthy behaviour in as many people as possible. If we focus at the population level, we will benefit vast numbers of individuals.

Whether public health will have the same impact on health in the twenty-first century as it has in the twentieth is unclear. However, it is not unreasonable to speculate that the unfolding knowledge of the human genome, together with epidemiology and biostatistics (core disciplines in public health) and computational biology, will have an increasingly important role in relating genetic variation and differences in gene expression to individual disease susceptibilities. Studies of large cohorts, such as the Harvard Nurses Study — a group of 121,000 healthy women followed for 23 years⁵ — will enable investigators prospectively to link not only extrinsic and environmental influences such as diet or smoking to the risk of developing a particular disease, but to associate extrinsic risks with intrinsic genetic susceptibility and resistance. This will essentially allow those in the rich countries to create individually tailored drug regimens and behavioural modi-

fications for overcoming predicted individual disease risks, creating a new field of 'boutique medicine'.

But we live in a world in which many countries are not sharing in the benefits of globalization and are not experiencing increased standards of health and quality of life. Much of the knowledge about individual risks that will derive from the Human Genome Project and modern biomedical science, and the resources to obtain the boutique treatments and preventions to overcome these risks, will simply not be available to the 85 per cent of the world's population who comprise the Third World. One can only hope that from the scientific knowledge gained in our current pursuit of sophisticated approaches to treat disease at the individual level, there will also emerge effective, safe and affordable preventions and treatments of relevance at the population level. It is principally these interventions that will make a difference in reducing the global disparities in health and in improving the life expectancy and quality of life of people in even the poorest countries and parts of countries.

We know that cardiovascular disease, infectious diseases, psychiatric disease and physical injuries represent the major global burdens of disease and disability in industrialized and developing countries alike. The challenge for biomedical science and public health in the coming century is to develop the population-based interventions needed to reduce these burdens. Vaccines to prevent AIDS, malaria, tuberculosis, dysentery and other respiratory and diarrhoeal diseases are needed. In addition, effective drugs to prevent as well as to treat cardiovascular disease and psychiatric illness are required, as are effective interventions to prevent injuries, for example, improving road and automobile safety worldwide (Fig. 2) and preventing injuries due to falls in the elderly. That, in my view, will be the major global challenge for biomedical science and public health in the twenty-first century.

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