During the last century, humanity has made marked achievements in its eternal struggle against premature death. Although the average lifespan has increased, the number of really longevous people has not increased. However, the period during which people suffer from disorders associated with old age and become dependent on others has increased. Is there a way out of this situation? We believe there is.

**Good Health Is Self-Sufficiency**

**V. N. Anisimov and V. N. Krut’ko***

In the 20th century, science has enriched humanity with a number of discoveries, each of which has worked a qualitative change in civilization. Just like many other formerly unfamiliar terms, the “computer,” the “atom,” the “sputnik,” and the “gene” are associated, on the one hand, with fundamentally new possibilities for accelerated progress and, on the other, with a whole range of extremely difficult social–economic and research problems. Gerontology and lifespan biology have also been developed this century. However, the public at large knows very little about the range and nature of questions that form the subject matter of these young disciplines. Our purpose is to make up for this deficiency.

TRIUMPH AND CRISIS OF THE PUBLIC HEALTH SERVICE

A population’s health standard is an important indicator of the quality of life. Many experts maintain that it is the cardinal criterion. At the same time, the main indicator of a nation’s health is the healthy, “disease-free” lifespan. For instance, the chief aim of the United State’s national health promotion and disease prevention program, which ends in 2000, is a 78-year life expectancy and 65-year healthy lifespan indicator [1]. The World Health Organization’s (WHO) European Regional Bureau states that, by the year 2000, the life expectancy indicator in Europe will be at least 75 years [2].

The achievements of medical science and public health services in the 20th century have nearly doubled the lifespan (Fig. 1). This accomplishment is largely due to processes defined as two epidemiological revolutions (ERs) [3].

The first ER, which began in the late 1890s and ended in the 1950s, considerably lowered the mortality caused by contagious diseases. This was made possible by mass vaccination programs and the invention of antibiotics. The second ER occurred in the 1960s–1980s. It enabled economically developed countries to lower mortality from noncontagious chronic diseases, such as cardiovascular disorders and cancer. However, the effect was not as impressive as in the first case. K. Kuper points out that, in the United States in the period from 1968 to 1977, deaths from cardiovascular diseases dropped 23 percent, including 36 percent from insult and 48 percent from hypertension [4].

However, during the same period, the lifespan showed an increase of only 2.7 years. Whereas humanity used to mainly suffer from plague, cholera, and smallpox and later from tuberculosis, diphtheria, influenza, and croupous pneumonia, the character of diseases today has radically changed. In developed countries, 85 out of 100 deaths are due to cardiovascular diseases, cancer, diabetis mellitus, mental disorders, and obesity. As the lifespan becomes longer, the number of years people suffer from poor health and complete or partial dependence on others increases.

The possibilities for prolonging life with the help of the aforementioned means have been practically exhausted. Therefore, the WHO has announced a new

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strategy. Formulated in the Ottawa Charter for Promotion of Health, it is regarded as the third epidemiological revolution [5]. In the drive for health, the emphasis is now on devising and observing self-preserving behavioral patterns oriented toward active longevity. It is the duty of the state to execute a whole range of social–economic measures that would improve the quality of life.

Though this strategy is costly and laborious, it does not promise a sizable increase in the healthy lifespan. Therefore, it would be fair to mention stagnation in the improvement of people’s physical condition. The traditional approaches in public health practices, which are based on the “human ecology” paradigm, i.e., on studies of people’s relations with their social and natural environment, are hardly effective. Most specialists maintain that medicine and public health services are gripped with a crisis both in separate countries and throughout world. This tendency is illustrated by the fact that the curves reflecting changes in lifespan (Fig. 1) have approached a limit.

What are the causes behind this crisis?

As a natural–social phenomenon, mortality may be represented in the form of a sum of two components: first, environmental factors in a broad sense and, second, evolutionally conditioned biological mechanisms governing the organism’s vital activity [6]. The 20th century has witnessed a change in the relationship between these components. In the past, each of them played a big role in determining the mortality rate of a population. However, today, developed countries have managed to practically remove the effect of environmental factors (Fig. 2). Does this affect the lifespan? And if so, how?

Figure 3 clearly shows that the shape of the “living-out” curve (i.e., the curve reflecting the late period of life) approaches that of a right angle. This means that, though the average lifespan has noticeably increased, the maximum length of life remains practically unchanged. However, our calculations show that even in an ideal environment, which is free from harmful agents, the living-out curve will never acquire this shape because the population is genetically heterogeneous. It follows that it is impossible to prolong the average lifespan today, unless its maximum indicator increases. This means that the only way to extend an individual’s lifespan is to influence the fundamental processes in the organism that determine the length of life of the given species.

SOCIAL–ECONOMIC ASPECT OF AN AGING POPULATION

Rapid aging of the population is the direct outcome of increased life expectancy, on the one hand, and a declining birth rate, on the other. In 1975, people 65 and over accounted for 5.3% of the world’s population. Specialists say that their share will increase to 6–8% by 2000. In developed countries, people of this age group make up 10–17% of the total population and, by the 2020s, this indicator will double [7]. The bigger towns and cities are gradually developing into “pensioners’ homes.” This tendency is increasing the “demographic load” on society and its economy (this is manifest in the ratio of the nonworking to the working population). Aging of the population causes changes in the structure of employment, social services, and budgetary resources to assure their timely adjustment to the new conditions. Thus, compared to 1960, federal appropriations in the United States in 1991 for aid to the elderly doubled. Today, these outlays account for one quarter...
changes, the RAS Institute of Systems Analysis considers the problem of extending the period of health and fitness (for work) during the lifespan to be a really serious problem that should be resolved without delay.

Our analysis shows that the use of such agents (now known as geroprotectors) in the immediate future will make it possible to increase the lifespan by an average of 15 years. This will enable Russia to prevent the demographic load factor from exceeding 0.7 and, in turn, help limit the scope of social–economic restructuring measures that would have otherwise been forced on society by the aging population. An individual approach to every case is even more effective. This is manifest in the application of a whole range of agents to improve the functioning of various levels and systems of the organism. This approach may increase the lifespan by 40–50 years.

However, it is important to know how an individual will live these “additional” years. Another significant point is that employment of geroprotectors “disproportionately” increases the period of active life and youth, though the old-age “phase” remains the same (Fig. 4, curve 2). It follows that the purpose is to improve the quality of life in general.

Aging inhibitors (retardants) may produce even more impressive results (Fig. 4, curve 3). Today, humanity is in a situation where the increase in the average lifespan is not accompanied by positive dynamics of its maximum length (compare Fig. 3 with curve 1 in Fig. 4). In this case, in both animals and people...
ple, the indicators of old-age disorders, cardiovascular diseases, and cancer, above all, show an increase [11].

Therefore, it would be fair to say that research for considerable extension of an individual's healthy and active life through gerontological research will effectively help solve public health problems. This line requires a fundamental review of public health service policies, methods, and results. This may be regarded as the fourth epidemiological revolution.

The latest achievements in informatics will “cata-
lyze” this revolution. Informatics will present, in quanti-
tative terms, the health-forming process. It will enable the public health service to switch over from a “pas-
"sive” health protection policy to constructive “health development” practices, to abandon the motto “this is conducive to health,” and to adopt the maxim “this pro-
motes health and ensures so many ‘extra’ years of active life.” Informatics help optimize the distribution of resources (on the basis of the maximum number of extra years of active life per input unit) and calculate the results of health-promotion measures in terms of lifespan, with respect to both the individual and the population [13]. This approach is being practiced more and more. For example, the World Bank has calculated that, in developing countries, an additional year of life “costs” five dollars per individual if this money is invested in measles vaccination, and $35 if it is invested in antibiotics for the population.

We have tried to draw the attention of the scientific community to this outstanding problem. To solve it, it will be necessary to accomplish a wide range of narrow professional and interdisciplinary tasks, including research in gerontology and lifespan biology;

development of geroprotector agents, production processes, and methods for the practical employment thereof;

conducting clinical tests (studies) of new agents and methods for prolonging life;

development of models and algorithms for appraising and forecasting changes in the organism’s functional reserves, its biological age, and life expectancy under the impact of a whole range of factors increasing or decreasing the lifespan (of individuals or populations); and

analysis of demographic, social, and economic con-
sequences following from one scenario or another designed to increase the lifespan at the population level.

To accomplish the tasks above, the government should launch a National Complex Special Purpose Program for Prolonging the Lifespan.

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