PREVENTIVE, THERAPEUTIC, AND DIAGNOSTIC TECHNOLOGIES. DEVELOPMENT AND PERSPECTIVES

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Contents

Summary

Medical care will rapidly progress with the application of the knowledge gained from research on the human genome, the development in informatics, the production of biocompatible materials, and the synthesis of new types of drugs that interfere in specific biological processes. Surgical care, as well as conservative therapy and diagnostics, will benefit from the provision of the new technology. However, the most efficient and cost effective outcome will be achieved through vaccination against communicable and non-communicable diseases.

1. Introduction

Health research and the provision of health care have become increasingly complex. The health status of populations and health care systems vary from one country to another, and modern health technology is versatile and sophisticated. This explains why health technology that proves to be effective in one condition may be less feasible for a different environment. Forecasting the impact of health technology in the future will have to take account of the differences in the provision of health to populations that live in various parts of the world.

Of the two main strategies for providing health, curative care is the dominant strategy in industrialized countries, whereas preventive health care is receiving more attention in developing countries, the reasons being that a) developing countries prefer to manage the health care system by means of the public sector, and b) the health sector often receives little financial support from government. In curative health care, the driving force for innovation is the interest in providing effective care to the individual, whereas

in preventive care it is efficiency in the provision of health to a population. Technology for curative care has immediate and often dramatic effects on individuals; the effect of technology for preventive care, however, may be evident only after years, and at the social level rather than at the individual level. Although preventive care was marginalized in industrialized countries, it is now receiving more attention in these countries since it has been found to be more cost effective in saving additional life than is curative care.

2. Preventive Medicine

The most important success ever achieved in reducing disease burden has been mass vaccination. The vaccination of the world's population against smallpox, which was one of the major life-threatening dangers until the late twentieth century, led to complete eradication of the disease. Poliomyelitis will no doubt be the next disease to have been eradicated, in the twenty-first century. The development of effective vaccines, and the establishment of vaccination programs visibly reduced the morbidity and increased the life expectancy of populations. New vaccines against infectious agents that are now the main causes of death, such as human immune deficiency and dengue viruses, bacterial, and protozoal agents transmitting tuberculosis, schistosomiasis, and malaria, are under development.

The vaccination campaigns were initiated against communicable diseases. Observations indicating a link between infections and non-communicable diseases initiated new development of vaccines for the prevention of non-communicable diseases, including certain forms of diabetes, cardiovascular disease, and certain types of cancer. The classical procedures for treatment of cancer are surgical intervention, chemotherapy, and radiation. However, patients suffering from cancer can often not be cured by these procedures. The immune system, which serves to protect the human body from hazardous agents, often does not recognize and therefore does not destroy tumor cells through an appropriate immune response, since many cancer cells do not carry antigens at their surface to trigger an appropriate immune response. In therapeutic immunization, vaccines containing cancer specific antigens will cause a strong and immune reaction that selectively destroys the tumor without affecting the normal tissue. In recent clinical experiments, patients suffering from metastazing nephrocarcinoma or melanocarcinoma showed full remission after treatment with a newly developed vaccine using monoclonal antibodies.

Research in biotechnology will have found ways to produce vaccine-carrying nutrients on a large scale. Genetically manipulated nutrients, such as potatoes, bananas, and corn may give ways to overcome major logistic constraints of vaccination programs for populations in developing countries.

3. Therapeutics

Another major achievement of the last half of the twentieth century in disease control has been the discovery of antimicrobials. Antimicrobial therapy has been so effectively introduced that a number of communicable diseases now contribute only marginally to the disease burden in most developed countries. Antimicrobial drug treatment has also

changed the social behavior of populations. Patients who suffer from certain communicable diseases are no more expelled from modern society, as they were during the Middle Ages. In developing countries similar trends can be observed.

However, communicable diseases are challenging the world's population again. Misuse and overuse of antimicrobials has led to a biological selection process. As a consequence, antimicrobial drug resistant strains of bacteria are causing a resurgence of diseases that were widely believed to be under control. Although the situation calls for new types of antimicrobials, their success in clinical therapy may not be sufficiently guaranteed, unless strict measures are implemented towards ensuring the proper use of antimicrobials worldwide.

The combined knowledge of the regulation of viral multiplication, the analysis of the molecular structure of enzymes involved in these processes, and computer-aided design have taught us how to synthesize new drugs with highly selective action. Such drugs are urgently needed to treat viral infections, such as immune deficiency virus and herpes virus infections, which cannot yet be effectively controlled.

Recombinant gene technology has been introduced by industry for the production of biologicals for human therapy. The industrial production of proteins of the coagulation system, insulin, and human growth hormone are examples that show how recombinant technology can secure the provision of safe and highly specific drugs of biological origin in the future that presently are not available in sufficient quantities for medical therapy.

Chemotherapeutic agents for the treatment of patients have the major disadvantage that they lack specificity and have unwanted systemic side effects. With new types of drugs, including "antisense drugs" and peptide nucleic acids for the selective treatment of cancer, viral diseases, and metabolic disorders, unwanted side effects will be avoided. These drugs interfere in the intracellular transcription and translation processes of cells. "Suicide genes" can be transferred into cancer cells able to destroy tumor cell during selective chemotherapy.

Research has found ways of using viruses or synthetic chromosomes as vectors for the introduction of normal genes into defective cells for treatment of blood diseases. The manipulation of genetically deficient germ cells will help to prevent hereditary diseases that today can only be symptomatically treated. However, manipulation of germ cells also opens the way for potential misuse. The production of humankind *in vitro* is already a reality.

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Biographical Sketch

Dr. Claus Heuck was trained as an organic chemist and specialized in internal medicine and laboratory medicine. He graduated with a doctorate in science, a doctorate, and a habilitation thesis in medicine at the University of Heidelberg, Germany. In 1971 he spent one year as a postdoctoral fellow at the Banting and Best Institute for Medical Research, Toronto, Canada. In 1983 he was nominated as a member of the Faculty of Medicine of the University of Heidelberg. In 1986 he received a call to the medical institutions of the University of Düsseldorf, Germany. From 1988 he was granted leave on being called to the headquarters of WHO in Geneva, Switzerland.

His scientific area of interest is the biological action of synthetic polymers in the field of coagulation and lipoproteins. He has also become involved in international standardization and quality assurance of clinical laboratory services and the promotion of clinical laboratory services in countries in need.