Chapter 2

Public Health Implications of Emerging Vaccine Technologies

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1. INTRODUCTION

This book provides insight into recent innovations or improved applications of existing technologies in the design of vaccines for the prevention of several specific diseases. It makes a broader contribution to the understanding of the vast array of technologies that support modern vaccinology. The objectives of this chapter are: (1) to provide an overview of how advances in vaccine-related technologies have fostered the development of vaccines with highly desirable characteristics for current and future public health vaccination programs; (2) to explore how the development and availability of such vaccines will shape public health concepts, policies, and practices; and (3) to explore how institutional and procedural changes may alter vaccine research and development, manufacture, and delivery to populations in need of immunization.

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1.1. The Children’s Vaccine Initiative

The goals as outlined in the Children’s Vaccine Initiative (CVI) have provided a remarkable stimulus for research and development of novel vaccine strategies and technological advances. In a “Declaration of New York” following the World Summit for Children, New York City, September, 1990, it was proposed that vaccines be developed that: (1) require one or two rather than multiple doses; (2) are able to be given early in life; (3) are able to be combined in novel ways so as to reduce the number of required injections or visits; (4) are stable, retaining potency during transport and storage; (5) are effective against a wide variety of diseases, including AIDS, acute respiratory infections, diarrheas, and parasites of public health importance that are not currently included in mass immunization campaigns; and (6) are affordable (V. S. Mitchell et al., 1993; La Montagne and Rabinovich, 1994). Some or all of the new technologies discussed in this chapter can contribute to achieving the goals of the CVI.

1.2. Unconquered Pathogens and Other Clinical Indications

While currently available vaccines have proven to be extremely powerful tools for disease prevention, many infectious diseases remain poorly controlled by available public health measures because of an absence of effective, safe, and licensed vaccines. Effective vaccines that prevent the diseases caused by an “unconquered pathogen” can provide the core for implementing a comprehensive control program. After more than a century of international attempts to develop vaccines to prevent many of these diseases, including the use of increasingly sophisticated technologies, many serious pathogens of humans and animals remain uncontrolled (Plotkin and Plotkin, 1994). Such microbial adversaries include organisms causing affictions described for hundreds or thousands of years, i.e., Neisseria gonorrhoeae, Treponema pallidum (syphilis), Mycobacterium leprae, Trypanosoma sp. (African sleeping sickness, Chagas disease), Plasmodium sp. (malaria), and the schistosomes. Pathogens such as rotavirus, streptococcus (Groups A and B, S. pneumoniae), respiratory syncytial virus (RSV), and parainfluenza continue to cause considerable pediatric morbidity and mortality worldwide. CMV infections in utero can cause devastating damage to the fetus. Shigella continues to be a major cause of diarrhea. Substantial efforts to develop improved vaccines against organisms such as M. tuberculosis and Vibrio cholerae are still incomplete (National Institute of Allergy and Infectious Diseases, 1993). Moreover, there is a need to develop strategies of control for a number of emerging diseases and syndromes such as Lyme disease, hemolytic uremic syndrome caused by Escherichia coli 0157:H7, drug-resistant pneumococcal disease, and the recently recognized hantavirus pulmonary syndrome (Centers for Disease Control and Prevention, 1993). Significant societal and economic benefit would be realized if the worldwide struggle to develop effective vaccines against the human immunodeficiency virus, type 1 (HIV-1), the cause of AIDS, is successful.

Special attributes of the “unconquered pathogens” or limitations in the repertoire of host immune responses probably account for their having eluded vaccine preventive efforts to date. Perhaps the new biotechnologies can overcome these obstacles through novel vaccine antigen presentation, formulation, or delivery. Identification of immunological