CHAPTER 7

Social Confounders of Vaccine Response

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Introduction

Among public health initiatives, vaccination has played an important role in improving human health. Every year, it is estimated that vaccines prevent about six million deaths worldwide (Ehreth 2003). In the US, vaccines such as MMR (Measles, Mumps, and Rubella), DTP (Diphtheria, Tetanus, and Pertussis), and Hib (Haemophilus influenza type B vaccine) have been responsible for a 99 percent decrease in incidents of those diseases. This decrease has resulted in a similar decline in mortality and disease sequels from 1990–1998 (Centers for Disease Control and Prevention (CDC) 1999). However, the concept of “one size fits all” in the vaccination field has been used in populations with very different characteristics (Kennedy and Poland 2011; Poland, Ovsyannikova, and Jacobson 2008). The assumption is made that most people will respond and develop antibodies in the same way; therefore, the same vaccine doses are administered equally to different groups of people. This practice overlooks individual and subpopulation differences in immune responses, such as poor vaccine response due to inadequate uptake of the antigen or failure of the immune system to produce the appropriate antibody response. Such differences are partly due to the complex interaction between biological, genetic, social, and environmental factors in immune response. Although the final goal of vaccine research is ideally to develop a universal vaccine that provides standardized protection to various populations across the world, inconsistent outcomes of vaccinations have been observed across populations with different features. A study conducted in the UK and Malawi, regarding the Bacillus Calmette-Guérin (BCG) vaccination
against tuberculosis (TB), has shown that the “one size fits all” approach is unlikely to be the best option. The same study reported that since the BCG vaccination was introduced in the UK adolescent population, the protection against pulmonary TB has increased from 50 to 80 percent. However, no protection was observed when the same BCG vaccine was used in Malawian adolescents (Black et al. 2002). It was suggested that the variability in BCG efficacy is the effect of the populations’ differential sensitization due to environmental mycobacteria exposure. Thus the universally standardized vaccine is not effective in every locality.

Throughout the history of vaccinology, the development of vaccines has relied on trial-and-error experimental processes that may influence the pathway of vaccine response; the early events of immunity development remain unknown. The task of vaccine development focuses on reducing a pathogenic microbe to its smallest immunogenic component. It then relies on the immune system to build a protective immune response against it. Later in the process, the same immune system will destruct the exogenous microbial particles. The success of vaccine development is dependent on the human responses at the end of clinical trials. If the experimental vaccines do not induce the expected protective and sustained immune response, alternative antigen candidates are selected or new adjuvant delivery systems are formulated and developed; the developers then begin again with trial and error. An additional challenge in the development process is that the human immune system is highly complex and the environmental factors that change the intrinsic capacity of the recipient’s response to a vaccine remain mostly unknown (Bernstein, Pulendran, and Rappuoli 2011).

Once the vaccine has been introduced into a population, every characteristic of the population plays a role in the human biological pathway of vaccine response. Such characteristics could play an important role in biological processes in the global setting. Vaccines are critically important to human health, especially in low- and middle-income countries (LMICs); further research in the field of vaccine efficacy and socioenvironmental factors is required to improve the process of developing vaccines for the benefit of different populations.

For a long time, immunological research has focused on the interplay among biological, behavioral, and social factors in health and disease. More recently, the influence of social factors on the immune system has been investigated (Azad et al. 2012; Cohen and Herbert 1996; Dowd et al. 2008; Ponton et al. 2011). However, similar research on the relationship between the social environment and responses to vaccines is currently lacking. At present, there are no extensively validated approaches for studying the