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Why public health might address the emerging role of vaccinomics?

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The greatest public health benefit of the advances brought about by the understanding of the human genome, completely sequenced in 2000, will likely occur as genomic medicine expands its focus from rare genetic disorders towards the inclusion of more common diseases also, such as coronary heart disease, diabetes mellitus, cancer and infectious disease. Advances in Genomics hold the promise of improving the delivery of health care, particularly that of preventive medicine, and of tailoring drug treatment. The recently approved Italian National Prevention Plan assigns an important potential role for health promotion and prevention of diseases to predictive medicine, thus confirming the need for a responsible transmission of genome-based knowledge into health system. The integration of genome-based knowledge has the potential to change preventive strategies, resulting in the possibility of targeting primary (e.g., vaccines) and secondary prevention (e.g., assiduous monitoring) for those individuals more susceptible to common complex diseases because of their genetic make-up. Public Health Genomics (PHG) is an emerging multidisciplinary scientific approach which aims to integrate genome-based knowledge in a responsible and effective way into public health [1] and it fosters progress in translational research and supports the introduction of new concepts of prevention [2, 3]. In our opinion, how genome-based information might affect vaccine development and potentially modify vaccination policies is an important public health issue to be faced due to the practical implications it implies [4].

Since the origin of modern vaccination in 1796, when the smallpox vaccine was made available, the history of vaccinology from the 18th century until the 1990s can be briefly synthesized by the "isolate, inactivate and inject" Pasteur paradigm, widely used for the development of the most successful vaccines [5]. The second generation recombinant-type hepatitis B vaccines began to introduce the challenging approach of molecular medicine into vaccinology. Afterwards pneumococcal and meningococcal vaccines were developed by means of what is called reverse vaccinology that is applied to the pathogens' genome to identify the full repertoire of surface expressed antigens instead of the classical approach to use either whole microorganisms (either killed or live attenuated) or purified subunits of a microorganism [6, 7]. Given the crucial role of the individual host's immune system response to vaccination in terms of its antigenic protection and safety, the other side of the coin is represented by the role of human genomics in vaccine design named vaccinomics [6]. It refers to the investigation of heterogeneity of host genetic markers at the individual or population level that may result in variations of humoral, cell-mediated, and/or innate immune responses to vaccines [8]. Apparently the emerging field of vaccinomics seems to provide a more personalized or individual approach to vaccine practice, but it might change the well established vaccination policies. In fact, a poor or lacking response to vaccination not only threatens vaccinated individuals, but potentially affects the so called herd immunity that works only if immunization rates in a community are consistently high, thus allowing the final goal of vaccination programs to prevent or, at least, reduce the transmission of a pathogen within that population [9]. Thus, the exploding field of vaccinomics might represent a new ''golden era'' in vaccinology [10] that will allow us to answer vexing questions such as, if those who are genetically susceptible to a disease should be vaccinated, or which schedule should be adopted (how many doses and the time interval between them) or the extent of significant adverse events that are likely to occur.

DNA vaccines could represent a viable alternative to classical vaccines, which rely on attenuated viruses or subunit vaccines because of several advantages.They are more stable, less expensive, easy to modify in response to viral mutations, and safer than subunit or viral-based vaccines. As

the immune response to DNA immunization can also be enhanced by using molecular adjuvants acting as immune modulators able to direct the T-helper cell toward the desired pathway [11], research efforts are focusing on more effective vaccine formulations that can be developed by incorporating novel immunostimulators as potent adjuvants, thus stimulating both innate and appropriate adaptive immunity.

As the increasing application of vaccinomics due to the application of whole-genome scanning occurs, the ever-growing body of genomic data on the individual inherited vaccine response will be responsibly managed by public health pesonnel to enable timely improvement of vaccination practices.

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