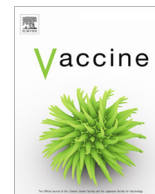




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Vaccine strategies: Optimising outcomes

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ABSTRACT

Successful immunisation programmes generally result from high vaccine effectiveness and adequate uptake of vaccines. In the development of new vaccination strategies, the structure and strength of the local healthcare system is a key consideration. In high income countries, existing infrastructures are usually used, while in less developed countries, the capacity for introducing new vaccines may need to be strengthened, particularly for vaccines administered beyond early childhood, such as the measles or human papillomavirus (HPV) vaccine. Reliable immunisation service funding is another important factor and low income countries often need external supplementary sources of finance. Many regions also obtain support in generating an evidence base for vaccination via initiatives created by organisations including World Health Organization (WHO), the Pan American Health Organization (PAHO), the Agence de Médecine Préventive and the Sabin Vaccine Institute. Strong monitoring and surveillance mechanisms are also required. An example is the efficient and low-cost approaches for measuring the impact of the hepatitis B control initiative and evaluating achievement of goals that have been established in the WHO Western Pacific region. A review of implementation strategies reveals differing degrees of success. For example, in the Americas, PAHO advanced a measles-mumps-rubella vaccine strategy, targeting different population groups in mass, catch-up and follow-up vaccination campaigns. This has had much success but coverage data from some parts of the region suggest that children are still not receiving all appropriate vaccines, highlighting problems with local service infrastructures. Stark differences in coverage levels are also observed among high income countries, as is the case with HPV vaccine implementation in the USA versus the UK and Australia, reflecting differences in delivery settings. Experience and research have shown which vaccine strategies work well and the factors that encourage success, which often include strong support from government and healthcare organisations, as well as tailored, culturally-appropriate local approaches to optimise outcomes.

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Abbreviations: AMP, Agence de Médecine Préventive; DTP, diphtheria-tetanus-pertussis; EPI, Expanded Programme on Immunisation; GAVI, Global Alliance for Vaccines and Immunisation; HBV, hepatitis B virus; HBsAg, hepatitis B surface antigen; HPV, human papillomavirus; MMR, combined measles-mumps-rubella vaccine; MVP, Meningitis Vaccine Project; NESI, Network for Education and Support in Immunisation; NITAG, National Immunisation Technology Advisory Group; PAHO, Pan American Health Organization; SAVIC, South African Vaccination and Immunisation Centre; SIA, supplementary immunisation activities; WHO, World Health Organization.

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1. Introduction

Successes in the eradication of smallpox offered high hopes for vaccines and the control of infectious diseases [1]. This experience contributed to the Expanded Programme on Immunisation (EPI), which was introduced in 1974 by the World Health Organization (WHO) [2]. Comprehensive vaccination programmes were developed and became the cornerstone of good public health intervention [3].

Although progress has been impressive, global vaccination coverage rates show there is room for improvement, with nearly 19 million infants not receiving routine immunisation, such as three doses of diphtheria-tetanus-pertussis (DTP) vaccine, in 2014 [4]. More than 60% of these children live in 10 countries in Africa

and Asia, indicating regional disparities [4,5], although outbreaks of vaccine-preventable diseases in high-income regions show that there is a need to expand or adapt vaccination strategies worldwide [1,6].

The benefits of successful vaccination strategies are clear, providing not only direct protective effects but also sometimes indirect effects among unvaccinated individuals (herd protection) [7,8]. The consequences of under-vaccination include a shift of infection to different age groups and rebound effects [9].

Strategies to address vaccine hesitancy are discussed in an accompanying paper [6]. This paper provides an overview of the vaccine introduction strategies and the key factors underlying their effectiveness.

2. Key principles of vaccination strategies

The main objective of all vaccination strategies is to meet disease reduction goals by achieving high levels of immunity in the targeted population via adequate immunisation coverage and vaccine effectiveness (Box 1) [10]. The strategy varies according to the target of a vaccination programme, which may be selected groups or whole populations (Table 1). Theoretically, targeting subjects with the highest risk of disease or its complications would be most effective, since the rate of prevented cases per administered dose

would be maximised. Unfortunately, vaccine-preventable diseases are often not exclusively present in risk groups or there is no particular risk condition for their acquisition (for instance, measles, rubella, varicella and rotavirus). The other difficulty lies in the ability to reach all those at risk, since healthcare systems may fail to ensure patients receive all recommended vaccines, as discussed in an accompanying paper [11]. Consequently, age-based strategies complemented by risk group strategies have been found to be most effective for disease reduction [12].

For most vaccine-preventable diseases, a single cohort approach is used in which immunisation is started at a given age (for example, 2–3 months for DTP) and the targeted population receives all recommended doses at specific times. Sometimes a double-cohort approach is useful to speed up the impact of a vaccination programme, for instance, simultaneous vaccination of infants and adolescents or young adults [13,14]. Mass vaccination occurs when a large number of people are immunised within a short period of time for efficient disease reduction and generation of herd protection, depending on the mode of disease transmission [15]. It may be used in response to an emerging or existing epidemic, such as polio in the 1950s [16] and, more recently, meningococcal, measles and yellow fever epidemics in sub-Saharan Africa and Latin America [15]. This programme may also be employed to prevent a predicted epidemic, such as the annual influenza campaign in industrialised countries [15]. For catch-up vaccination, in addition to routine immunisation of an age cohort, other population groups are actively offered vaccination, usually for a limited time.

Various factors are considered when determining the feasibility of the immunisation strategy in the targeted population. This includes the demographic composition of the population to immunise, the age at which most disease cases occur and the biological and social factors underlying infection transmission that determine the basic reproductive rate (R_0) of the infectious agent [8,9]. Calculation of the disease burden, expressed in terms of incidence and prevalence rates, associated hospitalisations, disability and mortality, provides valuable information on the particular disease and its importance or seriousness compared with other health conditions [10]. Detailed mathematical models can help make inferences on the total disease burden when such data are incomplete, as well as on spread of infection and critical vaccination coverage [17].

Assuming vaccination is feasible, the strategy for its introduction must take into account the structure and strength of the local healthcare system, service funding and means of monitoring success. Each of these factors is considered below.

Box 1

Main elements of vaccination strategies.

Programmatic objectives	<ul style="list-style-type: none"> • Meet disease reduction goals in targeted population via <ul style="list-style-type: none"> – Adequate immunisation coverage – Adequate vaccine effectiveness
Factors for an effective vaccination strategy	<ul style="list-style-type: none"> • Structure and strength of local healthcare system <ul style="list-style-type: none"> – Infrastructure for vaccine distribution and administration – Compatibility with existing immunisation calendar – Political will • Immunisation service funding • Surveillance and monitoring systems for disease impact and vaccine coverage
Implementation aspects	<ul style="list-style-type: none"> • Strategy and planning • Human resources • Supportive framework • Advocacy and communication

Table 1

Main vaccination strategies and disease reduction goals.

Vaccination strategy ^a	Example vaccine	Goals
Routine vaccination (selective immunisation)		To eradicate, eliminate or contain disease
Single birth cohort	DTP, Rotavirus HBV	
Double cohort (e.g., infants and adolescents)		
Mass immunisation (entire population in affected area or priority risk groups ^b)		
Response to an emerging epidemic	Yellow fever	To rapidly limit morbidity and mortality due to the documented presence of a vaccine-preventable disease
Response to a predicted epidemic	Influenza	To establish population immunity before risk occurs
Response to a diseases outbreak	Hepatitis A	To establish population immunity and reduce number of cases after several cases are reported in a certain area/group of people
Catch-up vaccination	MMR	To protect individuals whose vaccinations have been delayed or missed
Specific immunisation campaigns/supplemental immunisation activities	OPV	To eradicate, eliminate or contain disease, where not achieved by routine vaccination

Abbreviations: DTP = diphtheria-tetanus-pertussis, HBV = hepatitis B virus, MMR = measles-mumps-rubella, OPV = oral poliovirus.

^a A combination of strategies may be appropriate, most commonly age-based complemented by risk group strategies.

^b Priority risk groups: groups at highest risk of disease morbidity or mortality, such as young children, pregnant women, older adults, healthcare professionals.

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