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The role of surveillance in assuring mutual protection for vaccine-preventable diseases

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ABSTRACT

Herd immunity is crucial for the success of vaccination programmes. Immunity levels needed for assuring mutual protection strongly depend on vaccine coverage, and thus on acceptance of vaccination by the public. Surveillance activities are essential for monitoring vaccine coverage as well as the impact of vaccination programme on disease spread. Vaccine programme managers may use data and information provided by surveillance activities for monitoring the programme and implementing actions aimed at establishing herd immunity. During the last decades, effective communication has become more and more important due to a progressive lack of confidence of the public towards vaccination. Evidence-based communication supported by reliable information on vaccine effectiveness and safety may be central for improving vaccine confidence and assuring mutual protection. **P.L. Lopalco, CMI 2016;22:S85**

Introduction

Vaccines against communicable diseases provide a certain degree of mutual protection at the community level. The size of such indirect effect—also called herd immunity, social immunity or community protection—mostly depends on vaccination coverage levels in the population [1]. Programmes of eradication or elimination of infectious diseases strongly rely on the herd immunity effect. As a matter of fact, reaching 100% vaccine coverage in the target population is virtually impossible; nevertheless, lower vaccination coverage levels, thanks to the mutual protection granted by the vaccine, may result in disease elimination. Vaccination coverage needed for elimination—the so-called herd immunity threshold—is proportional to the transmission potential of the infectious agent (R_0): it is very high (close to 95%) for highly transmissible diseases like measles and a bit lower (around 80%) for less transmissible diseases like poliomyelitis [1].

Planning, implementing and monitoring elimination programmes cannot be done without assessing population immunity and disease incidence. Surveillance activities—defined as an ongoing systematic collection and dissemination of data [2]—are therefore paramount for the success of elimination campaigns.

Close monitoring of basic indicators like vaccination coverage and disease incidence is crucial to early detection of any issues and to improve the programmes' performance. The scope of the present review is to describe how surveillance activities may support vaccination strategies and how collected data may inform any action aiming at improving mutual protection.

Which Data Are Needed to Improve Community Protection?

Vaccination coverage and disease incidence are not the only parameters necessary to inform vaccination programmes in order to reach the vaccination threshold necessary to stop disease transmission. Other aspects of the programme should be carefully monitored. Briefly, three main domains to be monitored may be identified: targeted disease, vaccine products and vaccination programme (Table 1). For each of these domains, several activities may be considered (Table 2).

Monitoring the targeted disease is extremely important. In fact, information on disease incidence represents the main indicator of programme performance. In addition, timely detection of local outbreaks and proper outbreak investigation are the bases for triggering adequate actions, especially during the final phases of the elimination efforts [3]. Moreover, data on disease

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Table 1
Activities needed for monitoring vaccination programmes

Disease
• Disease surveillance.
• Disease impact evaluation.
• Population level of protection evaluation.
Vaccine product
• Vaccine safety evaluation.
• Vaccine effectiveness evaluation.
Vaccination programme
• Vaccine uptake monitoring.
• Vaccine hesitancy monitoring.

burden—including mortality, long-term sequelae and hospitalization rates—are important to support advocacy and communication activities related to the programme. Finally, knowing the actual level of protection of the target population may be necessary in order to identify immunity gaps and implement tailored vaccination activities (i.e. supplementary immunization activities). There is some evidence demonstrating that well-performing vaccine coverage monitoring systems can be a good option when *ad hoc* seroprevalence studies are either not feasible or are not cost-effective. Definitively, thorough assessment of the targeted disease is paramount for the programme managers in order to identify geographical areas or population subgroups where circulation of the infectious agent is not yet interrupted by herd immunity.

Vaccine acceptance is the key to sustaining herd immunity. Gathering data and information on vaccine safety and effectiveness is necessary both for monitoring purposes and for supporting effective communication to the public. In particular, vaccine safety rumours are particularly dangerous because they may severely affect vaccine confidence [4]. For this reason, adverse events after immunization must be detected early and effectively monitored and assessed. Timely information on alleged serious adverse events after immunization should be provided to programme managers in order to counteract rumours and subsequent vaccine hesitancy. Assessing vaccine effectiveness can be also a good support to programme managers for implementing timely corrective measures and avoiding lack of trust among the public [5].

Monitoring vaccine coverage is, of course, essential to warrant herd immunity. But it is not the only indicator to be considered when assessing the overall functionality of the vaccination programme. In fact, it is becoming more and more important to monitor vaccine hesitancy by means of different tools, including using behavioural science methods and scanning social media on the Internet.

Table 2
Specific activities needed for monitoring vaccination programmes

Disease
• Routine surveillance.
• Outbreak detection.
• Outbreak investigation.
• Burden of disease.
• Hospitalization rate.
• Economic analysis.
• Seroprevalence studies.
• In-depth analysis of vaccine coverage data.
Vaccine product
• Safety signals detection.
• Safety signals monitoring.
• Safety assessment.
• Sentinel systems.
• Ad hoc studies.
Vaccination programme
• Administrative tools.
• Coverage surveys.
• Vaccine registries.
• Behavioural science.
• Social media on the Internet.

Vaccine-Preventable Disease Surveillance: Is Current Quality Enough?

Measles and rubella have been targeted for elimination in Europe and globally (http://apps.who.int/iris/bitstream/10665/44855/1/9789241503396_eng.pdf). Measles and rubella surveillance is well established in Europe, and improving surveillance is part of the elimination strategy. The European Centre for Disease Prevention and Control (ECDC) and the World Health Organization (WHO) Office for Europe collaborate to collect, analyse and communicate data on both suspected and confirmed disease cases on a monthly basis. Information is publicly available both on the WHO and ECDC websites (for EU countries only; http://www.euro.who.int/en/health-topics/communicable-diseases/measles-and-rubella/data-and-statistics, http://ecdc.europa.eu/en/healthtopics/measles/epidemiological_data/Pages/measles_past12months.aspx). Details on geographical distribution are patchily available—a limitation during the elimination phase. In fact, both measles and rubella outbreaks—with overall population immunity increasing—are likely to happen either in population subgroups or in limited geographical areas. Early identification of such areas is paramount for starting an effective response and limiting disease spread. On the other hand, international coordination is needed in case of cross-border outbreaks. Collecting information in one country can be useful to assure mutual protection in bordering countries by means of early warning activities. The latest EU legislation in this field is represented by Decision 1082/2013 of the European Parliament and of the Council [6], which provides some major benefits, improving risk assessment and management of cross-border health threats. This is also warranted by providing a solid legal mandate to the Health Security Committee for coordination of response activities.

Monitoring Immunity Level to Warrant Mutual Protection

While the level of knowledge regarding disease spread provided by routine/enhanced surveillance activities is good enough to monitor disease spread and to analyse temporal trends, monitoring immunity levels in the population can facilitate implementation of early countermeasures in specific situations. Seroprevalence studies are often considered the only way to assess immunity level. But cost and feasibility issues represent a serious obstacle to run large-scale seroprevalence surveys. For this reason, alternative methods may be considered. In the presence of good-quality administrative systems or registries, vaccine coverage can be considered a good proxy of the immunity level in the population. A seroprevalence study to assess IgG antibodies in German children found positive titre rate against measles of 88.2% in the age group 1–17 years, compared to the 88.8% of vaccination rate [7], thus showing the high effectiveness of the measles component of the measles, mumps and rubella vaccine. In-depth analysis of vaccine coverage data can definitively provide a good overview and can identify in a timely manner pockets of the underimmunized population. Such an analysis is particularly useful to be carried out by birth cohort in order to identify priority age groups. Mutual protection is important to is warranted within specific age groups because most social contacts happen between individuals of the same age [8]. Assessing vaccine coverage using historical data by birth cohort may early detect specific age groups where herd immunity is jeopardized. In 2011 a large measles outbreak was reported in France of about 15 000 cases [9]. More than 9200 cases were reported in people younger than 20 years of age. Fig. 1 shows the distribution of reported measles cases in people <20 years compared to the number of unvaccinated individuals in the same age groups, the result of analysis of WHO Centralized Information