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**COMMITTEE FOR MEDICINAL PRODUCTS FOR HUMAN USE  
(CHMP)**

**GUIDELINE ON  
THE CONDUCT OF PHARMACOVIGILANCE FOR VACCINES  
FOR PRE- AND POST-EXPOSURE PROPHYLAXIS AGAINST INFECTIOUS DISEASES**

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## Executive Summary

This guideline is addressed to Marketing Authorisation Holders and Competent Authorities. It should be read in conjunction with the other pharmacovigilance guidelines contained in **Volume 9A of the Rules Governing Medicinal Products in the EU** and provides additional guidance on the safety surveillance of vaccines used for the prevention against infectious diseases before or after exposure to an infectious agent. This guidance takes into account the relevant specific aspects of vaccines, such as the balance between risks for the healthy vaccinee and the benefits for that individual as well as the whole population and side-effects due to the activation of the immune system. In its final version, this guideline will be included in **Volume 9A**.

### 1. Introduction

Immunisation is one of the most effective and widely used public health interventions. The benefit of vaccination has been demonstrated for authorised vaccines, both at individual as well as community level. Prominent examples are the global eradication of smallpox and the elimination of poliomyelitis in most parts of the world. No vaccine is however 100% safe or effective. As the incidence of vaccine-preventable diseases is reduced by increasing coverage with the efficacious vaccine, vaccine-related adverse events, whether causally related or perceived as such, become increasingly prominent.

Vaccines are different from most other medicinal products in ways that influence safety considerations. Pre- and post-exposure vaccines against infectious diseases are a preventive measure, usually given to healthy individuals and especially young children at vulnerable age. They have a complex composition and a short duration of exposure with a long-term response. No (immediate) health benefit might be apparent to the individual vaccinee due to the success of vaccines in reducing illness in the community. As a consequence, there is limited acceptance of any potential risks. Any safety concern arising with a vaccine might impact on a significant number of subjects. Therefore, safety concerns need to be promptly evaluated. As vaccines are often used in several birth cohorts or even in the whole population, events inadvertently occur in temporal but not in causal association to vaccination. Perceived safety concerns have been increasingly discussed in the public area. Public confidence in vaccination programmes may only be maintained if it is considered that Competent Authorities will assess the safety of vaccines in a timely and adequate manner and take appropriate action. This includes investigation of rare and unexpected adverse events, increases in the occurrence of known adverse reactions and careful analysis of theoretical concerns.

In the EU, effective pharmacovigilance systems including systems covering the pharmacovigilance of vaccines are implemented in accordance with the legal requirements and the guidance provided in **Volume 9A of the Rules Governing Medicinal Products in the EU**. This guidance is intended to further strengthen the conduct of pharmacovigilance of vaccines for pre- and post-exposure prophylaxis of infectious diseases and to encourage the development of new approaches.

Standard assessment of a vaccine includes routine pharmacovigilance (see **Section I.3.7.1 of Volume 9A**) should always be comprehensive and of high quality, taking into account specific reporting requirements for vaccines set out in **Sections I.5.8 and I.5.9 of Volume 9A**. Requests for Risk Management Plans (RMP) (see **Chapter 6**) and post-authorisation safety studies (see **Chapter 7.3**) should be specific to the product with view to all available evidence as well as important missing information. Novel approaches on which vaccines may be based will have to be reflected in the RMP.

Special pharmacovigilance requirements applicable to vaccines used during public health emergencies are declared in **Section I.5.12 of Volume 9A**.

### 2. Scope

This guidance is addressed to Marketing Authorisation Holders and Competent Authorities. It should be read in conjunction with other pharmacovigilance guidance in **Volume 9A** and is not intended to replace any other relevant guidance. This guidance mainly covers post-authorisation aspects specific

for vaccines. Special attention is paid to the development of Risk Management Plans prior and after marketing authorisation.

The guidance is directed to Applicants/Marketing Authorisation Holders and Competent Authorities/the European Medicines Agency and also aims at providing guidance to other stakeholders (e.g. sponsors of clinical studies, Healthcare Professionals, public health authorities) who are expected to use the guidance and thereby strengthen the cooperation of all stakeholders.

The guidance outlines the special considerations for pharmacovigilance of vaccines used in all age groups for pre- or post-exposure prophylaxis of infectious diseases. It is not intended to cover therapeutic vaccines (e.g. viral-vector based gene therapy, tumour vaccines, anti-idiotypic vaccines such as monoclonal antibodies used as immunogens), as these will require different considerations.

### **3. Legal Basis**

This guidance should be read in conjunction with Regulation (EC) No 726/2004, Council Directive 2001/83/EC as amended (Title IX), Commission Regulation (EC) 540/95, Volume 9A of the Rules Governing Medicinal Products in the EU and other relevant guidance documents as referred to.

### **4. Roles and Responsibilities of Different Stakeholders**

Stakeholders involved in the process of vaccine pharmacovigilance include the vaccinee and, in the case of paediatric vaccination, their parents/carers, Healthcare Professionals, Applicants/Marketing Authorisation Holders, sponsors of clinical trials, Competent Authorities and public health authorities recommending vaccination programmes as well as the World Health Organization (WHO). Depending on their responsibility, each stakeholder may have an important role in contributing to this process. Competent Authorities and public health authorities have an important role in unbiased communication, in particular in situations where there is a gap between the scientific analysis of experts and public perception of perceived risks which is especially relevant to vaccines. The Competent Authorities should provide the media with the relevant information.

### **5. Key Factors Contributing to Safety Profiles of Vaccines**

#### **5.1 Vaccine-Intrinsic Factors**

##### **5.1.1 Type of Vaccine**

###### **5.1.1.a) Live Attenuated and Inactive Vaccines**

Live attenuated viral or bacterial vaccines and inactivated vaccines (including vaccines based on proteins or polysaccharides or protein-polysaccharide conjugate vaccines) may have different safety profiles. Safety concerns associated with different types of vaccines identified prior to marketing authorisation should be investigated in the pre-authorisation phase and addressed in the Risk Management Plan (RMP). For concerns identified during the post-authorisation phase, appropriate safety investigations and an (updated) RMP may be necessary. Both also apply to safety concerns which arise from experience with similar vaccines. What constitutes similar will be a case-by-case decision, based on the disease, the disease target population, the vaccine type, the carrier protein or other criteria, as scientifically appropriate.

Safety concerns for a vaccine include those due to inherent toxicities of the antigen and adjuvant, toxicities of impurities and contaminants and toxicities due to interactions of the vaccine components present in the vaccine formulation.

Certain live attenuated vaccine strains may be associated with adverse reactions usually seen with the wild type disease. The level of attenuation and the possible impact on safety should be discussed in the Safety Specification of the RMP. If necessary, targeted post-authorisation safety studies (PASS) should be conducted.

In rare occasions, some live attenuated vaccines may cause serious syndromes closely resembling wild-type disease, probably not associated with the vaccine but with individual host factors increasing susceptibility. An example is yellow fever vaccine and viscerotropic disease. Host risk factors such as age, gender and immune status of the vaccinee should be carefully investigated. Clinical, serological and immunochemical analysis as well as antigen detection, quantification, sequence analysis and cytokine release, may be helpful to further investigate the immune response elicited in the individual cases. Close collaboration with reference laboratories or specialised laboratories is recommended.

Reversion to virulence after multiplication in the human host might be of particular concern for some live attenuated vaccines. Careful investigation of cases indicating a possible reversion to virulence in the post-authorisation phase is essential, especially for new live attenuated vaccines. Validated and standardised assays, including assays to distinguish between wild and vaccine strains, should be developed and implemented prior to marketing authorisation for appropriate case assessment. Post-authorisation studies should also address, if relevant, the pattern of shedding, transmissibility to contacts and the potential of the strain to survive in the environment.

### **5.1.1.b) Novel Vaccines**

New approaches and novel concepts (e.g. temperature selected mutants), new technologies (e.g. vaccines using novel delivery systems such as viral and bacterial vectors or patches), novel adjuvants or alternative routes of administration (e.g. nasal administration) have recently been developed or are currently in the clinical testing phase and may give rise to new safety concerns. Targeted monitoring and special studies are required for certain types of rare but serious adverse reactions. These may be anticipated from the particular composition of the novel vaccine or from their relatedness to well-established vaccines. To establish evidence of safety, particular consideration should be given to what methods may be employed to detect long-term and delayed onset adverse reactions (see Chapter 7.3).

### **5.1.2 Immunogenic Adjuvants, Stabilisers, Preservatives and Residual Material from the Manufacturing Process**

Incorporation of a particular adjuvant into vaccine formulations to enhance immunogenicity may be linked with induction of both local and systemic adverse reactions. Use of (novel) adjuvants for stimulating a specific immune response justifies particular attention to specific issues such as auto-immune diseases and rare and/or delayed onset adverse reactions. The clinical impact of the adjuvant to modify the immune response, for instance by the T helper (Th) cell response (towards Th1 or Th2) could be investigated in the post-authorisation phase. Synergistic immune-mediated reactions of adjuvants and the biologically active antigen should be considered. Whereas currently used adjuvants are mainly aluminium salts and oil-in-water emulsions, a greater emphasis by vaccine manufacturers is now placed on discovery, development and testing of novel adjuvants for use, with the possibility of the occurrence of new safety concerns. The immunological mode of action of any novel adjuvants should be addressed in the pharmacovigilance specification of the Risk Management Plan. Where deemed necessary, post-authorisation safety studies (PASS) investigating potential rare and delayed onset effects of new adjuvants should be conducted.

Cells from human, animal (including insect), bacterial or yeast origin may be used in an early step of the manufacturing process. As a consequence, residual proteins of the host cells may be present in the final product. These impurities may consist of proteins that have structural homology with human proteins. In addition to extensive pre-clinical and clinical testing, post-authorisation surveillance may be appropriate to demonstrate that these residuals do not cause harm to vaccinees.

Preservatives and stabilisers may not be as immunologically inert as previously thought (e.g. polygeline). Removal of a preservative and/or stabiliser from a well-established vaccine may also have an impact on the safety profile of the vaccine as seen with a recent tick-bone encephalitis vaccine.

If feasible, it is important to analyse whether the antigen itself or any ingredient has caused the suspected adverse reaction. If necessary, risk minimisation strategies need to be explored.

### **5.1.3 Combined Vaccines**

Combined vaccines consist of two or more vaccine antigens in one pharmaceutical preparation, intended to prevent multiple diseases or to prevent one disease caused by different serotypes. Possible safety concerns such as increased frequency of known adverse reactions (local or systemic) or increase of severity of adverse reactions should be carefully followed up. In the pre-authorisation phase, it is only feasible to detect large differences in the incidence and severity of common adverse reactions between the combined vaccine and the precursor (combined or individual) vaccine(s), if available, whereas smaller differences of local or systemic adverse reactions are usually not detected in pre-authorisation studies. Therefore, pharmacovigilance for combined vaccines should focus on a possible increase in the frequency and severity of local and systemic adverse reactions which might translate into tolerability of the vaccine. If appropriate, risk minimising strategies might be explored.

### **5.1.4 Batch-Relatedness of Adverse Reactions**

Manufacturing of medicines in biological systems, such as fermentation of bacteria, growth of virus in cell culture or expression of proteins by recombinant technology may introduce variability within certain limits of the composition of the final product. In principle, contamination with unwanted infectious agents at many different points, as well as generating aberrant materials cannot be totally excluded. Although a great deal of effort is put into control of raw and starting materials and the manufacturing process as well as testing of each single batch to exclude contamination with infectious agents and other risks linked to any aberrant material, these potential risks which may result in adverse reactions should be considered. As these adverse reactions may be related to certain batches, pharmacovigilance systems in Member States should be capable of recording individual lots.

If there is reasonable suspicion of an association between the occurrence of adverse reactions and a particular batch of a vaccine, Competent Authorities for marketing authorisation and the competent authorities for batch release should be informed immediately by the Marketing Authorisation Holder. A full assessment of the possible reason for batch-relatedness of adverse reactions needs to be provided. Where a quality defect is suspected or confirmed, the procedures explained on the EMEA website<sup>1</sup> should be followed as well as the applicable national procedures.

### **5.1.5 Vaccination Schedule and Route of Administration**

Different immunisation schedules may impact on the safety profile of a given product. The pharmacovigilance plans of the Risk Management Plan, study designs and causality assessments should be focused as appropriate, drawing from prior experience (e.g. incidence and severity of limb swelling with subsequent doses of DTaP (Diphtheria, Tetanus and Pertussis-acellular) vaccine).

The vaccine administration route is known to be another important factor influencing safety of a vaccine. Potential implications need to be considered, in particular for alternative routes of administration (e.g. intranasal, oral, intradermal). The impact of adjuvants needs to be explored.

## **5.2 Host Factors**

### **5.2.1 Special Age Groups**

Immunological responses to vaccines depend on the independent and coordinated function of innate and adaptive immune responses which is different in young and older children as well as in young, older and elderly adults. Differences of the immune response in different age categories may not only translate to different efficacy of vaccines, but also to differences in the safety profile. Adverse reactions may occur solely in certain age categories, e.g. hypotonic hyporesponsive episode (HHE) in young children. Furthermore, the frequency of adverse reactions may change in relation to age.

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<sup>1</sup> Available on EMEA website <http://www.emea.europa.eu> under <http://www.emea.europa.eu/Inspections/Defects.html>.

Targeted surveillance of adverse reactions in different age groups may be warranted. Prior to marketing authorisation it may not be possible to study all aspects of age related safety issues for a new vaccine. Therefore, these aspects may be addressed in the Risk Management Plan, if relevant.

For the paediatric population, the age classification provided in the ICH-E11 Guideline<sup>2</sup> applies, unless another classification is justified.

### **5.2.2 Pregnancy**

Although, most live attenuated vaccines are contraindicated in pregnant women due to the known or suspected risk of transplacental infection of the foetus, inadvertent exposure during pregnancy cannot be avoided. Risk to the developing foetus from vaccination of the mother with an inactivated vaccine during pregnancy is considered theoretical and should be further investigated on the basis of data collected in the post-authorisation phase.

Investigations may range from follow-up of spontaneously reported abnormal pregnancy outcomes up to additional pharmacovigilance activities such as a pregnancy register (in particular if a new adjuvant is used). The detailed design of the preferred approach to collect such data should be provided as part of the Risk Management Plan. The studies should be designed to identify spontaneous abortions, stillbirths and congenital malformations. Adequate duration of follow-up of the offspring should be guaranteed. The adequate duration of follow-up is the expected time period until manifestation of the potential harm. Detailed information on vaccine exposure (including number of doses and gestational age at the time of exposure) before and/or during pregnancy is warranted. Documentation and investigation should also include other risk factors. Pregnancy registers which are already available may be capable of providing the necessary data. The Guideline on the Exposure to Medicinal Products During Pregnancy: Need for Post-Authorisation Data also applies to vaccines<sup>3</sup>.

Careful monitoring and follow-up of reported pregnancies is necessary for all vaccines.

### **5.2.3 Immunocompromised Individuals**

Immunocompromised individuals, including those infected with human immunodeficiency virus (HIV), may not only be very sensitive to serious infectious disease, including the one targeted by the vaccine, but may also be very sensitive to the occurrence of serious adverse reactions following vaccination, including impaired immunoresponse to vaccination and in particular when vaccinated with live vaccines. Therefore, the risk-benefit balance in this patient group needs separate consideration in the assessment.

## **6. Risk Management Plan**

As most aspects of existing RMP guidance are equally applicable to medicines and vaccines, this section should be read in conjunction with Chapter I.3 of Volume 9A of the Rules Governing Medicinal Products in the EU. That section provides additional guidance on some issues specific for vaccines.

### **6.1 Safety Specification**

#### **6.1.1 Non-Clinical Aspects for Further Consideration**

Safety concerns for a vaccine include those due to inherent toxicities of the antigen and adjuvant, toxicities of impurities, residuals and contaminants and toxicities due to interactions of the vaccine components present in the vaccine formulation.

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<sup>2</sup> Available on EMEA website <http://www.emea.europa.eu>.

<sup>3</sup> Doc.Ref. EMEA/CHMP/313666/2005 latest version, available on EMEA website <http://www.emea.europa.eu>.

If findings from pre-clinical testing with a possible impact on safety and/or serious adverse reactions possibly related to the investigated vaccine occur, there may be a need to extend the safety database in the post-authorisation phase in order to ensure that the pre-clinical findings do not translate into a risk in humans (e.g. potential concern of enhanced pathology in small children to subsequent infections after whole viral inactivated aluminium adjuvanted vaccines).

### **6.1.2 Limitation of the Safety Database and Population Not Studied in the Pre-Authorisation Phase**

Serious and clinically relevant adverse reactions are mostly rare and thus are unlikely detected prior to marketing as the sample size of clinical trial database is mostly limited to detect common and uncommon adverse events. Long-term follow-up of vaccinees might also be limited and pre-authorisation data will most likely not address concerns of long-term risks. Furthermore, in pre-authorisation clinical trials the study population is highly selected, whereas in the post-authorisation phase immunisation might be targeted at a heterogeneous population with diverse background diseases.

### **6.1.3 Potential Risks Requiring Further Investigation**

Experience with similar antigens, types of antigen and/or other adjuvants and other vaccine excipients should be described in the RMP. Safety concerns anticipated from experience with similar vaccines and vaccine ingredients should be addressed in the RMP and, if necessary, a commitment to undertake post-authorisation safety studies should be provided. Safety parameters based on biological plausibility of the occurrence of certain adverse reactions or previous experience with a similar authorised vaccine should be investigated in detail. It should be considered whether more additional information (e.g. cytokine profiles) might be of value. The impact of new adjuvants, stabilisers, preservatives or residuals of the manufacturing process on the safety profile of the vaccine should be discussed in the RMP.

### **6.1.4 Identified and Potential Interactions**

Emphasis should be placed on identified and potential interactions with co-administration of other vaccines. This should include a prospective specification based on issues with likely concomitant use across Member States such as increased risk for adverse reactions and clinically relevant immunological interference. Past experience with similar vaccines and types of antigens should be considered.

### **6.1.5 Epidemiology of the Target Disease and Background Incidence of Adverse Events of Interest**

This section of the RMP should focus on the different natural histories of the target disease across Member States as appropriate and highlight any particular considerations required. The section should discuss any relevant examples of impact of previous and similar vaccines on the disease and any potential concerns to monitor. For vaccines that may protect against only some types of organisms within a species, appropriate surveillance should be in place to detect strain replacement phenomena.

Emphasis should be given on assessing the population and age-specific background rates of adverse events of special interest in order to assist evaluation of spontaneous reports of adverse reactions.

### **6.1.6 Potential of Transmission of Infectious Agents**

The RMP should address for live attenuated vaccines aspects such as shedding (including shedding from vaccinee to unvaccinated close contacts), transmission of the attenuated agents to close contacts, risk for pregnant women and the foetus, and reversion to virulence (see Chapter 5).

As for all biological products, the potential for infections caused by residuals of biological material used in the manufacturing process as well as contaminations introduced by the manufacturing process should be evaluated and addressed in the RMP.

## **6.2 Pharmacovigilance Plan**

This section of the RMP is covered by **Chapter I.3 of Volume 9A** in general terms. There are special considerations for both routine and additional pharmacovigilance activities for vaccines such as the need to investigate serious but rare adverse reactions (even if the sole aim is to provide reassurance on safety), batch-related adverse reactions, if appropriate, safety of concomitant vaccination and evaluation of the impact of different immunisation schedules.

Different policies on use of vaccines concerning vaccination schedules and target population might give rise to different safety issues. It is acknowledged that it might not be feasible to study all recommended priming and booster schedules across the EU, however the Marketing Authorisation Holders should discuss the need for further evaluation (e.g. studying the most accelerated schedule) and should provide Pharmacovigilance Plans in the RMPs accordingly. If a specific safety concern associated with the vaccination schedule or the target population can be anticipated from other vaccines, targeted post-authorisation studies should be considered.

If clinical trials or literature data indicate potential interactions with medicinal products usually given to the target population or administered as a prophylactic treatment (e.g. antipyretics in order to minimise adverse reactions) adequate investigations in the post-authorisation phase might be warranted.

At the time of marketing authorisation, data on long-term duration of protection, the potential for waning immunity and the need for a (additional) booster dose are usually not available. Plans for collecting these data should be presented as part of the RMP.

Marketing Authorisation Holders should explore availability of systems for collecting data in different countries, particularly when addressing specific safety concerns. Pharmacovigilance methods with regard to data collection and signal detection and evaluation are further explored **in Chapters 7 and 8.3.**

## **6.3 Risk Minimisation**

Risk minimisation measures for vaccines are considered to be the same as for other medicinal products (see **Chapter I.3 of Volume 9A**).

## **7. Spontaneous Reporting**

### **7.1 Adverse Events Following Immunisation (AEFIs) and Adverse Reactions**

For pharmacovigilance for vaccines in the EU, the definitions for adverse event and adverse reaction provided in **Annex 1 of Volume 9A** apply.

At international level, the term Adverse Event Following Immunisation (AEFIs) has been defined in the **Report of the CIOMS-WHO Working Group on Vaccine Pharmacovigilance**<sup>4</sup>. According to this definition AEFIs may be causally related to the vaccine or the vaccination or happen coincidentally after vaccination.

Those AEFIs which are suspected to occur in causal relationship with the vaccine or vaccination represent suspected adverse reactions in line with **Annex 1 of Volume 9A**.

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<sup>4</sup> Under development.

They may be further classified, and the Report of the CIOMS-WHO Working Group includes guidance in this respect which may be useful for case assessment and finding the underlying cause of the adverse reaction, e.g. relating to a characteristic of the vaccine, a quality defect, an error in the handling or administration of the vaccine or to vaccination anxiety.

Vaccines are intended to have powerful effects on the immune system. It is understandable therefore that Healthcare Professionals and the public may perceive adverse events occurring in temporal association with vaccination as causally related, even if no causal link exists. AEFIs might be reported to either regulatory authorities as well as Marketing Authorisation Holders as spontaneous reports. In the EU, legal definitions and reporting requirements are laid down for adverse reactions but not for AEFIs.

### 7.1.1 Suspected Adverse Reactions

Spontaneously reported suspected adverse reactions remain an important source for the detection of safety issues in the post- authorisation phase, in particular with regard to rare, serious adverse reactions with a low background event rate. Spontaneous reporting is also useful to cover safety aspects in the diverse populations. Different types of adverse reactions should be considered:

- those that are perceived as adverse reactions, but may be visible signs of the immune response of the host (interleukin response, e.g. fever);
- those reflecting the clinical picture of the disease for which immunisation has been given (e.g. measles-like rash following vaccination); and
- those that are unexpected and for which a causal relationship remains to be elucidated.

For the assessment of individual case reports of suspected adverse reactions, it is essential that complete and accurate records documenting administration of all vaccines, together with in particular information on the date of vaccination, product administered, manufacturer, batch number, site and route of administration, detailed description and course of the adverse event/reaction as well as therapeutic intervention are provided. Appropriate follow-up of serious suspected adverse reactions is of inherent importance including data on possible alternative causes of the adverse event. It may be helpful to develop pre-defined check lists or formats for those reactions which may be anticipated from experience with similar vaccines for reporting in the post-authorisation phase in order to ascertain consistently relevant clinical information to ensure the quality of the causality assessment of an individual case. Standardised case definitions of adverse events are a key element for scientific assessment of immunisation safety as they provide a common terminology and understanding of adverse events/reactions and thus allow for comparability of data. Case definitions of the **Brighton Collaboration**<sup>5</sup> should be used, if appropriate.

Several aspects need to be considered when assessing single cases of suspected adverse reactions.

- The population of vaccinees is usually large and heterogeneous and coincident adverse events are likely to occur.
- In addition to the intended active ingredient, the antigen, additives and excipients for production, inactivation, preservation, and stabilisation of vaccines also play an important role in evaluating the causal relationship of a suspected adverse reaction with a given vaccine.
- Categories or algorithms used for causality assessment for medicinal products might not be equally applicable for vaccines. There might be a need to adopt the categories to vaccines. This should be stated in the RMP. It is encouraged to consider the currently ongoing work of the **CIOMS-WHO Working Group on Vaccine Pharmacovigilance**<sup>6</sup> in this respect as applicable. De-challenge and re-exposure testing which are important criteria for several algorithms are often not applicable to vaccines, but where they are, such data should be recorded.

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<sup>5</sup> Available on Brighton Collaboration website <http://www.brightoncollaboration.org>.

<sup>6</sup> Under development.

## 7.1.2 Vaccine Failures

Most vaccines are not 100% effective. Therefore cases of breakthrough infections are expected. A higher-than-expected efficacy of a vaccine, waning efficacy over time or replacement phenomenon cannot be fully investigated via spontaneous reporting. Nevertheless, expedited reporting of cases of lack of efficacy of a vaccine as an adverse reaction is required according to [Volume 9A, Chapter I.5.8](#). Risk factors for vaccine failure should be analysed (e.g. obesity, age, smoking status, vaccination schedule, concomitant disease). This may provide signals for reduced immunogenicity of the vaccine under daily life conditions in risk groups. If there is concern that a higher than expected rate of vaccine failures and break-through infections in certain risk groups exists, appropriate systematic investigations should be carried out. Appropriate case definitions and validated analytical tests for confirmation of the infective agents should be used wherever possible. Case definitions for vaccine failure, lack of effect, break-through infection are not universally agreed at present, but it is expected that consistent case definitions will be published in the near future by the [CIOMS-WHO Working Group on Vaccine Pharmacovigilance](#)<sup>7</sup>.

Reporting of vaccine failures from effectiveness studies at the level of the individual study subject is normally not required. Reporting procedures should be described in the study protocol. The final study report should be submitted to the national Competent Authorities/EMA (see [Chapter I.7 of Volume 9A](#)). In certain situations, the Marketing Authorisation Holder may clarify the reporting requirements with the national Competent Authorities/EMA prior to the start of study.

Vaccination failure should be addressed in the RMP.

## 7.1.3 Vaccination Errors

Inappropriate handling may lead to adverse events such as infection due to bacterial contamination of the vaccine, transmission of blood-borne infection, abscess formation at the site of injection or loss of efficacy. These issues apply particularly to multi-dose container vaccines without preservatives.

For some vaccines, the method of administration may be associated with adverse reactions and this should be considered when assessing a single case report of a suspected adverse reaction.

Marketing Authorisation Holders should adequately follow-up the root cause of any errors (e.g. cold chain investigation, batch investigation) and address this appropriately through communication. The potential for and risk minimisation actions addressing such errors need to be described in the RMP. It is of inherent importance to measure outcome of the actions taken.

## 7.2 Periodic Safety Update Reports (PSURs)

In addition to information which should be provided in the Periodic Safety Update Report (PSUR) for all medicinal products (see [Chapter I.6 of Volume 9A](#)), special consideration should be given in PSURs for vaccines to any potential impact on safety of major as well as minor changes in the manufacturing process. Issues related to batch(es), as well as age-related adverse reactions should be evaluated. Safety aspects in subpopulations (such as pregnant women) should be analysed. If relevant, the potential for local and systemic adverse reactions of a vaccine should be analysed for different doses of the vaccine and also across different vaccination schedules. Sub-analyses of spontaneous reports with regard to possible differences in the adverse reaction profile linked to different vaccination schedules is considered important but do not replace the necessary clinical investigations.

Reports of vaccine failure / lack of efficacy should be assessed in a separate chapter of the PSUR.

Vaccination errors and vaccination anxiety-related reactions such as syncope should also be summarised and analysed in the PSUR. Actions taken to avoid vaccination errors may be described in the PSUR. In accordance with [Chapter I.6 of Volume 9A](#), relevant published data on safety should be

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<sup>7</sup> Under development.

presented in the PSUR. Literature data should not solely focus on safety information available for the antigen(s), but should also summarise published information relevant for other vaccine components such as stabilisers, preservatives and adjuvants.

If concomitant vaccination with another vaccine is specifically mentioned in the Summary of Product Characteristics (SPC), co-administration of vaccines should be analysed separately and the analysis be summarised in the PSUR if there is a safety concern. The data have also to be analysed for new concerns regarding concomitant vaccination, independently of whether concomitant use is mentioned in the SPC or not.

### **7.3 Signal Detection**

Signals of possible unexpected adverse reactions or changes in severity, characteristics or frequency of expected adverse reactions may arise from any source including preclinical and clinical data (e.g. spontaneous reports from Healthcare Professionals or Consumers; epidemiological studies; clinical trials), published scientific and lay literature.

Spontaneous reports may not be used for calculating incidence rates. In databases containing spontaneous reports, the method of choice may be a measure of disproportionality, detecting a signal of disproportionate reporting (SDR). SDRs refer to a statistical association between medicinal products and adverse events. There are several statistical methods used to detect SDRs, such as the proportional reporting ratio (PRR) or Bayesian approaches.

Vaccines may require special consideration when applying such tools. Intrinsic differences between vaccines and other medicinal products should be considered, for example frequent reporting of unrelated adverse events in the target population (e.g. Sudden Infant Death Syndrome (SIDS) and childhood vaccination, myocardial infarction and influenza vaccines). Furthermore, the safety profile of a vaccine may differ substantially among the target population (e.g. higher risks in younger vaccinees). In order to reduce background noise, estimates of disproportionality should be calculated based on a comparison across groups that have a similar likelihood of experiencing similar adverse events. The choice of the comparator group will depend of the objectives of the analysis and the information available in the database. A comparison with all medicinal products may result in the detection of reactions specifically related to vaccines, but may also identify a high number of false signals (e.g. SIDS in infants) or already known mild and expected reactions (e.g. local reactions). On the other hand, using all vaccine-related reports available in the database may result in signals of age-related reactions (e.g. cardiac disorders if the vaccine of interest is used in the elderly). In a first step, it may therefore be appropriate to examine results of statistical methods using both comparator groups, or to use reports for other vaccines as the comparator group with a stratification made at least by age. Given the large differences in reporting rates between regions and countries, stratification by geographical region may also be considered. Stratification by co-morbidity or co-medication is desirable, but may be difficult to achieve. If Consumer/Patient reports of suspected adverse reactions are included in the database, signal detection could also be stratified by source (Healthcare Professionals, Consumers/Patients). Stratification between study reports and spontaneous reports may be appropriate. Seasonality of vaccine administration may be relevant for some vaccines and needs consideration.

The MedDRA hierarchy needs to be considered before commencing a database search. Grouping of medically related Preferred Terms may also be considered.

When stratification is performed, it may be wise to examine the results of both adjusted and non-adjusted analyses. Results could be inspected in each stratum as pooled result of a stratified analysis may miss signals.

Where almost complete birth cohorts are vaccinated, it will be inevitable that coincidental events causing concerns will be reported in close temporal association with immunisation. There is therefore a need to assess the population and age-specific background rates of events of interest in order to assist evaluation of passive data. A simple method of investigating a signal is to compare the number of

cases observed in temporal relationship to a suspected exposure during a period of time (O) to the number of natural incidences of the disease estimated to occur in the same period of time (E), assuming no relationship to the suspected exposure. Observed means usually reported via spontaneous reporting. O/E analyses are the first level of evaluation of safety signals. A classical approach is to calculate the O/E ratio and determine if this ratio is significantly different from one. Certain limitations of this analysis should be considered (e.g. underreporting, healthy vaccinee effect). A robust calculation of the exposed population and the incidence of the natural disease are warranted. Usually, the classical O/E analysis does not account for variability of parameters that were used to estimate the expected number of cases, such as variability of the incidence of the event, the age distribution of the event and the age distribution of vaccination. As a consequence the approach is considered to be rather conservative. Less conservative but more complex approaches have been developed recently. These approaches focus on E rather than on O/E and accounts for an age effect on E. In this analysis E is not a fixed number and O/E must be interpreted as a point estimate with variability around them.

Standardised MedDRA (Medical Dictionary for Regulatory Activities) Queries (SMQs)<sup>8</sup> may be used in the process of signal detection and evaluation. Sensitivity and specificity testing of SMQs for vaccines needs to be done beforehand in order to adequately interpret the results.

Signal evaluation is of inherent importance. Case definitions as e.g. published by the Brighton Collaboration<sup>9</sup> may be used for signal validation. However, this needs to be justified on a case by case basis.

When evaluating signals, the following potential biases should be taken into account (in addition to age and seriousness):

- vaccination policy (target group of subjects to be immunised);
- the incidence of natural disease in the target population;
- public information (public campaign, press) that may favour certain reports in some periods;
- seasonality.

Of note, a statistical association does not imply any kind of causal relationship between the administration of the vaccine and the occurrence of the adverse events.

## **8. Additional Pharmacovigilance Activities**

As rare but serious adverse reactions, reactions with delayed onset and reactions in subpopulations are usually not detected prior to marketing authorisation post-authorisation evaluation of safety in studies is critical for vaccines. Safety concerns arising during the post authorisation may relate to:

- the increased incidence of a natural disease;
- vaccine specific adverse reactions;
- a higher rate of expected adverse reactions compared to comparators or precursor vaccines.

If safety concerns, including concerns over missing data, arise, the conduct of post-authorisation safety studies (PASS) may be necessary.

The guidance on PASS in Chapter I.7 of Volume 9A should be followed. It is encouraged to consider guidance developed in the framework of the project on Vaccine Adverse Event Surveillance and Communication (VAESCO), funded by the European Centre for Disease Prevention and Control (ECDC)<sup>10</sup> as applicable.

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<sup>8</sup> Council for International Organizations of Medical Sciences (CIOMS). Development and rational use of Standardised MedDRA Queries (SMQs). Geneva: CIOMS; 2004. Available on CIOMS website <http://www.cioms.ch/>.

<sup>9</sup> Available on Brighton Collaboration website <http://www.brightoncollaboration.org>.

<sup>10</sup> Expected to be available on ECDC website <http://www.ecdc.europa.eu>.

For assessment of safety signals, controlled clinical trials and prospective cohort studies are considered to provide the highest level of evidence. Active surveillance of rare adverse reactions by follow-up of a cohort recruited at the time of vaccination requires follow-up of a large number of vaccinees. Retrospective (i.e. historical) cohort studies may be conducted, where the group in whom the adverse events/reactions is studied is not defined at the time of vaccination but is defined retrospectively, according to the population-based data set available at the time the study is conducted.

In order to interpret the rates of the (various) event(s) that will occur over time in the vaccinated cohort, an unvaccinated control group is also required, consisting of individuals born during the same period, recruited at the same age and followed up since recruitment through the same methods. However, this may not be feasible because of a large sample size needed. Furthermore, once a vaccination is recommended for use, it may not be possible to identify appropriate concurrent controls. In such cases, historical controls may be an option.

An alternative to clinical trials and cohort studies for the active surveillance of adverse events/reactions is the use of databases with computerised data sets of clinical diagnosis and information on immunisation records of a large number of individuals. By use of databases, studies may be conducted following different designs. Studying large populations may provide the opportunity to even study rare adverse events. A recently established method in this respect is the use of record linkage of computerised data sets (disease/diagnosis and immunisation records) from different databases using a unique patient identifier. Clinical diagnosis/disease data may be diverted from computerised hospital discharge data, computerised general practice records data or other clinical databases (insurance company database). Such linked data sets have been used for formally testing hypothesis raised by uncontrolled observations. When such linked data sets are trawled for statistically significant associations for which no a priori hypothesis was used, and if enough associations are sought, some will be considered statistically significant just by chance. Therefore, database studies should be interpreted with particular caution. Caution should also be exercised if such database studies are used for generating hypotheses.

Computerised databases may also be used for conducting case-control studies. Vaccination histories of cases and controls may be compared in order to study the effect of vaccination on the risk of an adverse event/reaction and to study the effects of co-variables. This method allows for detection and assessment of risk factors and identification of vulnerable subgroups. It is ideal for rare events/reactions and for such reactions preferable to cohort studies. However, the limitations of such a study design needs to be acknowledged. This is in particular important for vaccines as many serious adverse events are so rare that it is even difficult to study them in a case control design (e.g. anaphylactic reactions). Using the case-control approach in rare events, relative risk may reliably be estimated by odds ratios. Odds ratios may be adjusted for potential confounders by logistic regression. It is important to select controls appropriately, since selection bias in controls may potentially compromise representativeness and introduce a systematic error in effect estimates.

Particularly in studies on vaccination, one has to expect potential confounding by health awareness, for example if subgroups are more or less likely to be immunised. In studies unable to adjust for such effects, odds ratios for immunisation effects may systematically over- or underestimate any true association.

To estimate an association between vaccination and adverse events, the self-controlled case-series (SCCS) design proposed by Farrington et al (*Am J Epidemiol.* 1996; 143:1165-1173) has been used in the past as it might to avoid bias in a case-control design when the coverage rate of immunisation is high in universal vaccination programmes (lack of appropriate un-immunised control group). According to this study design, only vaccinated cases are included in the analysis. For each case, the observation period following each vaccine dose is divided into risk period(s) (the days immediately following each vaccination) and control period (the remaining observation period). Incidence rates within the risk period after vaccination are compared with incidence rates within the control period, taking age, in particular, into account, under the null hypothesis, that incidence rates would be equivalent if no association with vaccination is present. An SCCS analysis has the advantage of an implicit control of any potential confounders, even when unknown, which are stable over time and

may also control for age effects. For unique events, this method requires the additional assumption that the cumulative incidence of events in the population over the observed period is low. Data analyses may be performed early and time efficiently. Compared to cohort or case-control studies, an SCCS analysis tends to be faster and may be more feasible when examining rare events, as only information on cases is required. Besides these strengths, the SCCS method has some limitations. Like cohort or case-control studies, the SCCS method remains susceptible to some bias if vaccination is timed to minimise the risk of an adverse event. In principle, the case series method is capable of estimating relative risks. Another problem is that a relevant time interval needs to be defined. Primary immunisation with several doses might result in problems of ascertainment of cases.

Ecological studies examine the correlation between the trends in an indicator of vaccine coverage and the trends in incidence of a disease that is a presumed effect of that vaccine. These trends can be examined over time or across geographical regions. In such analysis, it is hypothesised that a strong correlation between the two trends is consistent with a causal relationship, while a weak correlation would indicate a weak relationship. However, they compare data at the population level and not at the individual level and are unable to control for confounding variables and differentiate between true association and coincidence. Their results should therefore be interpreted with caution. Ecological studies may be useful to generate hypotheses.

In many Member States, vaccination programmes are organised in a way that provide the opportunity to establish vaccination registries also addressing vaccine safety (source population for large cohort studies). Vaccination registries may be usefully augmented by disease registries.

Safety parameters in PASS should be appropriate for the specific study vaccine. A pre-requisite is the use of globally accepted standards for case definitions (e.g. those published by the [Brighton Collaboration](#)<sup>11</sup>) to compare the frequency of adverse reactions across different studies. The possibility of meta-analysis of different studies for identification of rare adverse reactions should be discussed. It is encouraged to consider the recommendations in the [Report of the CIOMS-WHO Working Group on Vaccine Pharmacovigilance](#)<sup>12</sup> for the study design as applicable.

Despite availability of the above mentioned tools, the difficulty of investigating possible long-term risks which may only become evident several years or even decades after vaccination is acknowledged.

Experimental investigations should be considered in addition to address safety concerns including virological, bacteriological and/or immunological experiments and methods to elucidate the aetiology of an adverse reaction.

Feasibility studies may be necessary before finalising a study protocol.

## **8.1 Data Management**

It is of utmost importance that data are managed in a form that allows data retrieval and analysis by age groups (e.g. premature infants, neonates, infants and the elderly), number of doses, different vaccination schedules, defined risk factors or underlying diseases and adverse event/reaction types. Clusters of reported adverse events/reactions should be identified. The safety profile of a vaccine may vary across different batches, therefore retrieval by batch number is also necessary. The same holds true for changes which are introduced into the manufacturing process. Full traceability of all manufacturing changes and links to safety data should be ensured.

As part of the investigation, additional data should be collected and analysed (in addition to the data on the patient and the immunisation history), including data about the vaccine and the diluent (if applicable) administered to the patient, manufacturer(s), batch number(s), batch release specifications, expiry date(s), distribution data, storage conditions, and laboratory test results about the vaccine/batch,

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<sup>11</sup> Available on Brighton Collaboration website <http://www.brightoncollaboration.org>.

<sup>12</sup> Under development.

if appropriate. Distribution and administration-related data should also be collected and analysed, such as storage and handling conditions for vaccines in the healthcare institution where immunisation took place. This information may help identify products inappropriately used or patterns of error.

## 8.2 Risk Evaluation

The objectives of pharmacovigilance for vaccines are to identify rare or new adverse events, identify those that are causally related to the vaccine /vaccination and estimate their rate of occurrence. In addition, any change in the frequency or severity of a known safety concern requires prompt evaluation. Evidence of causality is *inter alia* based on biological plausibility supported by laboratory evidence and/or statistically significant excess of events in the post-vaccination period. Passive reporting systems have methodological limitations, particular for ascertaining reliable adverse event/reaction rates and investigating causal relationship. Therefore, additional pharmacovigilance activities are required.

Errors in manufacturing, handling and administration should also be evaluated. Action to avoid such errors should be explored.

Guidance on causality assessment has been developed in the framework of the project on Vaccine Adverse Event Surveillance and Communication (VAESCO), funded by the European Centre for Disease Prevention and Control (ECDC)<sup>13</sup>, and it is encouraged to consider this as applicable. In general, the criteria of the Global Advisory Committee on Vaccine Safety of the World Health Organization (WHO)<sup>14</sup> may be consulted.

## 8.3 Risk-Benefit Assessment

The risk-benefit balance for vaccines depends largely on the incidence of the infectious disease in the target population, the proportion of infected persons with clinical disease, the severity of clinical disease as well as the risk of transmission, identification of high risk groups and geographical and seasonal characteristics of the infectious disease. For vaccines already included into the extended vaccination programme, the impact of the vaccine on the epidemiology of the vaccine-preventable condition should be considered as well as the impact on individual protection. Due to the success of vaccination programmes in their later stages, whether there is herd immunity as well as individual protection, the risk-benefit balance might change. Differences in morbidity and mortality of an infectious disease in different countries have to be considered.

The general guidance provided in Chapter I.8 of Volume 9A applies also to vaccines.

## 9. Risk Minimisation and Regulatory Action

In principle, regulatory tools and risk minimisation activities for vaccines are similar to those of conventional medicinal products.

### 9.1 Precautionary Measures

There may be circumstances where scientific evidence is insufficient, inconclusive or uncertain and where there are reasonable grounds for concerns that the potential risks may be inconsistent with the chosen level of protection. A decision to take measures without waiting until all necessary scientific knowledge is available, may be particularly relevant for vaccines in certain situations, e.g. vaccines for healthy children. Because the potential for any risk is considered less acceptable in the case of preventive vaccines than in the context of disease treatment, decision-makers may respond to concerns over the risk-benefit balance of a vaccine despite uncertainties of scientific knowledge by taking precautionary measures.

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<sup>13</sup> Expected to be available on ECDC website <http://ecdc.europa.eu>.

<sup>14</sup> World Health Organization (WHO). Causality assessment of adverse events following immunization. WHO Weekly Epidemiological Report. 23 March 2001.

## 9.2 Product Information

The guidance documents on the Summary of Product Characteristics (SPC) and the Package Leaflet (PL)<sup>15</sup> should be adhered to when evaluating proposed SPC/PL wordings. Please also refer to the Annex on SPC Requirements (CHMP/VWP/382703/2006) of the Guideline on the Clinical Evaluation of New Vaccines (CHMP/VWP/164653/2005)<sup>16</sup> for guidance on format and content concerning SPCs for vaccines.

## 9.3 Risk Communication

As immunisation programmes in countries mature, incidence rates of the targeted diseases are substantially decreased by high vaccine coverage rate. The level of trust in immunisation is usually high at the beginning of an immunisation programme when the disease is frequent and Patients and Healthcare Professionals have personal experience with the disease. As immunisation programmes successfully reduce the incidence of vaccine-preventable diseases, an increasing proportion of vaccinees and Healthcare Professionals are removed from personal experience with the disease and consequently rely for on historical and other more distant descriptions. This situation markedly influences risk perception and in return real or perceived adverse effects of immunisation receive relatively more attention.

Risk perception may differ between stakeholders (Patients, Healthcare Professionals, scientists, vaccination programme officers, regulators), especially when there is uncertainty about a risk. Public confidence in vaccination programmes may only be maintained by the public knowledge that systems are in place to ensure a complete and rapid safety assessment and to take measures even on precautionary basis. Communication of safety information is essential to respond to public concerns. Delivery of rapid, transparent, accurate and well-balanced information on the scientific evidence base is warranted. Communication to the public should be a collaborative undertaking between industry, regulators and public health organisations with input from all stakeholders. A key element is to clearly explain what is known about the safety and efficacy of a vaccine when it is first used in the population and what processes are in place for gathering additional safety data.

Communication may differ in different scenarios of vaccine use among Member States and with regard to different vaccines. It is essential to maintain a high level of transparency and to define the roles and responsibilities of each stakeholder in each phase.

Guidance on vaccine risk communication has been developed in the framework of the project on Vaccine Adverse Event Surveillance and Communication (VAESCO), funded by the European Centre for Disease Prevention and Control (ECDC)<sup>17</sup>, and it is encouraged to consider this as applicable.

## 9.4 Audit and Outcome Assessment

There is a need to ensure effective follow-up of the pharmacovigilance process and measurement of the outcomes of any actions taken. Actions taken, measures and methods as well as time-lines should be clearly described in the RMP.

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<sup>15</sup> Available on EMEA website <http://www.emea.europa.eu>.

<sup>16</sup> Available on EMEA website <http://www.emea.europa.eu>.

<sup>17</sup> Expected to be available on ECDC website <http://www.ecdc.europa.eu>.