**Challenges in the implementation of EAACI AIT Guidelines: Allergen manufacturing and quality aspects for allergen immunotherapy in Europe and the United States**

A. Bonertz1, G. Roberts2, J.E. Slater3, J. Bridgewater3, R.L. Rabin3, M. Hoefnagel4, M. Timon5, C. Pini6, O. Pfaar7,8, A. Sheikh9, D. Ryan10, C. Akdis11, J. Goldstein12, L. K. Poulsen13, R. van Ree14, C. Rhyner15, D. Barber16, O. Palomares17, R. Pawankar18, D. Hamerlijnk19, L. Klimek20, I. Agache21, E. Angier22, T. Casale23, M. Fernandez-Rivas24, S. Halken25, M. Jutel26, S. Lau27, G. Pajno28, G. Sturm29,30, E. M. Varga31, R. Gerth van Wijk32, S. Bonini33, A. Muraro34\*, S. Vieths1\*

\*Denotes equal contribution

1) Paul-Ehrlich-Institut, Langen, Germany

2) University of Southampton, Southampton, UK; University Hospital Southampton NHS Foundation Trust, Southampton, UK; David Hide Asthma and Allergy Research Centre, Newport, Isle of Wight, UK

3) US Food and Drug Administration, Silver Spring, MD, USA

4) CBG-MEB (Medicines Evaluation Board), Utrecht, The Netherlands

5) Division of Biological Products, Advanced Therapies and Biotechnology, Agencia Española de Medicamentos y Productos Sanitarios (AEMPS), Madrid, Spain

6) Istituto Superiore di Sanità, Rome, Italy

7) Department of Otorhinolaryngology, Head and Neck Surgery, Medical Faculty Mannheim, Universitätsmedizin Mannheim, Heidelberg University, Mannheim, Germany

8) Center for Rhinology and Allergology, Wiesbaden, Germany.

9) The University of Edinburgh, Scotland, UK

10) Usher Institute of Population Health Sciences and Informatics, University of Edinburgh, Edinburgh, UK; Asthma UK Centre for Applied Research, The University of Edinburgh, Edinburgh, UK

11) Swiss Institute of Allergy and Asthma Research, University Zurich, Davos, Switzerland

12) Division of Allergy, Immunology and Transplantation; National Institute of Allergy and Infectious Diseases; National Institutes of Health, Bethesda, MD, USA

13) Allergy Clinic, Copenhagen University Hospital at Gentofte, Copenhagen, Denmark

14) Departments of Experimental Immunology and of Otorhinolaryngology, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

15) SIAF, Davos, Switzerland

16) Universidad CEU San Pablo, Madrid, Spain

17) Department of Biochemistry and Molecular Biology, School of Chemistry, Complutense University of Madrid (UCM), Madrid, Spain

18) Nippon Medical School, Tokyo, Japan

19) Patient advocacy group, Dutch Lung Foundation, Amersfoort, Netherlands

20) Center for Rhinology and Allergology, Wiesbaden, Germany

21) Transylvania University Brasov, Faculty of Medicine, Department of Allergy and Clinical Immunology, Brasov, Romania

22) Sheffield Teaching Hospital, Sheffield, UK

23) University of South Florida, Tampa, FL, USA

24) Allergy Department, Hospital Clinico San Carlos, IdISSC, Madrid, Spain

25) Hans Christian Andersen Childrens Hospital, Odense University Hospital, Odense, Denmark

26) Wroclaw Medical University, Poland and ALL-MED Medical Research Institute

27) Department for Pediatric Pneumology and Immunology, Charité Universitätsmedizin, Berlin, Germany

28) Department of Pediatrics and Allergy Unit, University of Messina, Messina, Italy

29) Department of Dermatology and Venerology, Medical University of Graz, Austria

30) Outpatient Allergy Clinic Reumannplatz, Vienna, Austria

31) Medical University of Graz, Graz, Austria

32) Erasmus MC, Rotterdam, Netherlands

33) University of Campania Luigi Vanvitelli; IFT-CNR, Naples and Rome, Italy

34) Padua University Hospital, Padua, Italy

**Address for correspondence:**

Stefan Vieths, Paul-Ehrlich-Institut,

Paul-Ehrlich-Str. 51-59, 63225 Langen,

Germany.

Tel.: +49 6103 77 2000

Fax: +49 6103 77 1240

E-mail: stefan.vieths@pei.de

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**Abstract**

Adequate quality is essential for any medicinal product to be eligible for marketing. Quality includes verification of the identity, content and purity of a medicinal product in combination with a specified production process and its control. Allergen products derived from natural sources require particular considerations to ensure adequate quality. Here, we describe key aspects of the documentation on manufacturing and quality aspects for allergen immunotherapy products in the European Union and the United States. In some key parts, requirements in these areas are harmonized while other fields are regulated separately between both regions. Essential differences are found in the use of Reference Preparations, or the requirement to apply standardized assays for potency determination. Since the types of products available are different in specific regions, regulatory guidance for such products may also be available in one specific region only, such as for allergoids in the European Union. Region-specific issues and priorities are a result of this. As allergen products derived from natural sources are inherently variable in their qualitative and quantitative composition, these products present special challenges to balance the variability and ensuring batch-to-batch consistency. Advancements in scientific knowledge on specific allergens and their role in allergic disease will consequentially find representation in future regulatory guidelines.

**Introduction**

Allergens used in the diagnosis and treatment (Allergen immunotherapy (AIT)) of type I allergies are biological medicinal products. An essential prerequisite for any detailed consideration of a specific allergen product with regard to safety and efficacy is that these are of sufficient quality, i.e. with respect to identity, content and purity. For biological products, such quality is highly dependent on the manufacturing process and the capability of this process to produce a consistent product and control its quality accordingly. For the European Union (EU), Directive 2001/83/EC defines a biological substance as a substance that is produced by or extracted from a biological source and that needs for its characterization and the determination of its quality a combination of physico-chemical-biological testing, together with the production process and its control (1). In line with this, the manufacturing process is considered to be one of the defining characteristics for a product. Consequently, two products produced from the same source material but using differing manufacturing processes should be considered to be different products, unless their comparability with regard to their qualitative and quantitative composition has actually been demonstrated. Even potentially small differences in the manufacturing, e.g. of the extraction process (2–4), may result in considerable differences between products. Sufficient quality of allergen products and consistency of batches are considered to be prerequisites for successful application of these products in clinical practice (5–7). Only when consistency of quality within clinical batches and in comparison to batches to be marketed is assured, can efficacy and safety (to be proven by respective clinical documentation) be expected to be similar. To comply with these requirements, numerous regulations need to be considered and followed by allergen manufacturers. The main aspects addressed in these guidance documents are appropriate control of the manufacturing process, the intermediates and products produced, and appropriate batch-control testing (8). Based on the range of clinical trials performed (9, 10), Europe and the United States (US) may arguably be the most important regions for the gathering of clinical evidence and the subsequent marketing authorisation application of candidate AIT products. Here, we will describe and discuss the most critical aspects related to the manufacturing and quality control of AIT products considering the regulatory situation in Europe and the US. While an overview on the regulation of AIT products in different parts of the world (11) as well as some key aspects concerning the regulation and standardization of AIT extracts in the EU and US (12) have been previously published, an actual comparison of manufacturing and quality aspects between Europe and the US has not been described and discussed so far for allergen products.

In recent decades, multiple areas have experienced harmonization between the US and the EU. For instance, marketing authorization applications are compiled according to a shared format - the Common Technical Document (CTD). An overview on the most important segments with respect to the quality documentation is summarized in Table 1. The respective requirements on the content of these dossiers are mostly harmonized within Europe and guidance developed by the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH) are applied widely, including in Europe, the US and Japan. ICH guidelines already cover a wide range of issues, amongst others stability issues, changes in the manufacturing process, validation of manufacturing processes and test methods, and quality systems (for example (13–20)). Current Good Manufacturing Practice (cGMP) regulations apply to the manufacturing of drug products and biologic products in both the EU and the US, assuring the identity, strength, quality, and purity of drug products by requiring that manufacturers adequately control manufacturing operations. This includes establishing strong quality control management systems, obtaining appropriate quality raw materials, establishing robust operating procedures, detecting and investigating product quality deviations, and maintaining reliable testing laboratories (21). However, when it comes to the requirements for the quality documentation of an allergen product to be provided by allergen manufacturers to obtain marketing authorization, there are also diverging approaches between the EU and the US.

In this systematic analysis, we provide an overview of how AIT products are regulated with respect to their manufacturing and quality aspects in Europe and the US. As in both regions there are currently only AIT products available that are derived from natural extracts, we focus on this type of product. This analysis has been prepared by the European Academy of Allergy and Clinical Immunology’s (EAACI) Taskforce on Regulatory Aspects of Allergen Immunotherapy (AIT) and is part of the EAACI AIT Guidelines. Pertaining to these guidelines, we have previously described the general regulatory approaches for AIT products in selected parts of the world (11). The primary audiences are expected to be clinical allergologists and regulators, but the document is also likely to be of relevance to all other healthcare professionals dealing with AIT.

**Legal requirements and guidance on manufacturing and quality aspects in Europe**

In Europe, Article 8(3) in accordance with Annex I of the Directive 2001/83/EC represents the basis for the request for quality documentation to be provided for marketing authorization of a medicinal product. As also referenced here the European Pharmacopoeia (Ph. Eur.), which is a collection of pharmaceutical rules developed by the European Directorate for the Quality of Medicines & Healthcare (EDQM), are applicable and thus mandatory to be followed by manufacturers. The Ph. Eur. includes monographs on specific medicinal products (such as the monograph on allergen products (22) or the monograph on parenteralia (23)) as well as on pharmaceutical test methods. The monograph on allergen products applies to allergen products manufactured from natural sources, thereby excluding allergens derived by recombinant DNA technology and epicutaneous test allergens of chemical origin such as fragrances. It describes acceptance criteria for the source materials, manufacturing requirements and testing of the final product. It states requirements for the purity, identity and potency of allergen products, but also includes specific requests for subtypes of allergen products, for example, mandatory potency testing of therapeutic allergens and the requirement of sterility testing for skin prick tests. In addition, the monograph also defines standards for the establishment of an In-house-reference-preparation (IHRP). In the 1980’s, several international collaborative studies developed reference preparations for allergens that have become acknowledged by the World Health Organization (WHO) as International Standards for Allergens. However, these standards inherited a number of shortcomings, for example incomplete information on their preparation and dependence on individual protocols resulting in lack of comparableness of assigned units (24). They are therefore rarely used in practice. As a result, and as long as no internationally harmonized and agreed standards are available allowing comparison of products from different manufacturers, each manufacturer establishes its own IHRP for each respective product, consequentially resulting in labelling of arbitrary in-house units. This IHRP is then used as a standard to compare batches produced for the market (e.g. for identity verification or potency testing). As a result of this *modus operandi*, there are substantial differences in the individual allergen contents of the marketed products (25–28). Due to the different and non-standardized assays applied, these characteristics are not directly comparable and critically these differences are not evident to the physician or the patient. Although there are only few data available on the effect of differing contents of major allergen on clinical efficacy (29–31), better comparability of these products would be highly desirable (7, 32). The currently ongoing BSP090 project of the EDQM aims at developing standards for the quantification of certain allergens and has already developed European Pharmacopeia reference standards for the major grass allergen Phl p 5 and the major birch allergen Bet v 1 (33, 34) as well as validated methods for the quantification of Bet v 1 (35). In addition to the aforementioned monograph on allergen products, recently, several monographs on allergen source materials have been included in the Ph. Eur., each covering a separate group of allergens (36–40). It should be noted that, although defining a common set of standards for the source materials, these monographs allow much flexibility in the choice of methods used for characterization. It therefore remains within the responsibility of the manufacturers to choose and justify those methods most suited to reliably characterize respective source materials.

Furthermore, guidelines developed by different parties, such as working groups of the European Medicines Agency (EMA), the WHO and ICH, form an extensive collection of documents giving guidance on various aspects of the manufacturing of medicinal products, including allergen products. Concerning the quality and manufacturing issues of allergen products, the “Guideline on Allergen Products: Production and Quality Issues” (41) developed by EMA’s Committee for Medicinal Products for Human Use (CHMP) and the associated Biologics Working Party (BWP) is the most important allergen specific guidance available. Drafted in 2008, it gives the most up-to-date overview of the requirements to be considered for allergen manufacturing and controls thereof. In contrast to the aforementioned monograph on allergen products, it covers the manufacturing of allergens from both natural as well as biotechnological sources. The guideline details aspects of manufacturing and process controls for various stages of the manufacturing process, including specific considerations on the source materials, the drug substance and the drug product. One crucial aspect presented in this guideline is the concept of homologous groups. According to this concept, allergens from related species can be integrated in a homologous group (42). Overall, the guideline proposes six different homologous groups (for trees (Fagales group, Oleaceae group, Cupressaceae group), grass and cereal pollen, weeds, and mites). These groups may be extended and new groups may be formed if certain criteria are fulfilled (Table 2). Within a homologous group, extrapolation of data on clinical efficacy and safety as well as limited data on quality aspects (such as process validation and stability studies) from a representative species to other species of the same group are accepted by regulatory bodies.

In addition, the guideline specifies requirements for different types of allergen products produced, e.g. considerations on the demonstration of stability as well as laying out a framework for characterization of allergoids.

**Characterization of allergoids in the EU**

Allergoids are allergens that are chemically modified (e.g. by treatment with glutaraldehyde or carbamylation) to reduce IgE activity (43) and are commonly available on the European market. Many of these are additionally adsorbed to carriers such as Aluminium hydroxide. The characterization of this group of products is especially challenging as, due to the resulting cross-linking, various critical tests cannot be performed after the chemical modification. Therefore, specific tests such as determination of total allergenic activity are not performed at the drug product stage but earlier in the manufacturing process, e.g. at the stage of the native allergen extract. As a result, the manufacturer must take additional measures (e.g. by setting appropriate in-process limits) to ensure that the potency of the final drug product still remains within a controlled range even though it cannot be further determined after modification. For certain modifications, the identity of the drug product cannot be confirmed by common test methods (e.g. protein profile by SDS-PAGE) that are typically applied to native extracts. Nevertheless, manufacturers must monitor several quality attributes of these products, including the efficacy and stability of the adsorption, for example by determining the total soluble protein and/or the presence of IgE-binding components in the supernatant. With the latest version of EMA Guideline on the quality of allergen products (41), additional requirements were introduced to allow further in-depth characterization. Test methods have to be established to identify the relevant allergens in the modified form. Furthermore, potency tests are required that allow discrimination between native and modified molecules. These tests should permit a quantitative conclusion on the content of the active substance after modification and should be specific to confirm the identity of the modified drug substance. An in-depth review on qualitative aspects concerning allergoids can be found in a recent review by Zimmer et al *[to be added]*.

**Legal requirements and guidance on manufacturing and quality aspects in the US**

In the US, the basis for manufacturing and quality requirements for allergen products are US laws (Acts) and Federal Regulations. Allergen products are regulated by the US Food and Drug Administration (FDA) as biologic products (biological medicinal products) under the Public Health Service Act (PHS Act) and related amendments; and as drug products under the Federal Food, Drug and Cosmetics Act (FD&C Act) and related amendments. Additional laws may contain important provisions for regulation of biological products and drug products, but the PHS Act and FD&C Act and their related amendments are the primary laws under which biological products are regulated. The US Congress has the sole authority to enact federal laws in the US. Laws authorize or require that federal agencies develop regulations through a public rulemaking process that include details necessary for implementation. Federal Regulations, which have the force of law, specify manufacturing and quality requirements for drug products, biologic products, medical devices, and foods. Federal regulations for FDA-regulated products are located in Title 21 of the Code of Federal Regulations (21 CFR). US laws and regulations provide the critical legal framework for regulation of allergen products, and are designed to ensure that allergen products meet manufacturing and quality standards and are safe, pure, and potent. Additionally, the FDA has developed guidance documents that describe FDA’s current thinking on a range of regulatory topics including manufacturing and product quality. FDA guidance documents are not legally binding on FDA or the public and allow for use of alternative approaches provided they satisfy the requirements of the applicable laws and regulations. Finally, as stated above, several ICH guidance documents are also applicable to allergen products and provide a harmonized approach on certain manufacturing and quality related issues.

With some exceptions, manufacturing and quality requirements for allergen products are similar to those for other biologic products or drugs. Generally, manufacturing and quality standards do not differ between allergen products approved for diagnosis or therapy. FDA‘s main regulatory standard for ensuring product quality is the cGMP regulations for finished pharmaceuticals, located at 21 CFR parts 210 and 211. The regulations contain the minimum cGMP standards for methods to be used in, and the facilities or controls to be used for, the manufacture, processing, packing, or holding of a drug. Application of cGMPs are intended to assure that a drug meets the requirements of the FD&C Act as to safety, and the drug has the identity and strength and meets the quality and purity characteristics that it purports or is represented to possess. Additional cGMP requirements for biologics are located at 21 CFR parts 600-680, and specific requirements for allergenic products are located at 21 CFR part 680. Although the cGMP regulations at 21 CFR parts 210 and 211 specifically refer to finished pharmaceuticals; compliance with general principles of cGMPs is also required under the FD&C Act. FDA guidance documents inform applicants on approaches to complying with cGMPs. Examples of guidance document topics include process validation principles and practices (44), sterile drug products produced by aseptic processing (45) analytical procedures and methods validation for drugs and biologics (46), and quality systems approach to cGMP regulations (47). Harmonization has been achieved in several areas relevant to cGMP and quality systems that are applicable to allergen products, including ICH guidance documents for stability studies (14), methods validation (16), and quality systems (17–20).

As indicated above, cGMP requirements for allergen source materials and allergen products are located at 21 CFR part 680. Allergen source material regulations include testing and quality requirements for pollen, mold, mammalian and avian source materials (21 CFR 680.1). Basic requirements for allergen product manufacturing include limits on extraneous allergenic substances during the manufacturing process and in culture media used in production (21 CFR 680.1). Specific testing requirements include identity and potency (21 CFR 680.3). The potency test regulation (21 CFR 680.3(e)) is specifically related to sterile injectable allergen extracts derived from natural biologic source materials that are currently licensed for diagnosis and treatment of Type I allergies. Licensed allergen extracts are identified as *standardized* or *non-standardized*. The potency test regulation requires that the potency of each lot of allergenic extract be determined according to a potency test method that measures the allergenic activity of the product. Historically, in addition to development of a suitable potency test, FDA develops and maintains US reference standards and serum pools used by licensed manufacturers for final drug product release testing of each lot of standardized extract and for routine stability studies. Standardization ensures that standardized allergen extracts have a consistent measure of potency across manufacturers. The potency test regulation further specifies that licensed manufacturers may continue to use non-standardized units until notified by FDA of the existence of a potency test. Accordingly, non-standardized extracts are labeled in units of weight/volume (w/v) or protein nitrogen units (PNUs), and are exempt from stability testing [ 21 CFR 211.166(d)] and identity testing [21 CFR 680.3(a)]. Additional regulations under the General Biological Products Standards (21 CFR Part 610) also apply to allergenic extracts. These regulations include requirements for lot release, sterility testing, constituent materials (ingredients and preservative content) and cultures used in manufacturing. In addition to specific regulatory requirements, FDA’s Guidance for Submission of Chemistry, Manufacturing, and Controls Information for Allergenic Products (48) details additional considerations for source materials and manufacturing and process controls for the drug substance and the drug product.

**Differences in Regulatory Approaches Between the EU and the US**

The EMA/CHMP “Guideline on Allergen Products: Production and Quality Issues” (41) delineates specific approaches to use of IHRPs and homologous groups that are different from US approaches. For US standardized allergen extracts, a national reference standard is used to maintain consistent potency among US manufacturers. FDA permits the use of IHRPs properly calibrated to US reference standards for standardized extracts although this approach is rarely used. For non-standardized extracts, IHRPs are not used because:

1. As non-standardized extracts are explicitly exempted by regulation from potency testing and stability studies, there is no inherently obvious role for use of IHRPs, and
2. The proprietary biological unitage associated with IHRP use would raise significant concerns in the US about potentially increasing the variability that already exists among non-standardized extracts.

With respect to homologous groups, the EMA guideline formalizes an approach to homologous groups of allergen species, based on manufacturing similarities and cross-reactivity among allergen species from a taxonomic group. Proposed groups (see above) are based on existing data, although manufacturers may propose additional groupings from new data. According to EMA guidance (41, 49), data may be extrapolated from one member of a homologous group to others in support of product quality and even clinical claims. Although FDA guidance documents have not delineated similar regulatory treatment of allergen extracts with either cross-reactive or otherwise similar source materials, the FDA has applied comparable logic in its analyses of non-standardized allergen extracts (50), and in a recent Biologics License Application (BLA) approval for a sublingual tablet formulation for which the data supported a broader indication for the product.

The EMA guideline also provides specific requirements for distinct types of allergen products such as recombinant allergens or synthetic peptides, or novel classes of active substances such as allergoids or conjugates. These types of allergen products are not currently licensed in the US. Regardless of allergen product type, FDA reviewers work with Investigational New Drug (IND) Sponsors and BLA Applicants to ensure that the manufacturing process is properly designed and validated; quality is built into the process; test methods are suitable for their intended use and provide adequate control of the manufacturing process and the product; conformance to cGMPs is established; and consistency with clinical lots is demonstrated.

In the US, allergen products in transdermal patch delivery systems are considered combination products under the FD&C Act and the regulations at 21 CFR Part 3 (51). Therefore, applicants seeking licensure for such products must meet applicable regulatory requirements for combination products during the clinical development and licensing phases as well as the post-approval phase. Certain FDA guidance documents for combination products and transdermal drug delivery systems may apply to allergen products (52, 53). Other allergen product delivery systems such as pre-filled syringes or microneedles also meet the definition of combination products, and requirements may differ based on packaging configurations and product labeling. IND sponsors and BLA applicants should consult with FDA as early as possible in the development process to determine if their allergen products meet the definition of a combination product and ensure that appropriate clinical and manufacturing studies are performed. An overview on key similarities and differences in the regulation of allergen manufacturing and quality control between the EU and the US is depicted in table 3.

**Variability in the product characteristics of AIT products**

Production and control of allergen products derived from natural extracts can prove to be a considerable challenge. The complexity of the source material and the final product is high, as it is composed not only of a mixture of allergenic proteins, but also of non-allergenic proteins as well as other non-allergenic compounds. There is high variability in the source material itself resulting in final products that mirror this variability. This is also reflected by the comparably wide acceptance criteria allowed by the European Pharmacopoeia for the testing of allergen products (22).

It should be noted that current versions of the European Pharmacopeia allow comparably wide ranges with respect to the specifications of the allergen products. For example, the potency as determined by the total allergenic activity may vary between 50 to 150 % of a stated amount (22). This wider limit is required given the variability between batches of starting material but also to accommodate for the inherent variability of the (mostly immunochemical) potency assays. Accordingly, a batch produced at a total allergenic activity of 50% would be in line with a given specification and, presuming that all other specifications are fulfilled as well, could be marketed. The same would be true for a batch at the higher end of the specification (e.g. at 150% of a stated amount). In consequence, substantial variation with regard to the potency of an allergen product is possible where a new batch is being applied to a patient. However, it should be noted that a product must comply with such specifications over its whole shelf life, which implies that given some expected decrease over time the levels at release should not be at the lowest specification level. Similar to the determination of total allergenic activity, such circumstances are observed for additional parameters such as the determination of the total protein content (for therapy allergens, a range of 50 to 150% is allowed) and the determination of individual allergens, where a range of 50 to 200 % is allowed. Figure 1 illustrates the variation that would be possible for a hypothetical product in regard to the content of individual allergens. These considerably large ranges give credit to the biological source material being used and the natural variation in quality characteristics resulting from the nature of the material. However, applicants must justify a chosen specification and it may be required to tighten such specification beyond the limits requested by the Ph. Eur (22). Monographs are considered to demand minimum requirements. Furthermore, there are also specific in process controls (IPCs; e.g. protein content and allergenic activity) that are typically applied and monitored during manufacturing. Trend analysis of such IPCs in the manufacturing process is applied to prevent that the variability in the starting material leads to extensive batch-to-batch variation in potency. It therefore is a balancing act of allowing some variation to account for this while restricting variation to an acceptable degree to secure batch-to-batch consistency.

Even with such comparably wide ranges allowed, the natural origin of the source materials of AIT products can result in considerable difficulties. As it is essential that a medicinal product can be produced consistently and its qualitative and quantitative composition remains comparable and consistent throughout its lifecycle, a manufacturer must ensure that the manufacturing process is flexible enough to balance variances and trends in the composition of the source material, and that such trends are recognized as early as possible. For example, it has been reported that the allergenic composition of pollen is changing as a long-term trend, possibly due to climate change (54). As it is not possible to simply change the strength or composition of a product due to such observations, e.g. with respect to the overall allergenic activity, the process must assure that the product can still be produced according to the given quality characteristics and in assurance of batch-to-batch consistency.

**Future perspectives**

As is evident from the descriptions above and despite much progress achieved in harmonization, there remain considerable differences in the in-depth quality and manufacturing requirements between the US and the EU. Regional specific issues and priorities are a result of this. There appears to be consensus in Europe that updating of existing regulations may be needed here to account for the changes in the landscape of available allergen products observed in this region. Scientific guidance and legislation may need to differentiate more between certain types of allergen products. For example, in the EU, current guidance applicable to allergen products only scarcely considers the impact of allergy prevalence. In the Guideline on Allergen Products: Production and Quality Issues (EMEA/CHMP/BWP/304831/2007) (41) some initial considerations are presented for products where certain tests may not be applicable (e.g. “*because a sufficient number of patients is not available to create an appropriate sera pool*”). Staggered requirements for quality and/or clinical data in dependence of the prevalence of a specific allergy may be a path forward to support the market availability of a wider array of products while, at the same time, securing the quality, efficacy and safety of these products as far as possible.

The need for such adaptions has also been recognized at a European level. For example, the Co-ordination group for Mutual recognition and Decentralised procedures – human (CMDh), which is responsible for the examination of any question relating to marketing authorisations of a medicinal product in two or more Member States, has requested the CHMP to develop specific scientific guidance for allergies with lower prevalence in order to address critical issues in relation to the data generation for these products. The CHMP has agreed to form a respective drafting group to evaluate this request (55).

There are additional areas where experience and specific guidance is fragmented. For example, products for diagnosis or treatment of IgE-mediated food allergy, including peanut allergy, are an area of increased interest for product development in the US and Europe. For this, to our knowledge, there is currently no approved form of therapy available in any country so far. Yet, there is only limited experience available at this point with regard to standards and requirements for manufacturing and quality control as there are no marketed products available and current guidance only scarcely considers this type of product specifically. In particular, the issue of specific allergen content is critical and regulatory decisions on the need for specific allergen specifications (as opposed to a food certificate of analysis) are based on clinical and product quality data generated during product development.

Finally, a comprehensive characterization of AIT products with regard to quality aspects remains essential. While current guidelines already implemented the request on the definition and verification of the presence of relevant allergens for each product (22, 41), the knowledge on which the relevant allergens for specific types of allergies are is rapidly increasing, as has been shown for Bet v 1 in birch pollen allergic patients (56, 57). Another example concerns hymenoptera AIT where it has been suggested that minor allergens are critically important in the probability of success of the treatment for some patients (58). Accordingly, choosing products that reliably contain such critical compounds for specific patients may become essential. As analytical procedures evolve and allow more precise characterizations of allergen products, it is safe to predict that the regulatory framework will follow these developments with some follow-up time. In line with this and considering that allergens are the defining elements for the efficacy of these products, demands on their characterization and verification with regard to identity and quantity on a routine basis in these products will likely intensify in the future.

**Disclaimer**

The views expressed in this review are the personal views of the authors and may not be understood or quoted as being made on behalf of or reflecting the position of the respective national competent authorities, the European Medicines Agency or one of its committees or working parties.

**Authors’ contributions**

This document was drafted by Bonertz A, Slater J, Bridgewater J, Rabin R, Hoefnagel M, Timon M, Pini C and Vieths S. It was revised following critical review by Roberts G, Pfaar O, Sheikh A, Ryan D and then by all the co-authors. The EAACI task force developing the manuscript was chaired by Vieths S. Coordination of authors’ contributions was done by Bonertz A. This study is part of the EAACI AIT guidelines project, chaired by Muraro A and coordinated by Roberts G.

|  |  |  |
| --- | --- | --- |
| Data on the manufacturing of the active substance |  | Data on the manufacturing of the finished product |
| General Information on the active substance |  | Description and composition of the medicinal product |
|  |  | Pharmaceutical development   * Components of the Medicinal Product * Manufacturing Process Development * Microbiological Attributes |
| Manufacturing process of the active substance   * Manufacturing process description * Control of Materials * Control of Critical Steps and Intermediates * Process Validation * Manufacturing Process Development |  | Manufacturing process of the finished product   * Batch Formula * Manufacturing process description * Control of Critical Steps and Intermediates * Process Validation |
|  |  | Control of Excipients |
| Control of the active substance   * Specifications * Description of analytical procedures * Validation of analytical procedures * Batch Analysis Data * Justification of Specification |  | Control of the finished product   * Specifications * Description of analytical procedures * Validation of analytical procedures * Batch Analysis Data * Characterization of Impurities * Justification of Specification |
| Reference standards or materials |  | Reference standards or materials |
| Stability of the active susbstance |  | Stability of the finished product |

Table 1: Simplified overview on critical segments of a marketing authorisation dossier with respect to the documentation on the quality of a medicinal product

Table 2: The concept of homologous groups as stated in (41)

|  |  |  |
| --- | --- | --- |
| Criteria for grouping as homologous groups | Data extrapolation allowed | Homologous groups as accepted in (41) |
| Comparable physicochemical and biological properties of the source material | Stability data | Birch group (Alder, Hornbeam, Hazel, Oak, Sweet Chestnut, Beech) |
| Cross-reactivity/Structural homology of the allergens | Manufacturing process validation | Oleaceae group (Olive, Ash, Privet, Lilac) |
| Identical formulation of the finished product | Efficacy | Cupressaceae group (Cedar, Cypress) |
| Identical production process of the allergen extract and of the finished product | Safety | Sweet grasses (Sweet vernal grass, Oat, Cocksfoot, Meadow fescue, Velvet grass, Barley, Perennial ryegrass, Timothy grass, Kentucky bluegrass, Cultivated rye, Cultivated wheat) |
|  |  | Weed pollen (Ragweed, Mugwort, Pellitory) |
|  |  | House dust mites (Dermatophagoides pteronyssinus, Dermatophagoides farinae) |

Figure 1: Choosing the house dust mite allergens Der f 1 and Der f 2 as examples, displayed is the theoretical range allowed by the European Pharmacopeia for the content of individual allergens (50 to 200 % of the stated amount of each relevant allergen component). Any value between 0,5 and 2 would be accepted for a batch to be produced the individual allergens, respectively.

|  |  |
| --- | --- |
| **Key similarities** | **Key differences** |
| * Harmonized use of ICH-Guidelines in various areas, including stability studies, methods validation, quality systems * Applicability of cGMP regulations * Common Technical Document format for regulatory procedures * **EU:** Extrapolation of quality, non-clinical and clinical data based on homologous groups possible according to [Ref]   **US:** Concept of homologous groups not delineated in FDA guidance, but comparable concepts can be applied   * Consistency of the manufacturing process and of batches used for clinical development must be demonstrated | * Regulation is also based on region specific laws, regulations, and guidelines * **EU:** Allergen products are regulated by the National Competent Authorities of the EU member states, EMA and its committees   **US:** Regulated by the FDA   * **EU:** Use of manufacturer-specific in-house reference preparations and serum pools for release testing and stability studies   **US:** Development and maintenance of US reference standards and serum pools to be used by licensed manufacturers for release testing and stability studies   * **EU:** AIT products are typically labelled in in-house potency units. In specific circumstances, labelling can also be in protein content.   **US:** AIT products are labelled according to a standardized potency. Where no standardized potency assay is available by FDA, products are labelled in units of weight per volume or protein content (protein nitrogen units).   * **EU:** Aqueous extracts for subcutaneous, oral and sublingual AIT and tablets for sublingual AIT are available; Allergoids and adsorbed products are available.   **US:** Mostly aqueous extracts for subcutaneous AIT are being used; Some sublingual AIT tablet products are available; no allergoids or adsorbed products are available. |

Table 3: Key similarities and differences in the regulation of allergen manufacturing and quality control between the EU and the US

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