**EAACI Guidelines on Allergen Immunotherapy: Hymenoptera venom allergy**

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**Abbreviations:**

AAI, adrenaline autoinjector; AIT, allergen immunotherapy; ACEI, angiotensin-converting enzyme inhibitors; AGREE II, Appraisal of Guidelines for Research & Evaluation; BAT, basophil activation test; CBA, controlled before-and-after studies; CCT non-randomized controlled clinical trial; EAACI, European Academy of Allergy and Clinical Immunology; ELIFAB, enzyme-linked immunosorbent facilitated antigen binding; ENT, ear nose and throat; HVA, hymenoptera venom allergy; LLR, large local reaction; MAOI, monoamine oxidase inhibitors; QoL, quality of life; RCT, randomized controlled trial; SCIT, subcutaneous immunotherapy; SLIT, sublingual immunotherapy; SR, systematic review; SSR, systemic sting reaction; VIT, venom immunotherapy (subcutaneous, unless otherwise stated).

 **Abstract**Hymenoptera venom allergy is a potentially life-threatening allergic reaction following a honeybee, vespid or ant sting. Systemic allergic sting reactions have been reported in up to 7.5% of adults and up to 3.4% of children. They can be mild and restricted to the skin or moderate-to-severe with a risk of life-threatening anaphylaxis. Patients should carry an emergency kit containing an adrenaline autoinjector, H1-antihistamines, and corticosteroids depending on the severity of their previous sting reaction(s). The only treatment to prevent further systemic sting reactions is venom immunotherapy. This guideline has been prepared by the European Academy of Allergy and Clinical Immunology’s (EAACI) Taskforce on Venom Immunotherapy as part of the EAACI Guidelines on Allergen Immunotherapy initiative. The guideline aims to provide evidence-based recommendations for the use of venom immunotherapy, has been informed by a formal systematic review and meta-analysis and produced using the Appraisal of Guidelines for Research and Evaluation (AGREE II) approach. The process included representation from a range of stakeholders. Venom immunotherapy is indicated in venom allergic children and adults to prevent further moderate to severe systemic sting reactions. Venom immunotherapy is also recommended in adults with only generalized skin reactions as it results in significant improvements in quality of life compared to carrying an adrenaline auto-injector. This guideline aims to give practical advice on performing venom immunotherapy. Key sections cover general considerations before initiating venom immunotherapy, evidence-based clinical recommendations, risk factors for adverse events and for relapse of systemic sting reaction, and a summary of gaps in the evidence.

**Introduction**
This guideline has been prepared by the European Academy of Allergy and Clinical Immunology’s (EAACI) Taskforce on Venom Immunotherapy (VIT) and are part of the EAACI Guidelines on Allergen Immunotherapy (AIT). This guideline aims to provide evidence-based recommendations for the use of VIT in children and adults. The primary audience is clinical allergists although these are also likely to be of relevance to all other healthcare professionals (e.g. primary care practitioners, emergency departments and other specialist doctors, nurses and pharmacists working across a range of clinical settings) who may dealing with insect venom allergic patients. Development of this guideline has been informed by a formal systematic review and meta-analysis of AIT for Hymenoptera venom allergy (HVA) with systematic review principles being used to identify additional evidence where necessary1.

Insects stings by Hymenoptera species are very common with data indicating that 56.6-94.5% of the general population has been stung at least once in their lifetime2. The most frequent clinical presentations of HVA are large local reactions (LLR) at the sting site and systemic sting reactions (SSR). A large local reaction has been defined as a swelling exceeding a diameter of 10 cm that lasts for longer than 24 hours3. In SSR, mild symptoms usually manifest as generalized skin symptoms including flushing, urticaria and angioedema. Typically, dizziness, dyspnea and nausea are examples of moderate reactions, while shock and loss of consciousness, or even cardiac or respiratory arrest all define a SSR. The rate of self-reported SSR in European epidemiological studies ranges from 0.3 to 7.5% in adults4 and up to 3.4% in children4, 5. LLRs occur in 2.4% to 26.4%6 of the general population. Severe reactions are life-threatening and have been attributed to fatatlities. Although only 0.03 to 0.48 fatalities/1 000 000 inhabitants/year are reported2, Hymenoptera sting mortality may have been underestimated due to unrecognized stings in unexplained causes of death. Patients with HVA are advised to carry an emergency kit comprising of an adrenaline autoinjector (AAI), H1-antihistamines, and corticosteroids depending on the severity of their previous sting reaction(s). The only treatment that can potentially prevent further systemic sting reactions is venom immunotherapy (VIT), which is reported to be effective in 77-84% of patients treated with honeybee venom7, 8, in 91-96% of patients receiving vespid venom7, 8, and in 97-98% of patients treated with ant venom9, 10.

The systematic review suggested that VIT is effective in reducing subsequent SSRs reactions in both children and adults and that this treatment modality can have a significant beneficial impact on disease specific quality of life (QoL)1. VIT proved to be safe and no fatalities were recorded in the studies included in this review. The cost-effectiveness of VIT needs to be established. Modelling cost-effectiveness suggested that VIT was likely to be cost-effective in those at high risk of repeated systemic sting reactions and/or impaired quality of life. However, primary studies assessing the cost-effectiveness of VIT could not be identified.

**Methodology**This guideline was produced using the Appraisal of Guidelines for Research & Evaluation (AGREE II) approach11, 12, an internationally recognized and accepted structured approach to guideline production. This is designed to ensure appropriate representation of the full range of stakeholders, a careful search for and critical appraisal of the relevant literature, a systematic approach to the formulation and presentation of recommendations and steps to ensure that the risk of bias is minimized at each step of the process. The process started in April 2015 beginning with detailed face-to-face discussions agreeing the process and the key clinical areas to address, followed by face-to-face meetings and regular web-conferences in which professional and lay representatives participated. The present guideline is based on the systematic review and they follow the methods and criteria applied1.

**Clarifying the scope and purpose of the guideline**The scope of this EAACI guideline is multifaceted, providing statements that assist clinicians in the optimal use of use of VIT in the management of patients with Hymenoptera venom allergy and identifying gaps for further research.

**Ensuring appropriate stakeholder involvement**Participants in the EAACI Taskforce on VIT represented a range of 14 European countries and disciplinary and clinical backgrounds, including allergists, pediatricians, primary care practitioners, ophthalmologists, ear nose and throat (ENT) specialists, pharmacists, immunologists, nurses and patient representatives. Representatives of immunotherapy product manufactures were given the opportunity to review and comment on the draft guideline as part of the peer review and public comment process. These comments were considered by the taskforce and, where appropriate, revisions were made.

**Systematic reviews of the evidence**The initial full range of clinical questions that were considered important were rationalized through several rounds of iteration to agree on one key question: what is the effectiveness, cost-effectiveness and safety of VIT in patients. This was then pursued through a formal systematic review and meta-analysis of the evidence1. We continued to track evidence published after our systematic review and meta-analysis with a cut-off date of July 1, 2017 and, where relevant, studies were considered by the taskforce chairs. This evidence will formally be considered in the systematic review update that will precede the update of this guideline, which is scheduled for publication in 2022.

**Formulating recommendations**
We graded the strength and consistency of key findings from these systematic reviews1 to formulate evidence-based recommendations for clinical care by applying the GRADE process13 (Box 2). This involved formulating clear recommendations with the strength of evidence underpinning each recommendation. Where the systematic review did not cover the clinical area, we took a hierarchical approach reviewing other evidence until we could formulate a recommendation, i.e.: (i) other systematic reviews on the subject to see if these provided any clarity on the topic; (ii) randomized controlled trials (RCTs) within these systematic reviews; (iii) other RCTs known to Taskforce members; and (iv) a consensus-based approach using an expert panel. Recommendations apply to all ages unless otherwise indicated in the tables. Experts identified the resource implications of implementing the recommendations, barriers, and facilitators to the implementation of each recommendation, advice on approaches to implementing the recommendations and suggested audit criteria that can help with assessing organizational compliance with each recommendation.

**Peer review and public comment**
A draft of this guideline was externally peer-reviewed by invited experts from a range of organizations, countries and professional backgrounds. Additionally, the draft guideline was made available on the EAACI website for a 3-week period in May 2017 to allow a broader array of stakeholders to comment. All feedback was considered by the taskforce and, where appropriate, final revisions were made in the light of the feedback received. We will be pleased to continue to receive feedback on this guideline, which should be addressed to the corresponding author.

**Identification of evidence gaps**
The process of developing this guideline has identified a number of evidence gaps which are prioritized.

**Editorial independence and managing conflict of interests**
The production of this guideline was funded and supported by EAACI. The funder did not have any influence on the guideline production process, on its contents or on the decision to publish. Taskforce members’ conflict of interests were declared at the start of the process and taken into account by the taskforce chairs as recommendations were formulated. Final decisions about the strength of evidence for recommendations were checked by the methodologists who had no conflict of interests in this area.

**Updating the guideline**EAACI plans to update this guideline in 2022 unless there are important advances before then.

**General considerations before initiating venom immunotherapy**

**General indications**VIT is indicated in children and adults following a systemic allergic reaction exceeding generalized skin symptoms with a documented sensitization to the venom of the culprit insect with either skin prick tests and/or specific serum IgE tests and/or the basophil activation test (BAT). VIT should also be considered for adults with skin symptoms only but at high risk of re-exposure and/or impairment in QoL. VIT is not indicated if no sensitization to insect venom can be verified. Also, an incidental finding of sensitization to insect venom (e.g. using a multiplex system) in patients who have not had a SSR is not an indication for VIT. Furthermore it is not indicated in patients with unusual reactions that cannot be attributed to Type I immediate reactions such as thrombocytopenic purpura and vasculitis, rhabdomyolysis or renal failure after multiple stings. The risk for future systemic reactions is low in patients with LLR, in whom only 0.8-7% are expected to develop SSR in the future14-16. As patients with repeated LLRs have been reported to have a minimal risk for SSR17, 18, VIT is generally not recommended in these patients. However, subcutaneous VIT has been shown to reduce the size and duration of LLR19. Therefore, VIT could be considered a treatment option in patients with recurrent, troublesome LLRs. Additional precautions should be taken to avoid insect stings during the build-up phase of VIT by following preventive measures such as not going barefoot, not eating outdoors and avoiding gardening. Beekeepers should stop beekeeping until the maintenance dose is reached because of the increased risk of stings and consecutive SSR (Table 1).

**Absolute and relative contraindications and VIT in patients with special conditions**An European position paper on clinical contraindications has been in 2015 published tackling all relevant contraindications in detail20. In a recently published survey among 520 mainly European allergists, up to 47% had experience with administration of AIT in patients with risk conditions such as cardiovascular disease, taking ACEI or beta-blockers, malignant disease in remission, and autoimmune disease which previously had been considered as contraindications21. Problems were uncommon and mostly minor so we have reconsidered contraindications in VIT. Below contraindications are briefly described, and recommendations are given in Table 2.

Cardiovascular diseaseFatality studies have shown that particularly elderly patients with HVA and pre-existing cardiovascular disease have an increased risk of dying from a sting22. Therefore, in contrast to respiratory allergies, VIT is commonly performed in elderly patients. Based on the risk / benefit profile, cardiovascular diseases *per se* are not a contraindication for VIT20.

Beta-blockers
There is good evidence that anaphylaxis does not occur more frequently in patients receiving beta-blockers, as recently summarized in an EAACI position paper20. However, these patients may theoretically be at increased risk of more SSRs, and emergency treatment with adrenaline may be less effective. Elderly patients with HVA and cardiovascular disease treated with beta-blockers are considered to be particularly at high risk of severe SSR in the case of an insect sting23. Based on the risk/benefit profile, there is no contraindication for VIT in patients treated with beta-blockers20.

Angiotensin-converting enzyme inhibitors (ACEI)
Studies with large number of patient participants conclude that treatment with ACEI does not affect the safety of VIT24, 25. One study reported a higher risk for more severe SSR26, however there is a growing base of evidence that indicates that ACEI do not increase the risk for severe SSR in untreated patients27-29. In univariate analyses,results are often confounded by patient’s older age which has been shown to be a strong risk factor for more severe SSR27, 29, 30. One multicenter study reported that all patients on ACEI tolerated a sting challenge or field sting during VIT31, whereas in another study patients taking ACEI had a higher risk for relapse32. However, the risk of ACEI may have been overestimated in certain studies due to the very small patients’ group and highly selected patients with suggested cardiovascular comorbidity33. Therefore, ACE inhibitor therapy may be continued during VIT, but the patient should be informed about possible risks
Malignant neoplasia
AIT was safely administered in patients suffering concomitantly from vespid venom allergy and less advanced stage cancer in one small case series of four patients34. No controlled studies are available relating to the risk or effectiveness of AIT are available in malignant neoplasias20. Therefore, acute malignant neoplasias are considered a relative contraindication, even if there is no evidence on any unfavourable effects of VIT on tumor growth or the efficacy of chemotherapy. The benefits of VIT should be weighed against the possible burdens of the treatment and the activity of the tumour disease. To conclude, VIT can be recommended in high risk venom allergic patients when malignant disease is stable or in remission.

Autoimmune disordersCaution should be exercised when prescribing VIT to patients with multi-organ autoimmune disorders. Due to a lack of available data, there is a relative contraindication in autoimmune disorders in remission and an absolute contraindication in active forms20. Organ-specific autoimmune disorders, such as e.g. diabetes mellitus, Hashimoto’s thyroiditis, Crohn’s disease, ulcerative colitis, and rheumatoid arthritis are not considered a contraindication when the disease is stabilized, but concerns were raised that immune-suppressive medication could theoretically negatively influence the effectiveness of VIT35. Therefore, VIT can be recommended in patients with organ-specific autoimmune disorders when the underlying disease is stabilized

Monoamine oxidase inhibitors (MAOI)
The prescribing of MAOIs is now extremely limited, due to their wide range of dangerous drug-drug interactions36. The major concern with their use in the context of AIT is that they prevent the breakdown of sympathomimetic drugs; therefore, in the event of adverse events emergency treatment with adrenaline could result in severe hypertension and/or tachycardia20, 36. To conclude, treatment with MAOIs is not a contraindication for VIT but caution is recommended with the use of adrenaline

Children below five years of ageGenerally, severe SSR are less frequent in children, and appear to be rare in children of preschool age (<5 years)37. In the rare event of a SSR, decisions should be made on an individual basis considering the risk of future severe systemic reactions. Successful VIT in children under four years have been reported38; as the age limit of five years is arbitrary, there are no specific concerns regarding children younger than five years and the same recommendations as in adults apply.

PregnancyThe incidence of prematurity, toxemia, abortion, neonatal death and congenital malformation appears to be similar in patients on AIT during pregnancy compared to the general population39. During VIT only two mild adverse events were observed in 43 pregnancies40. VIT appears to be safe in pregnant women, but data are scarce. Therefore, initiation of VIT is not recommended. Due to the high risk of relapse after early termination of VIT41, 42 and the low risk of adverse events24, 43, a well-tolerated ongoing VIT regime during pregnancy should be continued, using the tolerated VIT maintenance dose administered before pregnancy.

MastocytosisMastocytosis is a risk factor for both the development of HVA and for more severe SSR44. VIT is usually well tolerated by the majority of patients with underlying systemic mastocytosis45, although adverse events can occur more frequently46. In a recent large study on patients with confirmed systemic mastocytosis and severe initial sting reactions (63% suffered from loss of consciousness), it could be shown that VIT was safe and effective47. Whether elevated serum tryptase levels alone increase the risk for adverse events is still a debated issue and robust data are scarce. One study showed a slightly elevated risk for adverse events24, whereas others did not identify a higher risk25 which may be related to a very low overall rate in objective side effects in all patients. Generally, there is no evidence from the literature that VIT should be performed indefinitely in patients with mastocytosis48. However, VIT may be less protective in patients with severe initial SSR and mastocytosis and/or elevated serum tryptase ( >11.4 µg/L). Therefore, for safety reasons, it should be prolonged in those patients; it remains unclear whether it should be given life-long or after which duration of treatment it should be stopped.

**Quality of life**For most patients, and their families, any allergic reaction (regardless of severity) is a frightening experience. Given the effort required to avoid accidental exposures and the inherent uncertainty of success, living with HVA negatively influences QoL. This is particularly due to emotional distress of being alert during activities of daily living49. VIT improves QoL in vespid venom allergic patients even when they do not experience a re-sting50. In a study where patients were offered a sting challenge after VIT, 80% of patients reported a significantly increased QoL after tolerating a sting challenge51. In contrast, therapy with the AAI alone was shown to negatively impact on health related QoL50, 52, a significantly increased burden for patients53 and a higher level of anxiety and depression54. In contrast, more than 90% of patients perceived VIT as (extremely) positive53, with health and allergy-related QoL improving significantly during treatment50, 52, 55, dysfunctional beliefs decreasing55 and anxiety and depression levels were the lowest among VIT treated subjects54. In a randomized study evaluating dermal reactors, QoL was also impaired in these systemic reactors and VIT was also able to improve their QoL in contrast to the AAIs52.

**Venom immunotherapy: evidence based clinical recommendations**

 **Available venoms**
Venom of *Apis mellifera* and Vespula species is available throughout Europe, whereas venom of Polistes is accessible in those countries where allergy to Polistes *species* (e.g. *Polistes dominula* in Spain and Italy) is most often occurs. The use of bumblebee venom would be preferable if the primary sensitization was induced by bumblebee stings56, 57. Bumblebee venom for VIT is currently only available in some countries, e.g. in Italy. Worldwide, also ant venoms are available, such as venom of *Myrmecia pilosula* (Jack Jumper Ant) in Australia.

**Preparation of venom**Throughout Europe, non-purified aqueous, purified aqueous preparations and purified aluminium hydroxide adsorbed preparations (so-called “depot” preparations) are used to perform subcutaneous VIT58. The efficacy is supported by studies using both sting challenge and ‘in-field’ stings58. The aqueous preparations can be used for build-up protocols including ultra-rush, rush, clustered and conventional, as well as for maintenance phase. Purified aluminium hydroxide adsorbed preparations are typically used for the conventional or clustered build-up and maintenance schedule. Treatment can be switched from aqueous to depot preparations following the rapid up-dosing phase59. Depot preparations seem to be associated with fewer local side effects than aqueous preparations, but results may have been biased by the slower build-up phase with depot preparations60. Purified aqueous preparations cause smaller local reactions compared with non-purified aqueous preparations 61. A systematic literature review has documented a similar rate of systemic adverse events when depot and aqueous venom allergen preparations were used, but the difference between purified and non-purified aqueous preparations was not taken into account62. A comparative study in honeybee venom allergic patients indicates the superiority of the purified aqueous preparations over the corresponding non-purified aqueous preparation under the same rush protocol in terms of systemic reactions during the build-up phase63 (Table 3).

**Treatment with more than one venom**
Selection of the correct venom preparation(s) is important to ensure optimal efficacy of VIT. Sensitization to venom of more than one Hymenoptera species is common in insect venom allergic patients64 and it can be difficult to determine whether this reflects double sensitization due to cross-reactivity of shared allergenic determinants or genuine multiple sensitization to more than one venom. However, in most of these cases treatment with only one venom appears to be sufficient64. A major diagnostic problem is that currently available tests, such as skin testing, IgE determination including component-resolved diagnosis or the BAT are not able to distinguish between asymptomatic sensitization and clinically relevant allergy with LLR and SSR18. However, if the initial sting reaction was severe and all allergy testsare almostequally positive to vespid and to honeybee venom, VIT with both venoms should be considered. As there is only limited cross-reactivity between honeybee and vespid venom and Vespula and Polistes venom, simultaneous injections with both venoms should be safe. This approach is common in the United States (US) and partly in Europe, however, no studies have examined this question (Table 3).

**Preventive pre-treatment**In several double-blind, placebo-controlled trials, it has been shown that pretreatment with H1 antihistamines improves the tolerability of VIT65-68. In detail, it was reported that levocetirizine decreased the rate of SSR68 and fexofenadine decreased the rate of LLR and cutaneous SSR67 (Table 3). Importantly, effectiveness of VIT was not negatively influenced68, 69. Antihistamines were usually administered 1-2 hours before the injections or sometimes twice daily. In case of repeated adverse events during up-dosing, pre-treatment with Omalizumab may be recommended70-72.

**Treatment protocols**
VIT is performed by subcutaneous injections. VIT consists of an up-dosing phase and a maintenance phase, which is necessary to ensure a sustained effect of VIT. Conventional protocols, where the maintenance dose is reached in several weeks to months, can be administered in outpatient clinics73. In an effort to reach the maintenance dose faster, rush 73-77 and ultra-rush protocols78-81 with several injections per day on consecutive days are performed in hospitals. Maintenance dose is reached either within a few hours or within a few days, respectively. Cluster protocols, with several injections per day usually 1-2 weeks apart, are also a quick alternative to conventional protocols82, 83. Importantly, the risk of adverse events is not associated with the severity of initial reactions24, 25, 84, high venom-specific IgE levels, or skin test reactivity at low venom concentrations84, 85. Conventional regimes appear to be best tolerated while rush and ultra-rush protocols are more frequently associated with adverse events24.

**Up-dosing**
The recommended starting dose in up-dosing protocols lies between 0.001 and 0.1*μ*g, but it has also been shown that a starting dose of 1*μ*g is usually safe and not associated with a higher rate of side effects in adults or in children86. A maximum dose of 100*μ*g venom allergen dose usually offers adequate protection against systemic allergic sting reactions in the majority of venom allergic individuals87-89.

**Maintenance dosing**
A maintenance dose of 100µg venom is significantly more effective than 50 µg 88. This dose is equivalent to the dry weight of approximately two honeybee stings or five wasp stings90 and has been adhered to as the recommended maintenance dose since the first controlled trial87. A further increased dose gives a better protection when needed91. A dose of 200*μ*g is recommended in patients who develop systemic allergic reactions following a field sting or sting challenge while on 100*μ*g maintenance VIT91. An increased maintenance dose should also be considered in allergic populations at high risk of multiple stings, such as beekeepers92 and in exceptional cases where patients have accumulated risk factors for treatment failure.
Although the European Medicines Agency (EMA) had no safety concerns regarding aluminium toxicity from their pharmacovigilance review of aluminium hydroxide in standard AIT, high dose VIT and life-long therapy has not been specifically evaluated. As a precaution, where life-long therapy is planned is can be undertaken with aqueous preparations. If a 200µg dose is required for maintenance, half can be given as an aqueous preparation.

The interval for maintenance VIT with 100*μ*g venom recommended by the manufacturers has been 4-6 weeks for aqueous preparations and 6-8 weeks for purified aluminium hydroxide adsorbed preparations (depot preparations). According to expert consensus, injections are usually given every four weeks in the first year of treatment, every six weeks in the second year, and in case of a five year treatment every eight weeks from year 3-593. Extending the maintenance interval to three months does not seem to reduce effectiveness or increase adverse events94-96, which could be relevant in terms of convenience and economic savings if life-long treatment is necessary. As there is no specific study available for mastocytosis patients with severe initial SSR, caution should be used in extending the intervals to three months in those patients. A dose interval of six months did not provide suitable protection in honeybee venom allergic patients97 and is therefore not recommended for standard practice (Table 3).

**Duration of VIT**Termination after approximately one or two years leads to a relapse rate of 22-27% 41, 42. Some studies have concluded that VIT for three years may be sufficient98, particularly in patients with only mild to moderate initial sting reactions98. Nevertheless, most of the studies concluded that a minimum of a five-year treatment is superior for long-term effectiveness99-102. Life-long therapy should be considered in patients with severe initial SSR, systemic adverse events during VIT, and honeybee venom allergic patients with high risk of future honeybee stings (Table 3, 4).
 **Adherence**
Adherence to VIT is high, possibly because of patients’ perception of an unpredictable risk of life threating sting reactions. In a recent study 95% and 84% of patients still continued VIT after three and five years, respectively103.

**Effectiveness**
Treatment with ant venom is very effective as 97 to 98% are protected after VIT9, 10. The effectiveness of honeybee and vespid VIT is different and ranges from 77 to 84% for honeybee venom compared to 91 to 96% for vespid venom7, 8. The underlying reasons are still unclear. It has been speculated that the amount of venom delivered by a honeybee sting is much larger and more consistent90. This may also explain the difference in the reaction rate to sting challenges, which has also been observed in untreated patients104-106. It also appears that the broad sensitization pattern in honeybee venom allergic patients may play a role in the lower effectiveness of honeybee VIT107. For example, some patients are predominantly sensitized to Api m 10, which may be underrepresented in certain available honeybee venom preparations108, 109. However, none of these studies included a patient analysis of molecular sIgE binding patterns to honeybee venom allergens before the start of VIT. Without such a specific IgE stratification aligned with the clinical outcome, the conclusions are of limited value. The specific preparation does not seem to have an impact on the effectiveness. The effectiveness of aqueous and purified aluminium hydroxide adsorbed preparations has been shown to be similar60, 110.

**Effectiveness of VIT after up-dosing phase**
Only one recent study has looked at how rapidly protection occurs. In honeybee VIT, 89% tolerated the sting challenge one week after reaching the maintenance dose in a 3-5 day rush protocol or a 3-4 month conventional protocol. Those patients who were not protected with 100µg venom, tolerated the sting challenge immediately after reaching the dose of 200µg89.

**Effectiveness during/after maintenance VIT**Most effectiveness data are obtained during VIT. Re-sting reaction rates of 0-10% 1-5 years after discontinuation of vespid VIT have been reported 100, 101, 111. Relapses after honeybee VIT are more frequent as 17% are reported to relapse one year after stopping VIT112. There are only few reports on the outcome following VIT withdrawal for more than five years, and there are no data for more than 10 years after discontinuing VIT. In two studies 7-7.5% of patients treated with vespid venom relapsed after 7 to 10 years98, 99, while 15.8% after stopping honeybee VIT had re-sting reactions99. Another study compared relapse rates after four and approximately 10 years and reported relapse rates of 10.2% and 16.2%, respectively113. In children, the long term outcome is superior compared to adults as only 5% with moderate-to-severe reactions relapsed after up to 20 years after stopping VIT15.

**Carriage of adrenaline auto-injectors during and after VIT**It is still a debated issue whether AAI should be carried during and after VIT, and it has also been difficult to reach a consensus on this topic. Most patients are protected after reaching the maintenance dose89. Therefore, patients usually do not need to carry AAIs at this point, particularly if their sting reaction had been mild or they had tolerated a sting challenge or field sting during VIT. It should also be considered that carrying an AAI can negatively impact on health-related QoL50, 52 (Table 3). According to the EAACI position paper “Self-medication of anaphylactic reactions due toHymenoptera stings”, 13% of experts/authors would still prescribe an AAI to patients who initially only had generalized skin symptoms after discontinuation of VIT; and 100% considered recommending carrying an AAI in patients who initially suffered from moderate-to-severe reactions after terminating VIT if risk factors for treatment failure were present114.

**Risk factors for systemic adverse events with VIT and relapse of SSR**

**Risk factors for systemic adverse events with VIT**
The frequency of systemic adverse events with VIT in large multi-center studies ranges from 8-20%24, 43, 84. Several risk factors for the occurrence of systemic adverse events have been described. Most of the studies include only small numbers of patients and provide conflicting data. The most important risk factor is treatment with honeybee venom. It has been consistently reported that there is a 3.1 to 6.0-fold higher risk for systemic adverse events due to treatment with honeybee venom24, 77, 86. Rapid dose increase during the build-up phase is a weaker, but nonetheless established risk factor24, 43. Mastocytosis and/or elevated serum tryptase was initially considered as risk factor for adverse events. An EAACI multicenter study found a slightly elevated risk when tryptase was elevated in vespid venom allergic patients (OR 1.56; CI 1.15-2.10)24, whereas another study performed in honeybee venom allergic patients did not85. A study performed in patients with mastocytosis concluded that VIT is safe and efficacious47, confirming previous data45. Although still a debated issue, ACE inhibitors and beta-blockers are not considered to be independent risk factors for adverse events23-25. Importantly, severe initial sting reactions24, 25, 84, positive skin tests at low test concentrations and high specific-IgE levels25, 84, 85 are not regarded as risk factors for adverse events (Table 4).

**Management of adverse events during build-up phase of VIT**Adverse events are generally mild and adequately respond to standard anti-allergic treatment20, 36. In the case of systemic adverse events, a common procedure during build-up phase is reducing the allergen dose (going one to two steps back in the protocol) and then continuing with the second last well tolerated dose of VIT. If not yet considered, premedication with H1 antihistamines should be established. When systemic adverse events prevent reaching the maintenance dose, premedication with Omalizumab may be an option. Currently, case reports and a case series have documented the usefulness of Omalizumab70-72, 115 but there is also one negative report116 (Table 4).

 **Risk factors for relapse of SSR (Table 4)**

Age and type of venom
As already mentioned above, children generally have a more favorable prognosis than adults15, and patients who were treated with honeybee venom had a higher risk for relapse compared to those who were treated with vespid venom98, 99, 113.

Severity of reaction prior to VIT
Two studies reported a higher relapse rate in patients who have had a severe SSR before VIT98, 100. In the larger study, relapses were observed in 4% with mild but 14% with severe pretreatment reactions98. Other studies concluded that the grade of the SSR prior to VIT was not relevant to the probability of a relapse112, 117. Although it is still controversial whether severe initial SSR are a risk factor for relapse, it has been agreed that those patients are at greater risk for severe SSR when they relapse118.
Systemic adverse events during VIT

Patients who developed systemic allergic adverse events during VIT showed a relapse risk of 38%, while those who did not, only had a 7% risk112. Two more studies reported similar results (46% vs. 8% and 16.4 vs. 5.4%, respectively)32, 102.

Mastocytosis/elevated serum tryptase levels
A large multicenter study could not detect an association between higher baseline tryptase and therapy failure31, and 86% of 50 mastocytosis patients were protected after initiation of VIT47. However, one study indicated that patients with tryptase >20 µg/L and/or mastocytosis in the skin had a 2.7-fold higher risk for therapy failure32. Available data are scarce and heterogeneous but it appears that mastocytosis is not a strong general risk factor for relapse but should be considered as risk factor in individuals with severe initial SSR.

ACEI
While in one multi-center study all patients on ACEI tolerated a sting challenge or field sting during VIT31, another study reported a higher risk for relapse in patients taking ACEI 32. However, the risk of ACEI might have been overestimated due to the very small patients’ group and highly selected patients with suggested cardiovascular comorbidity33.

**Procedures to monitor VIT**

Many attempts have been made to identify biomarkers to monitor AIT. In peripheral venous blood samples of treated patients, there are significant changes of venom-specific T cell populations, secreted cytokine patterns and immunoglobulin levels but these are not appropriate to estimate the individual risk for relapse of SSR. The sting challenge remains the gold standard in identifying unprotected patients (Table 5).

**Sting challenges / field stings**

Performing sting challenges is still the most reliable method and gold standard to monitor the effectiveness of VIT. VIT is effective immediately after reaching the first maintenance dose89. Therefore, if feasible, sting challenges should be performed as early as possible to identify those who are not protected with the maintenance dose of 100µg. If sting challenges cannot be performed, information about field stings may be helpful. However, the risk of misidentification of the stinging insect and the non-standardized sting procedure reduce reliability112.

The reproducibility of sting challenges, at least for diagnostic purposes, is a debated issue. A study on 129 patients revealed that in 95% of patients a diagnostic sting challenge provided a good prediction of tolerance for subsequent field stings119. On the other hand, it has been shown that 21% of patients not treated with VIT, who initially tolerated a sting challenge, had systemic symptoms after a second challenge120. The reliability of early sting challenges to monitor effectiveness of VIT appears to be high121, although repeated sting challenges during three to five years after treatment identified 8-10% of patients who relapsed101, 117. Importantly, tolerated sting challenges can improve health related QoL, especially in patients reporting high impairment of health related QoL before the sting challenge51. Thus, sting challenges should not only be seen in the context of evaluating effectiveness but also in terms of fostering individual belief in disease-specific safety.

**Specific-IgE and IgG4 levels**It has been repeatedly shown that specific-IgE levels to the respective venom decrease during VIT after an initial rise during the first months of treatment60, 121; they usually remain low even after stopping VIT117. VIT is associated with a significant increase in specific IgG antibodies that has initially been suggested as a marker of effectiveness122; these immunological changes induced by VIT were also reported in honeybee venom allergic children123. The sub-class of IgG antibodies is usually restricted to IgG1 and IgG4121. However, after stopping VIT, specific IgG starts to decrease99, 124, 125 and patients appear to be protected by a mechanism independent from venom-specific IgG122. Taken together, available data do not support the use of specific IgE, specific IgG or specific IgG subclasses or even ratios can be used as predictors for protection during and after VIT in the individual patient.

**Intradermal testing**Similar to the decline of specific IgE levels during VIT,intradermal testendpoint concentrations usually decrease from before to after VIT99, 101. No study has been able to identify a relevant difference in skin test reactivity between tolerant subjects and patients with relapses99, 100, 112. Moreover, patients with negative intradermal tests have been reported to have significant relapse, a few with near fatal reactions102, 113.

**Basophil activation test (BAT)**
Allergen-specific basophil response remains positive126 or even unchanged125 during VIT. However, basophil responses at submaximal allergen concentrations are markedly decreased after VIT in tolerant subjects and this decline seemed to be associated with the induction of tolerance125, 127. Also the measurement of basophil threshold sensitivity to anti-FcεRI stimulation has been proposed to monitor an early protective effect of VIT128. BAT inhibition with sera of treated subjects correlated well with effectiveness of AIT in grass pollen allergic patients129 but this has not yet been shown in patients with HVA.

**Enzyme-linked immunosorbent facilitated antigen binding (ELIFAB)**
The ELIFAB is a cell-free assay which is used to demonstrate inhibition of allergen-specific IgE binding by blocking antibodies130. One study measured the serum inhibitory activity of VIT-treated vespid-venom patients124. During VIT, patients displayed an increased ability to inhibit Ves v 5 binding by IgE antibodies. This allergen-blocking capacity correlated with serum concentrations of Ves v 5-specific IgG4. However, both the inhibitory activity and specific IgG4 levels were again reduced in patients who stopped VIT several years ago124.

Despite of the availability of new methods such as the BAT and the ELIFAB, most of the parameters cannot precisely distinguish between patients who are protected from future SSR and those who are at risk. Currently, it is not possible to estimate the individual risk for relapse of SSR with any of the currently available parameters (Table 6).

**Summary, gaps in the evidence and future perspectives**The EAACI Taskforce on VIT has developed this guideline as part of the EAACI AIT Guidelines initiative. The guideline have been informed by a formal systematic review and meta-analysis of VIT1. The guideline provides evidence-based recommendations for the use of VIT for patients with LLR and SSR. A summary of the guideline is provided in Box 3 and key messages for primary care practitioners are given in Box 4. The recommendations should be of value to all healthcare professionals involved in the management of patients with HVA.

There are a number of areas in this guideline where high-quality evidence is not available. The primary gaps are highlighted here and in Table 6. There is a major gap in the evidence for the clinical effectiveness of VIT in children and adolescents with recommendations at least one grade lower than for adults in most areas. Contrary to anecdotal findings, an important number of children do not outgrow allergic reactions to insect stings15. Additionally, the effect of VIT in children and their parents on health-related QoL should be investigated further. In adults, there is need for studies with sufficient power to evaluate risk factors for adverse effects during VIT or for treatment failure. There is also minimal data in the elderly population particularly for patients with cardiovascular disease. Additionally, we need cost-effectiveness and cost utility studies to use in discussions with healthcare funders. Biomarkers to predict effectiveness of VIT and to identify treatment failure are also urgently needed.

Despite all these gaps, we have clear evidence for the clinical effectiveness of VIT for patients with SSR. Potential barriers and facilitators for the implementation of these recommendations are described in Table 7. There is now a need to ensure that primary care healthcare professionals know which patients might benefit from VIT, that national healthcare providers understand that VIT is highly effective and is likely to be cost-effective, and that patients and patient support groups are aware of this approach.

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GJ Sturm and EM Varga jointly chaired the EAACI Guideline on VIT and initially drafted the manuscript**.**  H Mosbech,MB Bilò, CA Akdis, D Antolín-Amérigo,E Cichocka-Jarosz, R Gawlik, T Jakob, M Kosnik, J Lange, E Mingomataj, DI Mitsias, M Ollert, JNG Oude Elberink, O Pfaar, C Pitsios, V Pravettoni, , F Ruëff, BA Sin, I Agache,E Angier, S Arasi,MA Calderón, M Fernandez-Rivas, S Halken, M Jutel, S Lau, A Muraro, GB Pajno, R van Ree, G Roberts , D Ryan, R Gerth van Wijk were members of the taskforce who were involved in conceptualizing the guidelines and critically reviewed guideline drafts. S Dhami, H Zaman and A Sheikh provided methodological support to the taskforce. O Spranger was the patient group representative. All the authors satisfied the international authorship criteria with further details in table 1 of the online repository. This Guideline is part of the EAACI Guidelines on Allergen Immunotherapy, chaired by Antonella Muraro and coordinated by Graham Roberts.

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|  |
| --- |
| **Box 1. Key terms** |
| **Allergen immunotherapy (AIT)** | Repeated allergen administration at regular intervals to modulate immune response in order to reduce symptoms and the need of medication for clinical allergies. This is also sometimes known as allergen specific immunotherapy, desensitization, hyposensitization, or allergy vaccination |
| **Aqueous venom preparations** | Lyophilized venom, which is reconstituted in (albumin-containing) saline diluent. |
| **Depot venom preparations** | Venom preparation adsorbed onto aluminium hydroxide or L-tyrosine. |
| **Purified venom preparations** | Venom preparations where irritant low-molecular components <1000 Dalton are removed. |
| **Venom immunotherapy (VIT)** | AIT where insect venom preparations are administered as a series of subcutaneous injections to eliminate systemic allergic reactions after insect stings.  |

**Box 2: Assigning levels of evidence and recommendations [Oxford Centre for Evidence-based Medicine]**

**Level of evidence**

Level I Systematic reviews, meta-analysis, randomized controlled trials

Level II Two groups, nonrandomized studies (e.g., cohort, case–control)

Level III One group nonrandomized (e.g., before and after, pretest, and post-test)

Level IV Descriptive studies that include analysis of outcomes (single-subject design, case series)

Level V Case reports and expert opinion that include narrative literature, reviews, and consensus statements

**Grades of recommendation**

Grade A Consistent level I studies

Grade B Consistent level II or III studies or extrapolations from level I studies

Grade C Level IV studies or extrapolations from level II or III studies

Grade D Level V evidence or troublingly inconsistent or inconclusive studies at any level

**Strength of recommendations**

Strong Evidence from studies at low risk of bias /high quality studies

Moderate Evidence from studies at moderate risk of bias /moderate quality studies

Weak Evidence from studies at high risk of bias /low quality studies

Recommendations are phrased according to the strength of recommendation: strong: “is recommended”; moderate: “can be recommended”; weak: “may be recommended in specific circumstances”; negative: “can not be recommended”.

**Box 3 Summary**

* VIT is recommended in children and adults with detectable sensitization and systemic sting reactions exceeding generalized skin symptoms.
* VIT is recommended in adult patients with systemic sting reactions confined to generalized skin symptoms if quality of life is impaired
* VIT is not recommended in individuals with incidentally detected sensitization and no systemic symptoms
* Patients with severe initial sting reactions, high skin test reactivity, and high venom specific IgE levels are not associated with a higher risk of adverse events
* Pre-treatment with H1 antihistamines is recommended as it reduces large local reactions and to some extent also systemic adverse events
* VIT should be performed for at least three years. In patients with severe initial sting reactions, at least a five year treatment is recommended
* Life-long VIT may be recommended in highly exposed patients with honeybee venom allergy, patients with very severe initial sting reactions (Muller grade IV or grade III-IV according to Ring & Messmer), and patients with systemic side-effects during VIT as they are major risk factors for relapse
* All available diagnostic tests, including determination of venom specific IgE, IgG, BAT response and allergen-blocking capacity, are not able to estimate the individual risk for relapse
* Sting challenges are the most reliable method to evaluate effectiveness of VIT

**Box 4 Key messages for primary care practioners about referral to allergy services for venom immunotherapy**

- Venom immunotherapy is very effective in preventing future systemic reactions to honeybee, wasp, and ant stings

- Refer patients to an allergist with experience in venom immunotherapy for assessment

as below. If unsure on review seek advice from your local allergy centre

- Venom immunotherapy is recommended in individuals with

* systemic sting reactions exceeding generalized skin symptoms
* generalized skin symptoms only (including urticaria/angioedema) if quality of life is impaired

- Venom immunotherapy is not recommended in individuals with

* only local reactions, including large ones (defined as a swelling exceeding a diameter of 10 cm lasting longer than 24 hours)
* incidentally detected sensitization and without any systemic allergic symptoms

- A careful personal history should be taken (culprit insect, characterization of sting reactions, emergency and concomitant medication) and, if possible, venom specific-IgE should be determined before patients are referred to an allergist

- Negative test results are possible in patients with insect venom allergy. If there were clear symptoms of anaphylaxis after a sting, patients should be referred to an allergist

- Large local reaction typically develop within 24 hours and should be treated with oral antihistamines and corticosteroids but not oral antibiotics. No further follow-up is needed.

- Quality of life is impaired in many patients who only carry an adrenaline autoinjector and do not receive venom immunotherapy

Table1. Recommendations: indications for VIT

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Recommendations for individuals with venom allergy** | **Evidence level** | **Grade of recommendation** | **Strength of recommendation**  | **Other considerations** | **Key references** |
| VIT is recommended in adults and children with detectable sensitization and systemic sting reactions exceeding generalized skin symptoms | I(III for children) | A (B for children) | Strong-to-moderate for adults based on two high quality SR.1 131 Weak for children based on one low quality CBA15 and one low quality RCT study that included children87 | Carrying an AAI without VIT negatively impacts on health-related QoL  | Dhami 20171Boyle 2012131Golden 200415Hunt 197887 |
| VIT is recommended in adult patients with systemic sting reactions confined to generalized skin symptoms if quality of life is impaired | I | A | Strong-to-moderate based on one high quality SR1 and two adult RCTs of moderate quality50, 52 | Carrying an AAI without VIT negatively impacts on health-related QoL | Dhami 20171Oude Elberink 2002 and 200950, 52 |
| VIT can be recommended in adults with recurrent, troublesome LLR to reduce the duration and size of future LLR | II | B | Moderate/low based on one open, controlled trial of venom allergic adults with LLR19 | Cost/benefit profile should be considered for this indication. No pediatric data | Golden 200919 |
| VIT is not recommended in individuals with incidentally detected sensitization to insect venom and no clinical symptoms | IV | C | Weak based on one case series and expert consensus18 | Asymptomatic sensitization is very common | Sturm 201418 |
| VIT is not recommended in patients with unusual reactions that do not represent immediate type systemic reactions | V | D | Weak, as no studies have focused on this. Expert consensus | Reactions of non-allergic nature following Hymenoptera stings require neither diagnostic testing nor administration of VIT | Expert consensus |

Table 2. Recommendations: VIT in patients with special conditions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Recommendations for individuals with venom allergy** | **Evidence level** | **Grade of recommendation** | **Strength of recommendation**  | **Other considerations** | **Key references** |
| VIT can be recommended in patients with cardiovascular disease but the underlying disease should be stabilized before initiation | V | D | Weak based on reviews of expert opinions and one case series study20 |  | Pitsios 201520 |
| Beta-blocker therapy may be continued during VIT but the patient should be informed about possible risks | IV | C | Weak based on two case series studies26 24 and expert consensus  | Stopping beta-blocker may even harmful for some patients | Ruëff 200926Ruëff 201024 |
| ACE inhibitor therapy may be continued during VIT but the patient should be informed about possible risks  | IV | C | Weak based on two case series studies25 24 and expert consensus |  | Stoevesandt 201425Ruëff 201024 |
| VIT can be recommended in high risk venom allergic patients when malignant disease is stable or in remission | IV | C | Weak based on one case series study34 and expert consensus |  | Wöhrl 201134 |
| VIT can be recommended in patients with organ-specific autoimmune disorders when the underlying disease is stabilized | V | D | Weak based on expert consensus | Immune-suppressive medication may negatively influence effectiveness of VIT | Expert consensus |
| VIT cannot be recommended in patients with active, multi-system autoimmune disorders | V | D | Weak based on expert consensus |  | Expert consensus |
| Treatment with MAOIs is not a contraindication for VIT but caution is recommended with the use of adrenaline | V | D | Weak based on case reports and expert consensus | MAOIs are nowadays rarely prescribed | Expert consensus |
| VIT in children below 5 years of age should only be considered in the event of severe sting reactions and when the child is likely to be co-operative  | IV | C | Weak based on one case series38 and expert consensus |  | Stritzke 201338 |
| VIT should not be initiated during pregnancy, but well-tolerated ongoing VIT can be continued during pregnancy | IV | C | Weak based on case series studies39 40 |  | Metzger 197839Schwartz 199040 |
| VIT may be recommended in patients with underlying systemic mastocytosis as it is safe and effective | IV | C | Weak based on two case series45 47 | In few patients, side effects can be more frequent and severe | Bonadonna 200845, 201347 |

Table 3. Recommendations: preparation and venom dose, pre-treatment with antihistamines, duration of treatment, carriage of adrenaline autoinjectors during/after VIT

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Recommendations for individuals with venom allergy** | **Evidence level** | **Grade of recommendation** | **Strength of recommendation**  | **Other considerations** | **Key reference** |
| Purified venom preparations can be recommended as they have a lower frequency of local and systemic adverse events than non-purified aqueous preparations | I  | B | Weak to moderate based on one RCT of moderate/low quality63 |  | Bilo 201263 |
| For the majority of patients, VIT with one venom may be recommended as sufficient for protection. In patients with a history of systemic sting reactions to different insects or with severe initial reactions and clearly double positive tests, VIT with two venoms (i.e *Apis mellifera* and Vespula or Vespula and Polistes) is recommended. | IV | C | Weak based on one case series study64 and expert consensus |  | Stoevesandt 201364 |
| Two venoms can be administered simultaneously in the left and right arm, respectively. However, in the case of systemic adverse events, VIT should be continued with 30 minute intervals between injections | V | D | Weak based on expert consensus |  | Expert consensus |
| Pre-treatment with H1 antihistamines is recommended as it reduces large local reactions and to some extent also systemic adverse events | I | A | Strong to moderate based on four RCTs, two of them were of high quality68 67, two of moderate quality 66 65 |  | Müller 200868Reimers 200067Brockow 199766Berchtold 199265 |
| It is recommended to administer a standard maintenance dose of 100µg venom | II | B | Weak to moderate based on one CCT of moderate/low quality88 |  | Golden 198188 |
| If patients still react to field stings or sting challenges, a dose increase to 200µg of venom can be recommended | IV | C | Weak based on one case series study91 |  | Ruëff 200191 |
| It may be recommended to give injections every 4 weeks in the first year of treatment, every 6 weeks in the second year, and in case of a 5 year treatment every 8 weeks from year 3-5 | V | D | Weak based on expert consensus93 |  | Bonifazi 200593 |
| In the case of life-long therapy, 12 week intervals may be still safe and effective  | II | C | Moderate based one CCT94 and one CBA95 study |  | Simioni 201394Goldberg 200195 |
| It can be recommended to perform VIT for at least 3 years. In patients with severe initial sting reactions, at least a 5-year treatment is recommended | IV | C | Weak based on case series studies98 99 101 |  | Reisman 199398Lerch 199899Golden 1996101 |
| Life-long VIT may be recommended in highly exposed patients with bee venom allergy, patients with very severe initial sting reactions (Muller grade IV or grade III-IV according to Ring & Messmer), and patients with systemic side-effects during VIT as they are major risk factors for relapse. | IV | C | Weak based on case series studies31 8 98 |  | Ruëff 201331; 20148Reismann 199398 |
| During and after VIT, AAI cannot be recommended in patients with mild to moderate initial sting reactions without risk factors for relapse | V | D | Weak based on expert consensus  |  | Expert consensus |
| During and after VIT, AAI may be recommended in patients at risk of multiple stings or with risk factors for relapse  | V | D | Weak based on expert consensus  |  | Expert consensus |

Table 4. Recommendations: risk factors and management of side effects, risk factors for relapse

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Recommendations for individuals with venom allergy** | **Evidence level** | **Grade of recommendation** | **Strength of recommendation**  | **Other considerations** | **Key references** |
| It may be recommended that patients treated with bee venom and those on rapid up-dosing protocols should be closely observed for side effects as they are at a higher risk of experiencing adverse events | IV | C | Weak based on case series studies24 43 | The intake of beta-blockers or ACE inhibitors are not risk factors for adverse events during VIT. Also most of the mastocytosis patients tolerate VIT well |  Ruëff 201024 Mosbech 200043 |
| It may be recommended that patients with severe initial sting reactions, high skin test reactivity, and high venom specific IgE levels do not require special precautions during VIT, as they are not associated with a higher risk of adverse events | IV | C | Weak based on case series studies2524 84  |  | Stoevesandt 201425Ruëff 201024Lockey 199084   |
| In case of VIT- related systemic adverse events during build-up phase, a temporary reduction of the venom dose (e.g. going one to two steps back in the protocol) may be recommended to avoid further adverse events | V | D | Weak based on expert consensus |  | Expert consensus |
| In case of repeated systemic adverse events during up-dosing, pre-treatment with Omalizumab may be recommended | V | D | Weak based on case reports70 71, 72 |  | Stretz 201772Kontou-Fili 200870Schulze 200771 |
| In case of VIT related LLR, it may be recommended to split dose in 2 injections or change injection site but not necessarily to reduce venom dose | V | D | Weak based on expert consensus |  | Expert consensus |
| Life-long VIT may be recommended in patients who relapsed after stopping VIT | V | D | Weak based on expert consensus |  | Expert consensus |
| It may be recommended to avoid insect stings during build-up phase by abiding by preventive measures (eg stop beekeeping) until maintenance dose is reached  | V | D | Weak based on expert consensus |  | Expert consensus |

Table 5. Recommendations: monitoring of VIT

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Recommendations for individuals with venom allergy** | **Evidence level** | **Grade of recommendation** | **Strength of recommendation**  | **Other considerations** | **Key references** |
| In adults, a sting challenge can be recommended as the most reliable method to evaluate effectiveness of VIT  | IV | C | Weak based on case series studies117 101 |  | Van Halteren 1997117Golden 1996101 |
| If no sting challenge can be performed, it may be recommended to record outcomes of field stings to evaluate effectiveness of VIT | V | D | Weak based on expert consensus |  | Expert consensus |
| It may not be recommended to determine venom specific IgE, IgG levels, BAT response and allergen-blocking capacity to estimate the individual risk for relapse | IV | C | Weak based on case series studies99 112 100 |  | Lerch 199899Müller 1991112Keating 1991100 |

Table 6. Gaps in evidence

|  |  |  |
| --- | --- | --- |
| **Gaps** | **Plan to address** | **Priority** |
| Optimal duration of VIT in children and adults (for example, 3 versus 5 years or longer) | RCTs | High |
| Evaluation of biomarkers such as sting challenges, component-resolved diagnosis, and BAT (inhibition) in assessing the clinical efficacy of VIT | Prospective studies | High  |
| Identification of biomarkers for the risk assessment for side effects and relapse | Prospective studies | High |
| Comparison of different VIT up-dosing schedules, maintenance doses, and maintenance intervals in adults/children in terms of efficacy both short and long-term | RCTs | High |
| Safety and efficacy of VIT in patients taking antihypertensive drugs (beta-blockers, ACEI)  | Observational studies | High |
| Safety and efficacy of VIT in patients with elevated serum tryptase/mastocytosis verified by sting challenges | RCTs | High |
| Comparison of purified and non-purified bee venom preparations in respect of safety and efficacy verified by sting challenges  | RCTs | High |
| Safety of the simultaneous application of two or more venoms during up-dosing and maintenance phase | RCTs | High |
| Value of VIT on health-related quality of life compared to AAI in children and their parents | RCTs | Medium |
| Assessing the cost-effectiveness of VIT | Cost-effectiveness analysis of RCT | Medium |
| Safety of VIT in adults and children with concomitant disease such as cardiovascular disease | Observational trials | Medium |

Table 7. Barriers and facilitators to implementation, audit criteria and resource implications of recommendations

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **First-line intervention:** **VIT for venom allergic individuals**  |  |  |  | **Barriers to implementation** | **Facilitators to implementation** | **Audit criteria** | **Resource implications** |
| Venom immunotherapy is highly clinically effective in adults and children with moderate to severe allergic reactions to hymenoptera stings |  |  |  | Failure to recognize severe allergic reactions (anaphylaxis) following hymenoptera stingsLack of knowledge amongst patients, caregivers and professionals about the availability of venom immunotherapy Concerns about side-effects The hope that allergic reactions will subside with time or symptomatic treatments only (e.g. AAI, antihistamines/ glucocorticosteroids) | Education and training of emergency care doctors, general practitioners and other physicians on venom allergy and its grades of severity Information about need of follow-up visits with clinical allergists for diagnosis and management of venom allergyInformation sheets for patients and caregivers | Proportion of adults and children with moderate to severe SSR who are treated with VITProportion of adults and children experience relapses and/or side effects while on VIT | Venom allergen immunotherapy (VIT) needs to be prescribed by clinical allergists and made available to patients.Patient education about self-treatment with adrenaline (AAI) before starting VIT is important and requires availability of trainer devices |
| VIT is recommended in adult patients with systemic sting reactions confined to generalized skin symptoms if quality of life is impaired |  |  |  | Lack of knowledge amongst physicians, including clinical allergists about the indication of venom immunotherapy in these circumstances  | Education and training of physicians, and allergy specialistsInformation sheets for patients  | Proportion of patients experiencing impairment of QoL when venom allergy is confined to skin only who are treated with VIT | Education and training of both physicians and patientsCost /Benefit profile needs to be established |
| Life-long VIT can be recommended in highly exposed patients with bee venom allergy, patients with very severe initial sting reactions (Muller grade IV or grade III-IV according to Ring & Messmer), and patients with systemic side-effects during VIT as they are major risk factors for relapse. |  |  |  | Lack of resources (professional and financial)Adherence to life-long VIT unrealistic  | Provision of insurance cover for life-long VIT within EuropeEducation and training of clinical allergistsEducation of patients in terms of sting exposure risk behavior;patient leaflets, smartphone “shot” reminder apps etc. | Proportion of patients who adhere to life-long (or prolonged, i.e. > 5 years ) VIT and proportion of patients consecutively tolerate hymenoptera stings | Equipment of specialized allergy centers with skilled staff for successful administration of VIT Safety measures in place to minimize side effects in high risk patients |
| Pre-treatment with H1 antihistamines is recommended as it reduces large local reactions and to some extent also systemic adverse events |  |  |  | Lack of knowledge amongst health care professionals regarding pre-treatment Reluctance of patientsAdditional costs for health care system | Education of healthcare professionals, and patients | Proportion of patients with VIT who have antihistamine pre-treatment  | Prescription of antihistamines to be taken by patients prior to VIT  |
| AAI during and after VIT is recommended only in patients at risk of multiple stings or with risk factors for relapse |  |  |  | Lack of knowledge amongst health care professionals in terms of (non) prescribing AAIRisk behavior and misconception of patients | Education of healthcare professionals, and patients | Proportion of high risk patients carrying and administering intramuscular (AAI) during or after VIT | Time to educate and train physicians and patients |