



Handling of allergen immunotherapy in the COVID-19 pandemic: An ARIA-EAACI statement

Ludger Klimek¹ | Marek Jutel² | Cezmi Akdis³ | Jean Bousquet^{4,5,6,7} | Mübeccel Akdis³ | Claus Bachert⁸ | Ioana Agache⁹ | Ignacio Ansotegui¹⁰ | Anna Bedbrook⁷ | Sinthia Bosnic-Anticevich¹¹ | G. Walter Canonica^{12,13} | Tomas Chivato¹⁴ | Alvaro A. Cruz^{15,16} | Wiencyslawa Czarlewski¹⁷ | Stefano Del Giacco¹⁸ | Hui Du¹⁹ | Joao A. Fonseca^{20,21,22,23} | Yadong Gao²⁴ | Tari Haahtela²⁵ | Karin Hoffmann-Sommergruber²⁶ | Juan-Carlos Ivancevich²⁷ | Nikolai Khaltayev²⁸ | Edward F. Knol²⁹ | Piotr Kuna³⁰ | Desiree Larenas-Linnemann³¹ | Erik Melén³² | Joaquim Mullo^{33,34} | Robert Naclerio³⁵ | Ken Ohta³⁶ | Yoshitaka Okamoto³⁷ | Liam O'Mahony³⁸ | Gabrielle L. Onorato⁷ | Nikos G. Papadopoulos³⁹ | Ruby Pawankar⁴⁰ | Oliver Pfaar⁴¹ | Boleslaw Samolinski⁴² | Jurgen Schwarze⁴³ | Sanna Toppila-Salmi²⁵ | Mohamed H. Shamji⁴⁴ | Maria Teresa Ventura⁴⁵ | Arunas Valiulis^{46,47} | Arzu Yorgancioglu⁴⁸ | Paolo Matricardi⁴⁹ | Torsten Zuberbier^{50,51} | the ARIA-MASK study group

¹Center for Rhinology and Allergology, Wiesbaden, Germany²Department of Clinical Immunology, ALL-MED Medical Research Institute, Wrocław Medical University, Wrocław, Poland³Swiss Institute of Allergy and Asthma Research (SIAF), University of Zurich, Davos, Switzerland⁴Charité, Universitätsmedizin Berlin, Humboldt-Universität zu Berlin, Berlin, Germany⁵Department of Dermatology and Allergy, Berlin Institute of Health, Comprehensive Allergy Center, Berlin, Germany⁶University Hospital, Montpellier, France⁷MACVIA-France, Montpellier, France⁸ENT Department, Upper Airways Research Laboratory, Ghent University Hospital, Ghent, Belgium⁹Transylvania University Brasov, Brasov, Romania¹⁰Department of Allergy and Immunology, Hospital Quirónsalud Bizkaia, Erandio, Spain¹¹Woolcock Institute of Medical Research, Woolcock Emphysema Centre and Sydney Local Health District, University of Sydney, Glebe, NSW, Australia¹²Personalized Medicine, Asthma and Allergy - Humanitas Clinical and Research Center - IRCCS, Rozzano (MI), Italy¹³Department of Biomedical Sciences - Humanitas University - Pieve Emanuele (MI), Italy¹⁴School of Medicine, University CEU San Pablo, Madrid, Spain¹⁵ProAR - Nucleo de Excelencia em Asma, Federal University of Bahia, Salvador, Brasil¹⁶WHO GARD Planning Group, Salvador, Brazil

Ludger Klimek, Marek Jutel, Cezmi Akdis, Jean Bousquet, Mübeccel Akdis are participated equally to the paper.

[†]Member of ARIA and MASK boards

[‡]Member of EAACI board of officers

ARIA-MASK study group details are given in Appendix 1

- ¹⁷Medical Consulting Czarlewski, Levallois, and MASK-air, Montpellier, France
- ¹⁸Department of Medical Sciences and Public Health, Unit of Allergy and Clinical Immunology, University Hospital "Duilio Casula", University of Cagliari, Cagliari, Italy
- ¹⁹Department of Respiratory Medicine, Tongji Medical University, Wuhan, Hubei, China
- ²⁰Center for Research in Health Technologies and Information Systems- CINTESIS, Universidade do Porto, Porto, Portugal
- ²¹Allergy Unit, Instituto CUF Porto e Hospital CUF Porto, Porto, Portugal
- ²²Health Information and Decision Sciences Department - CIDES, Faculdade de Medicina, Universidade do Porto, Porto, Portugal
- ²³Faculdade de Medicina da Universidade do Porto, Porto, Portugal
- ²⁴Department of Allergology, Zhongnan Hospital of Wuhan University, Wuhan, China
- ²⁵Skin and Allergy Hospital, Helsinki University Hospital, Helsinki, Finland
- ²⁶Department of Pathophysiology and Allergy Research, Medical University of Vienna, Vienna, Austria
- ²⁷Servicio de Alergia e Inmunología, Clínica Santa Isabel, Buenos Aires, Argentina
- ²⁸GARD Chairman, Geneva, Switzerland
- ²⁹Departments of Immunology and Dermatology/Allergology, University Medical Center Utrecht, The Netherlands
- ³⁰Division of Internal Medicine, Asthma and Allergy, Barlicki University Hospital, Medical University of Lodz, Lodz, Poland
- ³¹Center of Excellence in Asthma and Allergy, Médica Sur Clinical Foundation and Hospital, México City, Mexico
- ³²Institute of Environmental Medicine, Karolinska Institutet and Sachs' Children's Hospital, Stockholm, Sweden
- ³³ENT Department, Rhinology Unit & Smell Clinic, Hospital Clínic, Barcelona, Spain
- ³⁴Clinical & Experimental Respiratory Immunoallergy, IDIBAPS, CIBERES, University of Barcelona, Barcelona, Spain
- ³⁵Johns Hopkins School of Medicine, Baltimore, MD, USA
- ³⁶National Hospital Organization, Tokyo National Hospital, Tokyo, Japan
- ³⁷Department of Otorhinolaryngology, Chiba University Hospital, Chiba, Japan
- ³⁸Departments of Medicine and Microbiology, APC Microbiome Ireland, University College Cork, Cork, Ireland
- ³⁹Division of Infection, Immunity & Respiratory Medicine, Royal Manchester Children's Hospital, University of Manchester, Manchester, UK
- ⁴⁰Department of Pediatrics, Nippon Medical School, Tokyo, Japan
- ⁴¹Department of Otorhinolaryngology, Head and Neck Surgery, Section of Rhinology and Allergy, University Hospital Marburg, Philipps-Universität Marburg, Marburg, Germany
- ⁴²Department of Prevention of Environmental Hazards and Allergology, Medical University of Warsaw, Warsaw, Poland
- ⁴³Centre for Inflammation Research, Child Life and Health, The University of Edinburgh, Edinburgh, UK
- ⁴⁴Immunomodulation and Tolerance Group, Allergy and Clinical Immunology, Inflammation, Repair and Development, National Heart and Lung Institute, Imperial College London, Asthma UK Centre in Allergic Mechanisms of Asthma, London, UK
- ⁴⁵Unit of Geriatric Immunoallergy, University of Bari Medical School, Bari, Italy
- ⁴⁶Faculty of Medicine, Institute of Clinical Medicine & Institute of Health Sciences, Vilnius University, Vilnius, Lithuania
- ⁴⁷European Academy of Paediatrics (EAP/UEMS-SP), Brussels, Belgium
- ⁴⁸Department of Pulmonology, Celal Bayar University, Manisa, Turkey
- ⁴⁹Charité – Universitätsmedizin, Berlin, Germany
- ⁵⁰Corporate Member of Freie Universität Berlin, Charité - Universitätsmedizin Berlin, Humboldt-Universität zu Berlin, Berlin, Germany
- ⁵¹Department of Dermatology and Allergy, Member of GA2LEN, Berlin Institute of Health, Comprehensive Allergy-Centre, Berlin, Germany

Correspondence

Ludger Klimek, Center for Rhinology and Allergology, Wiesbaden, Germany.
 Email: ludger.klimek@allergiezentrum.org

Abstract

The current COVID-19 pandemic influences many aspects of personal and social interaction, including patient contacts with health care providers and the manner in which allergy care is provided and maintained. Allergen-specific immunotherapy (AIT) is one of the most important treatment options for IgE-mediated allergies and is based on inducing an appropriate immune response in the allergic patient. This manuscript outlines the EAACI recommendations regarding AIT during the COVID-19 pandemic and aims at supporting allergists and all physicians performing AIT in their current daily practice with clear recommendations on how to perform treatment during the pandemic and in SARS-CoV-2 infected patients.

KEYWORDS

allergy treatment, clinical immunotherapy, immunotherapy vaccines and mechanisms

1 | INTRODUCTION

The current COVID-19 pandemic influences many areas of social life, medical treatments and the way allergy diagnosis and treatment is performed. Allergen-specific immunotherapy (AIT) is one of the most important treatment options for IgE-mediated allergies and is based on immunological effects on the diseased patient. This manuscript outlines the EAACI recommendations regarding AIT during the COVID-19 pandemic and aims at supporting allergists and all physicians performing AIT in their current daily practice with clear recommendations on how to perform treatment during the pandemic and in SARS-CoV-2 infected patients.

1.1 | Coronavirus disease 2019 (COVID-19)

On March 11, 2020, the World Health Organization (WHO) declared a pandemic of an infectious disease recently referred to as "coronavirus disease 2019" (COVID-19). Currently, COVID-19 is spreading rapidly across the globe. COVID-19 is caused by a novel strain of human coronaviruses, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), named by the International Committee on Taxonomy of Viruses (ICTV). SARS-CoV-2 was first detected in a cluster of patients with pneumonia in December 2019 in Wuhan, China.^{1,2} SARS-CoV-2 is a Betacoronavirus of the subgenus Sarbecovirus and the subfamily Orthocoronavirinae. It can be isolated from human samples obtained from respiratory secretions, nasal and pharyngeal smears and isolated on cell cultures.^{1,2} SARS-CoV-2 is the 7th member of the coronavirus family able to infect humans. It differs from the Middle East respiratory syndrome coronavirus (MERS-CoV), the severe acute respiratory syndrome coronavirus (SARS-CoV), and viruses responsible for the common cold (229E, OC43, NL63, and HKU1).³ Coronaviruses are zoonotic: they can be transmitted between animals and humans.

COVID-19 presents with many different clinical manifestations, ranging from asymptomatic cases to mild and severe disease, with or without pneumonia.⁴

Common signs of COVID-19 are respiratory problems, fever, cough, shortness of breath, and difficulties in breathing. Other signs of viral airway infection may include nasal symptoms and sore throat. In more severe cases, infection with COVID-19 can cause pneumonia, severe acute respiratory syndrome, kidney failure, and even death.⁴⁻⁸ In the published scientific literature on COVID-19, higher age, chronic respiratory diseases, diabetes mellitus, coronary artery disease, and immunodeficiency of different origins are listed as risk factors for severe illness, hospitalization, and death.^{4-6,8}

As COVID-19 is caused by a newly identified viral strain, there are no therapeutics proved to be effective in clinical trials or vaccines, so far, and there is presumed to be no pre-existing immunity in the population.⁹ In most instances, coronaviruses are believed to

be transmitted through large respiratory droplets from person to person, through inhalation or deposition on mucosal surfaces. Other routes implicated in the transmission of coronaviruses include contact with contaminated fomites and inhalation of aerosols produced during aerosol-generating procedures, such as sneezing or coughing. The SARS-CoV-2 virus has been detected in respiratory, fecal, and blood specimens.¹⁰ The highest risk of healthcare-associated transmission occurs in the absence of standard precautions, when primary infection prevention and control measures for respiratory infections are not in place, and when handling patients whose COVID-19 diagnosis is yet to be confirmed. Since airborne transmission is possible, we recommend a cautious approach because of possible transmission through aerosols.^{11,12}

More disease background information is available online from the European Centre for Disease Prevention and Control (ECDC),¹³ WHO,¹⁴ and the ECDC's Rapid Risk Assessment.⁹

1.2 | Allergen-specific immunotherapy (AIT)

AIT is the only disease-modifying therapy that confers a long-term clinical benefit for allergic airway diseases such as in allergic bronchial asthma or allergic rhinoconjunctivitis and other allergic conditions.¹⁵ Since its¹⁶ emergence over one hundred years ago (1911), AIT is an established and internationally recognized procedure for the causal treatment of immediate-type allergic reactions (type I allergy) and associated diseases.

AIT induces an immune tolerance responses against the allergen in sensitized patients.¹⁷

Systematic reviews and meta-analyses have confirmed that AIT is effective in reducing symptoms together with rescue medication in patients with allergic asthma¹⁸ and allergic rhinoconjunctivitis.¹⁹

This applies to both subcutaneous immunotherapy (SCIT)^{20,21} and sublingual immunotherapy (SLIT), liquid drops or tablets placed under the tongue.²²

The reduced risk of developing asthma in patients with allergic rhinitis is another advantage of AIT. This is still under debate but was demonstrated to be effective at least in the short term.^{23,24} AIT is also effective in patients with IgE-mediated food allergy²³⁻²⁶ and insect venom allergy.²⁷ Moreover, analyses by the European Academy of Allergy and Clinical Immunology (EAACI) demonstrated the cost-effectiveness of this disease-modifying therapy option.²⁸⁻³⁰

1.3 | AIT and viral infections

Even though it is well established that allergic airway diseases are associated with an increased risk of infection, little is known about the potential influence of viral infections on AIT.³¹

In a prospective and comparative clinical study, Ahmetaji et al. found no significant difference in the efficacy or in the improvement of symptoms of allergic asthma patients under subcutaneous allergen-specific immunotherapy with or without symptomatic influenza, nor in the standard chemical and hematology parameters and different cytokines during a one-year follow-up.³² These preliminary data suggest that SCIT in influenza-infected patients is safe and well-tolerated.

Lemoli et al. evaluated the safety and clinical effectiveness of sublingual grass tablet immunotherapy in a group of HIV-positive patients with allergic rhinitis under antiretroviral HIV therapy. HIV infection has been regarded to be a relative contraindication for AIT. Highly active antiretroviral treatment has improved the immune function and life expectancy in HIV-infected patients whose respiratory allergic incidence is similar to that of the general population.³³ Clinical efficacy data showed a significant improvement in SLIT-treated patients compared to controls but no considerable alteration of peripheral T CD4 lymphocyte cell counts and HIV viral load in either group. These data show that SLIT therapy in viro-immunological controlled HIV-positive patients is efficacious, safe, and well-tolerated.

Cytomegalovirus (CMV) was shown to enhance the allergenic potential of otherwise poorly allergenic environmental protein antigens in a mouse model of airway co-exposure to CMV and ovalbumin (OVA).³⁴ In contrast, immune reactions to virus-like-particles (Vlp) may enforce the immune responses in AIT and may even be used as AIT adjuvants for inhalational and food (peanut) allergen in the near future.^{35,36}

With the limited experimental data available so far, it seems that patients with allergic rhinitis did not develop additional distinct symptoms and more severe courses than other patients.⁴ Allergic children showed a mild course, similar to other children.⁴

2 | IMMUNE MECHANISMS IN AIT AND COVID-19—DIFFERENCES AND SIMILARITIES

AIT aims to induce allergen-specific immune tolerance in allergy patients by using multiple mechanisms including T cells, B cells, innately lymphoid cells (ILC), and effector cells, such as eosinophils, mast cells, and basophils. One of the main changes is the development of a T and B regulatory cell response and their suppressive cytokines such as IL-10 and TGF- β and surface molecules such as CTLA-4 and PD1, all of which form a suppressive milieu.^{29,37} This immune regulatory response is taking place in targeted antigen/allergen-specific T and B cells but does not affect the whole immune system and does not cause any systemic immune deficiency. T-cell responses in severe COVID-19 are represented with lymphopenia that is mainly affecting memory T lymphocytes. Both CD4 and CD8 T cells decrease; however, this change is more pronounced in CD8 + T cells. Cytotoxic T lymphocytes and NK cells in patients infected with SARS-CoV-2 are essential for an appropriate anti-viral response.³⁸ A recent study suggests that patients show functional exhaustion of cytotoxic T lymphocytes associated with SARS-CoV-2 infection. The total number of NK and CD8 + T cells was markedly

decreased in patients with SARS-CoV-2 infection.³⁸ This may cause a disruption of anti-viral immunity and may play a role in the pathogenesis and severity of COVID-19.

AIT significantly decreases allergen-specific Th2 cells in circulation and reduces the general type2 response by decreasing Th2 cells and type 2 ILCs.³⁹⁻⁴¹ COVID-19 does not significantly increase in severity in allergic patients, with conditions such as rhinitis, urticaria, and atopic dermatitis.^{4,42} It has not been demonstrated if there is a switch between TH1 and TH2 cells in COVID-19, but there are developing data that disease severity is linked to a systemic Th1 response and inflammasome activation together with a cytokine storm. Similar to SARS and MERS, a cytokine storm is a common feature of severe COVID-19 cases and a major reason for acute respiratory distress syndrome (ARDS) and multi organ failure. Several levels of evidence suggest that the rapid COVID-19 mortality might be due to a virus-activated "cytokine storm syndrome".⁴³ In a study of 41 hospitalized severe COVID-19 patients, high levels of proinflammatory cytokines were observed including IL-2, IL-7, IL-10, G-CSF, IP-10, MCP-1, MIP-1A, and TNF α .⁴⁴

AIT changes the cellular composition and inflammatory mediators in the affected organs, for example in the nose in allergic rhinitis.¹⁷ Eosinophils and their inflammatory mediators decrease in allergic rhinitis in the nose during AIT. In COVID-19, systemic eosinopenia was observed in 52.9% of the patients. Decreased blood eosinophil counts correlate positively with lymphocyte counts in severe ($r = 0.486, P < .001$) and nonsevere ($r = 0.469, P < .001$) patients after hospital admission.⁴ The reasons and mechanisms of systemic eosinopenia remain to be investigated.

In AIT, reduced eosinophil counts and regulation of specific TH2 response is only seen after several years of continuous therapy. This supports that AIT is not going to interfere with viral infections. AIT has a clear desensitization effect on effector cells. This effect is antigen specific and acts early during the course of AIT. Mast cells are not considered to be relevant in viral infection response.

Allergen-specific antibody levels change in the course of AIT with decreased specific IgE in the long run and a relatively rapid increase in specific IgG1 and IgG4.^{29,45} In COVID-19, like many viral infections, SARS-CoV-2-specific IgM increases in the acute phase followed by specific IgG.⁴⁶⁻⁴⁸

Overall, the COVID-19 immunological mechanisms seem to be similar to SARS and MERS and also to severe influenza infections. An appropriate anti-viral immune response should develop with cytotoxic T cells and IgM and IgG antibodies, whereas a very strong uncontrolled immune response as in a cytokine storm becomes detrimental (Table 1).

3 | PREVENTING ALLERGY FACILITIES AND CONTROL MEASURES IN AIT

We recommend using the infection prevention and control measures in any patient undergoing AIT according to ECDC and WHO. This implies that the recommended infection prevention and control measures of

TABLE 1 Immunological characteristics of AIT and COVID-19

Immunological changes	AIT	COVID-19
T-cell responses	Suppression of TH2 cells, induction of Treg and TH1 cells	Lymphopenia in severe cases
CD8 + T cells	There is no major change	Severe lymphopenia is observed in CD8 + T cells
TH1-TH2 responses	AIT decreases allergen-specific Th2 responses in circulation and in the affected organs such as in the nose	Severe disease shows a systemic severe inflammatory response with a cytokine storm
Eosinophils	Decrease in their numbers and mediators in the nose	Systemic decrease in their numbers in more than half of the patients.
Specific antibody levels	Allergen-specific IgE decreases in the late course, with an early increase in specific IgG4	In the acute phase, virus-specific IgM increases followed by virus-specific IgG during convalescence.

individual regions or countries should be followed, including those this document, as well as the procedures for reporting and for the transfer of persons under investigation and of probable/confirmed COVID-19 cases.

Those feeling ill with typical respiratory symptoms should be encouraged to contact healthcare services by telephone or E-Health/telemedicine/online to seek medical advice^{13,49} (triage). This will reduce the number of people with symptoms of COVID-19 that have contact with the Allergy center healthcare personnel.^{13,49}

Allergy services and primary care staff, including physicians, nursing, and administrative staff with patient contact, should be aware of the following: (a) the current COVID-19 epidemiologic situation in their country and globally; (b) known risk factors for infections; (c) clinical symptoms and signs of COVID-19; (d) recommended infection prevention and control measures in their region or country, including those in this document; and (e) procedures for reporting and for the transfer of persons under investigation and of probable/confirmed cases.

Appropriate personal protective equipment (PPE) should be available onsite for all personnel at the point-of-care to provide standard, contact, and droplet protection.

In each Allergy facility, a dedicated member of staff (e.g., head doctor/nurse) should lead the COVID-19 preparedness and implement relevant infrastructure and control measure policies.

Signs should be posted at all entrance doors listing the main symptoms compatible with COVID-19 (fever, cough, and shortness of breath) and informing visitors with any of these symptoms not to enter the Allergy Unit. Everyone within the Allergy clinic and all those entering the practice should adopt appropriate hand hygiene measures, using soap and water, or an alcohol-based handrub.

Based on a case-by-case risk assessment, the use of PPE for AIT should be considered. With the current knowledge on the transmission of COVID-19, in which respiratory droplets seem to play a significant role (although airborne transmission cannot be ruled out at this stage), and taking into consideration the possible shortage of PPE in healthcare settings due to the increasing number of COVID-19 patients, the suggested set of PPE for droplet, contact, and airborne transmission (gloves, goggles, gown, and FFP2/FFP3 respirator) can be adapted for the clinical assessment of suspected

COVID-19 cases. If available, a surgical mask should be provided for patients with respiratory symptoms (e.g., cough).⁵⁰

Healthcare workers performing aerosol-generating procedures (AGP), such as swabbing,⁵⁰ should wear the suggested PPE set for the prevention of droplet, contact, and airborne transmission (gloves, goggles, gown, and FFP2/FFP3 respirator).⁵¹

To maximize the use of PPE if there is an insufficient supply, staff should be assigned to carry out procedures, or a procedure, in designated areas.⁵²

4 | MANAGING AIT DURING THE COVID-19 PANDEMIC

AIT is a treatment that requires recurrent doctor/nurse/patient contact over a more extended period, for example, 3 years.

In SCIT, injections are administered with daily, weekly (up dosing phase), or monthly (continuation phase) intervals.

In SLIT, the initiation is given in allergy clinics or in a doctor's office, while continuation is performed by patients themselves with regular control visits.

Each SCIT or SLIT product needs approval by the competent authority. It must contain information on how to use the AIT product for patients, allergologists, and nurses. For most products authorized in Europe, instructions for use recommend that patients experiencing an acute respiratory tract infection should temporarily discontinue AIT treatment until the infection is resolved. We recommend taking similar action in COVID-19. Confirmed cases should discontinue AIT, both SCIT and SLIT, independent of disease severity, until the symptoms have completely resolved and/or an adequate quarantine has been performed. The possibility of expanding injection intervals in the continuation phase may be beneficial. In patients having recovered from COVID-19 or who are found to have a sufficient SARS-CoV-2 antibody response after (asymptomatic) disease,¹⁴ AIT can be started or continued as planned.

AIT can also be started or continued as usual in patients without clinical symptoms and signs of COVID-19 or other infections and without a history of exposure to SARS-CoV-2 or contact to COVID-19 confirmed individuals within the past 14 days.

SLIT offers the possibility of administration at home, thus avoiding the need to travel to or stay in an allergy clinic or doctor's office, which would be associated with a risk of infection.

5 | RECOMMENDATIONS IN NONINFECTED INDIVIDUALS DURING COVID-19 PANDEMICS OR RECOVERED PATIENTS AFTER COVID-19 INFECTION

Interrupting subcutaneous immunotherapy is not advised. Especially in potentially life-threatening allergies, such as venom allergy, SCIT should be continued regularly. The possibility of expanding injection intervals in the continuation phase should be checked and may be beneficial.

Interrupting sublingual immunotherapy is not advised. Supply the patient with sufficient medication for a minimum of a 14-day quarantine.

Sublingual immunotherapy can be taken at home. The intake of SLIT by the patient at home or any place is advantageous in avoiding contact to potentially infected persons.

Both subcutaneous and sublingual immunotherapy can be continued in the current COVID-19 pandemic, in any asymptomatic patient without suspicion of SARS-CoV-2 infection and/or contact with SARS-CoV-2 positive individuals, in any patient with a negative test result (RT-PCR) or in any patient after an adequate quarantine or with detection of serum IgG to SARS-CoV-2 without virus-specific IgM.

Preparedness of your Allergy clinic is imperative when coping with COVID-19. Follow WHO guidelines and advise staff accordingly.

These recommendations are conditional since there is a paucity of data and they should be revised regularly with incoming new information on COVID-19.

6 | RECOMMENDATIONS IN COVID-19 DIAGNOSED CASES OR SUSPECTED FOR SARS-COV-2 INFECTION

Interrupting subcutaneous immunotherapy is advised.

Interrupting sublingual immunotherapy is advised.

Both subcutaneous and sublingual immunotherapy should be discontinued in symptomatic patients with exposure to or contact with SARS-CoV-2-positive individuals, or patients with positive test results (RT-PCR).

CONFLICT OF INTEREST

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ORCID

- Ludger Klimek  <https://orcid.org/0000-0002-2455-0192>
- Cezmi Akdis  <https://orcid.org/0000-0001-8020-019X>
- Mübeccel Akdis  <https://orcid.org/0000-0003-0554-9943>
- Claus Bachert  <https://orcid.org/0000-0003-4742-1665>
- Ioana Agache  <https://orcid.org/0000-0001-7994-364X>
- Alvaro A. Cruz  <https://orcid.org/0000-0002-7403-3871>
- Tari Haahtela  <https://orcid.org/0000-0003-4757-2156>
- Ken Ohta  <https://orcid.org/0000-0001-9734-4579>
- Yoshitaka Okamoto  <https://orcid.org/0000-0001-9734-4579>
- Oliver Pfaar  <https://orcid.org/0000-0003-4374-9639>
- Sanna Toppila-Salmi  <https://orcid.org/0000-0003-0890-6686>
- Mohamed H. Shamji  <https://orcid.org/0000-0003-3425-3463>
- Paolo Matricardi  <https://orcid.org/0000-0002-2145-3776>
- Torsten Zuberbier  <https://orcid.org/0000-0002-1466-8875>

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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APPENDIX 1

ARIA-MASK STUDY GROUP

Ioana Agache, Mübecce Akdis, Mona Al-Ahmad, Emilio Alvarez Cuesta, Hasan Arshad, Maria Cristina Artesani, Zeinab Awad, Claus Bachert, Mostafa Badr Eldin, Sergio Barba, Cristina Barbara, Eric D Bateman, Bianca Beghe, Elisabeth Bel, Karl-Christian Bergmann, David Bernstein, Leif Bjerner, Attilio Boner, Sergio Bonini, Sinthia Bosnic-Anticevich, Isabelle Bosse, Jacques Bouchard, Louis-Philippe Boulet, Fulvio Braido, Christopher Brightling, Roland Buhl, Carmen Bunu, Andrew Bush, William W Busse, Fernando Caballero-Fonseca, Davide Caimmi, Silvia Caimmi, Paulo Camargos, G Walter Canonica, Vicky Cardona, Kai-Hakon Carlsen, Warner Carr, Thomas Casale, Lorenzo Cecchi, Niels H Chavannes, Mario Alfonso Cepeda, Tomas Chivato, Ekaterine Chkhartishvili, George Christoff, Derek K Chu, Cemal Cingi, Giorgio Ciprandi, Ieva Cirule, Jaime Correia de Sousa, Maria del Carmen Costa Dominguez, André Coste, Linda Cox, Alvaro A Cruz, Adnan Custovic, Ulf Darsow, Frédéric de Blay, Diana Deleanu, Pascal Demoly, Philippe Devillier, Alain Didier, Ratko Djukanovic,

Maria Do Ceu Teixeira, Dejan Dokic, Ruta Dubakiene, Stephen Durham, Patrik Eklund, Yehia El-Gamal, Regina Emuzyte, Julia Esser-von-Bieren, Alessandro Fiocchi, Wytske J Fokkens, Joao A Fonseca, MinaGaga, José Luis Gálvez Romero, Bilun Gemicioglu, Sonya Genova, José Gereda, Maximiliano Gomez, Maia Gotua, Ineta Grisle, Marta Guidacci, Maria Antonieta Guzmán, Tari Haahtela, Adnan Hejjaoui, Elham Hossny, Jonathan O Hourihane, Martin Hrubisko, Yunuen Huerta Villalobos, Guido Iaccarino, Carla Irani, Zhanat Ispayeva, Juan-Carlos Ivancevich, Edgardo Jares, Ewa Jassem, Erika Jensen-Jarolim, Sebastian Johnston, Guy Joos, Ki-Suck Jung, Jocelyne Just, Igor Kaidashev, Omer Kalayci, Fuat Kalyoncu, Przemyslaw Kardas, Jussi Karjalainen, Nikolai Khaltayev, Jorg Kleine-Tebbe, Ludger Klimek, Gerard Koppelman, Marek L Kowalski, Mikael Kuitunen, Piotr Kuna, Violeta Kvedariene, Amir H Abdul Latiff, Susanne Lau, Lan Le, Marcus Lessa, Michael Levin, Jing Li, Philip Lieberman, Brian Lipworth, Karin C Lodrup Carlsen, Bassam Mahboub, Mika Makela, Hans-Jorgen Malling, Gailen Marshall, Pedro Martins, Mohammad Masjedi, Juan José Matta, Cem Meço, Erik Melén, Eli O Meltzer, Hans Merk, Jean-Pierre Michel, Florin Mihaltan, Neven Miculinic,

Branislava Milencovic, Youssef Mohammad, Mathieu Molimard, Mario Morais-Almeida, Ralph Mösges, Joaquim Mullol, Lars Münter, Antonella Muraro, Tihomir Mustakov, Robert Naclerio, Alla Nakonechna, Leyla Namazova-Baranova, Kristof Nekam, Laurent Nicod, Robyn O'Hehir, Ken Ohta, Yoshitaka Okamoto, Kimihiro Okubo, Brian Oliver, Pier Luigi Paggiaro, Isabella Pali-Schöll, Petr Panzner, Nikos G Papadopoulos, Hae-Sim Park, Ana Pereira, Ruby Pawankar, Oliver Pfaar, Bernard Pigearias, Constantinos Pitsios, Davor Plavec, Wolfgang Pohl, Todor Popov, Fabienne Portejoie, Paul Potter, Lars Poulsen, Emmanuel Prokopakis, Klaus Rabe, Marysia Recto, Janet Rimmer, Jose Angelo Rizzo, Graham Roberts, Nicolas Roche, Antonino Romano, Jose Rosado-Pinto, Nelson Rosario, Lanny Rosenwasser, Philip Rouadi, Dermot Ryan, Mario Sanchez-Borges,

Joaquin Sastre-Dominguez, Glenis Scadding, Elie Serrano, Nikolaos Siafakas, Estelle F Simons, Juan-Carlos Sisul, Dirceu Solé, Talant Sooronbaev, Manuel Soto-Martinez, Cristiana Stellato, Rafael Stelmach, Timo Strandberg, Charlotte Suppli Ulrik, Carel Thijs, Peter-Valentin Tomazic, Sanna Toppila-Salmi, Massimo Triggiani, Ioanna Tsiligianni, Marilyn Urrutia Pereira, Erkkka Valovirta, Eric Van Ganse, Marianne van Hage, Olivier Vandenplas, Maria Teresa Ventura, Petra Vidgren, Martin Wagenmann, Dana Wallace, De Yun Wang, Susan Waserman, Magnus Wickman, Dennis Williams, Barbara Yawn, Arzu Yorgancioglu, Osman B Yusuf, Mario Zernotti, Mihaela Zidarn, Torsten Zuberbier.