Occupational asthma: Management, prognosis, and prevention

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INTRODUCTION

Occupational asthma (OA) is a form of work-related asthma that is characterized by variable airflow limitation, airway hyperresponsiveness, and airway inflammation induced by immunologic or nonimmunologic exposures in the work environment [1]. Work-exacerbated asthma is defined as preexisting or concurrent asthma that worsens in the workplace, but is not induced by it.

The management, prognosis, and prevention of OA will be reviewed here. The definition, epidemiology, causes, risk factors, pathogenesis, clinical features, evaluation, and diagnosis of OA, and the diagnosis and management of RADS and irritant–induced asthma are discussed separately. (See "Occupational asthma: Definitions, epidemiology, causes, and risk factors" and "Occupational asthma: Pathogenesis" and "Occupational asthma: Clinical features, evaluation, and diagnosis" and "Reactive airways dysfunction syndrome and irritant-induced asthma".)

MANAGEMENT

The key element is to make the diagnosis and remove the subject from exposure as quickly as possible after the onset of symptoms, as a long duration of exposure is associated with a poor prognosis of the disease. In some cases, OA may be cured if removal from exposure occurs early following onset of symptoms. The management of OA requires a combination of avoidance of further exposure to sensitizing agents, reduction in exposure to irritant agents (eg, environmental tobacco smoke, strong fumes and fragrances, extremes of temperature and humidity) and pharmacotherapy based on the severity of asthma. The management of occupational rhinitis, which may accompany OA, is discussed separately. (See "Occupational rhinitis".)

Exposure avoidance — Exposure avoidance is the cornerstone of management of immunologic OA [2-7]. For comparison, the role of exposure avoidance in other forms of work-related asthma is also discussed.

Immunologic occupational asthma — The most important intervention after identification of immunologic OA is prompt removal of the worker from further exposure to the sensitizing agent. Patients with OA generally have progressive deterioration in lung function if they remain in the working environment [8-10], and fatal cases have occurred among workers with ongoing workplace exposure to either high-molecular-weight or low-molecular-weight provocative antigens [11]. A description of high and low-molecular-weight agents is provided separately (table 1). (See "Occupational asthma: Definitions, epidemiology, causes, and risk factors", section on 'Causative agents'.)

Systematic reviews that assessed the outcome of immunologic OA indicate that complete and definitive removal from exposure to the causal agent is the optimal treatment for immunologic OA [12,13]. Workers with immunologic OA who remain exposed to their causal agent are at high risk of experiencing asthma exacerbations. Workers with persistent OA may develop bronchospasm with exposure to nonspecific asthma triggers due to bronchial hyperresponsiveness. Thus, the management plan should also include avoidance of other asthma triggers (eg, environmental tobacco smoke, extremes of heat and cold) at and away from work. (See "Trigger control to enhance asthma management".)

Irritant-induced asthma — Workers with nonimmunologic, irritant-induced asthma may be able to continue to work if the risk of a high-level exposure to the inciting agent is reduced by use of appropriate engineering controls and respiratory protective devices [14]. Due to the irritant nature of the inciting agent, low dose exposures are less likely to cause an increase in symptoms, compared with immunologic inciting agents. Chronic exposure to irritant agents may contribute to work-related asthma [15]. (See "Reactive airways dysfunction syndrome and irritant-induced asthma", section on 'Treatment'.)

Work-exacerbated asthma — For workers with work-exacerbated asthma, avoidance of asthma triggers both at work and away from work (eg, environmental tobacco smoke, extremes of heat and cold) is important together with the use of appropriate medications to control asthma symptoms. In general, as long as these goals are achieved, the worker need not change jobs or leave the work environment. (See "Trigger control to enhance asthma management".)

Exposure reduction — Reducing exposure to the causal agent, rather than complete avoidance represents a substantially less satisfactory approach in terms of respiratory outcome, compared with complete avoidance or removal.

In one systematic review, a reduction in exposure was associated with a lower likelihood of improvement or resolution of asthma symptoms and a higher risk of worsening of the symptoms

and nonspecific bronchial hyperresponsiveness compared with complete avoidance [16]. In another systematic review, reduction of exposure increased the likelihood of reporting absence of symptoms, but did not affect forced expiratory volume in one second (FEV_1); removal from exposure was associated with an increased risk of unemployment [12].

Some workers with OA, often those with milder symptoms, may choose not to leave their workplace due to concerns about a reduction of income with job reassignment or unemployment [12]. Ongoing surveillance is advised for workers with OA who have continued low level exposure to a known causative agent. Evidence of further deterioration in asthma control or lung function should lead to renewed recommendations for complete avoidance of exposure.

Respiratory protection devices — Engineering and work practice controls are generally regarded as the most effective methods to control exposures to airborne hazardous substances. However, as an alternative, several respiratory protection devices (RPDs) are available to help protect workers from noxious occupational inhalants.

RPDs include air-purifying masks that filter particulates (eg, dust or particulate respirators) or chemically remove vapors or gases (eg, masks with cartridges or canisters) and powered air purifying respirators (also known as personal powered respirators, or PPRs) that supply clean air. The particular device is chosen based on the characteristics of the causative agent. These devices require proper fitting, careful removal practices, and regular maintenance. Patients with impaired pulmonary function at baseline may not tolerate the extra work of breathing resulting in suboptimal compliance with these devices. Further work is needed to evaluate efficacy with long-term use in the workplace.

Data in support of using RPDs to reduce exposure to an agent known to have caused OA are limited to a few small case series that found only partial protection when the RPD was used in workers with OA due to high-molecular-weight agents [17]:

- The use of a dust respirator (such as an N95 mask) was examined in two workers with OA due to buckwheat or wheat flour, one with only a late phase reaction and one with both early and late onset of asthma symptoms [18]. Both early and late reactions were suppressed when the dust respirator was worn during workplace exposure. Information about long-term efficacy of the mask was not provided.

- The efficacy of personal powered respirators (PPRs) was assessed in 26 farmers by measuring pulmonary function after work-related dust exposure in the laboratory with and without the PPR [19]. The PPR blunted the increase in airway resistance following dust exposure, but did not entirely prevent it.

- Personal powered respirators (PPR) were evaluated in 24 agricultural workers with OA [20]. Morning and evening peak expiratory flow rates and daily symptoms of the subjects were monitored for 3 months without and for 10 months with the PPR. Morning peak flow rate

improved with the PPR and daily variation in the peak flow rate diminished, consistent with improved asthma control. Occupational rhinitis also improved with use of the PPR. In a separate study, eight patients with OA due to laboratory animal allergy wore a PPR (Racal Airstream) during workplace exposure for seven weeks [21]. Six of the eight patients had adequate protection based on peak flow readings and a symptom diary.

- A laminar flow helmet with a high efficiency air purifying (HEPA) system was tested in 10 subjects with latex-induced OA, during challenges that simulated work exposure to latex gloves [22]. The helmet with HEPA filtration was effective in preventing the asthma symptoms and fall in FEV_1 that occurred during challenges without the helmet. However, it is not known whether this type of protection would be adequate protection against exposure to other high-molecular-weight causative agents in a work environment.

- Positive pressure helmets can be used by workers with OA caused by low-molecular-weight agents, if the duration of exposure is short. However, these protective devices are cumbersome and not well tolerated for longer intervals such as a work shift.

Further study is needed to determine whether any form of respirator would adequately prevent inhalation of a causative agent, such that a worker with OA could continue working in the same workplace.

Pharmacologic treatment of asthma — Pharmacologic treatment of OA is essentially the same as for non-occupational asthma, although it cannot replace exposure prevention [3,4]. The general goals of pharmacologic therapy for asthma and the treatment of irritant-induced asthma are discussed separately. (See "An overview of asthma management", section on 'Pharmacologic treatment' and "Reactive airways dysfunction syndrome and irritant-induced asthma", section on 'Treatment'.)

Approach to treatment — Initiation of pharmacologic therapy for OA follows a step-wise approach, as described for nonoccupational asthma in the NAEPP and the Global Initiative for Asthma (GINA) guidelines [23,24]. (See "An overview of asthma management", section on 'Pharmacologic treatment' and "Treatment of intermittent and mild persistent asthma in adolescents and adults" and "Treatment of moderate persistent asthma in adolescents and adults" and "Treatment of severe asthma in adolescents and adults".)

The optimal duration of pharmacologic therapy for OA is unknown. We typically re-assess asthma control at 8 to 12 week intervals. When asthma control is achieved, we taper the controller medications based on perceived efficacy, presence of adverse effects, patient preference, and cost considerations. Guidelines for tapering of inhaled GCs have not been validated, but we usually decrease by 20 to 25 percent increments at one to three month intervals to a medium or low dose.

Immunotherapy — Subcutaneous immunotherapy (SCIT) is occasionally administered to workers with OA who are unable or unwilling to change their work environment and are sensitized to high-molecular-weight agents for which appropriate allergen extracts are available [25]. Sublingual immunotherapy (SLIT) has demonstrated benefit in allergic asthma, although not specifically in OA. However, supportive data for SCIT and SLIT are limited, particularly regarding workers with ongoing high level exposure, such as that experienced in a workplace. (See "Subcutaneous immunotherapy for allergic disease: Indications and efficacy", section on 'Allergic asthma' and "Sublingual immunotherapy for allergic rhinoconjunctivitis and asthma", section on 'Patients with concomitant asthma'.)

The evidence supporting the use of SCIT for selected patients with OA comes from a few small studies of SCIT with high-molecular-weight antigens [25-28]. As examples, two randomized trials have tested SCIT among patients with cat or dog dander-induced asthma [26,27]. In one trial, 28 subjects were assigned to cat allergen SCIT or control and noted a marked reduction in symptoms during subsequent cat exposure without any significant adverse reactions [26]. In the other trial, SCIT improved symptoms related to cat exposure but not to dog exposure. Subsequent studies have confirmed that dog SCIT requires a high maintenance dose to achieve benefit, so the absence of benefit to dog SCIT in this study may have been due to an insufficient dose [29,30]. (See "Subcutaneous immunotherapy for allergic disease: Indications and efficacy".)

Two randomized trials of SCIT administered for OA involved healthcare workers sensitized to natural rubber latex [31,32]. After specific SCIT, a significant improvement was observed in tolerance to direct exposure (glove-use test), but not in other parameters of asthma control, such as symptom scores, use of medication, or bronchial reactivity. Systemic reactions occurred in 69 percent of patients and after 8 percent of the doses [32]. However, SCIT is no longer a consideration for latex OA, as workplace practices to reduce latex exposure have subsequently improved to the point that SCIT is not needed. (See "Anaphylaxis induced by subcutaneous allergen immunotherapy", section on 'Background' and "Latex allergy: Management".)

Several factors limit the use of SCIT for OA:

- Only a few therapeutic allergen extracts are commercially available for agents that cause OA (eg, cat and dog epithelia, house dust mites, pollen, and rat and mouse epidermal extracts).
- Mixed sensitization to several allergens may also be a problem. (See "Occupational asthma: Definitions, epidemiology, causes, and risk factors", section on 'Combined exposures'.)
- SCIT to foods, such as wheat, fish, shellfish or nuts, is not currently advised (outside of research settings) due to lack of data regarding safety or efficacy. However, a few case reports and case series have supported the use of SCIT to wheat extracts for bakers with OA [14,25,28,33].

- Systemic reactions have required modification or discontinuation of SCIT among many workers with OA [32,34], and the risk of severe systemic reactions may be greater among these patients due to their high level of allergen exposure [31,35]. SCIT is not advisable in patients with uncontrolled or severe asthma due to increased risk of life-threatening systemic allergic reactions [36].

- SCIT, using low-molecular-weight allergens, has not been tested due to concerns about toxicity [14].

- SCIT has no role in the management of OA caused by corrosive or irritative substances.

Anti-IgE therapy — Anti-IgE therapy is typically indicated for patients with moderate-to-severe persistent asthma, demonstrable sensitivity to a perennial aeroallergen, and incomplete symptom control despite high dose inhaled glucocorticoid and a long-acting beta agonist. However, it is considered experimental therapy for OA, pending additional research on efficacy and safety. When caring for a patient with poorly-controlled OA, the strong recommendation would be for complete avoidance of the causative agent, rather than anti-IgE therapy. (See 'Immunologic occupational asthma' above.)

For patients who may be candidates for anti-IgE therapy, elevation of serum total IgE and specific IgE to the causative workplace allergen must be documented. Dosing and monitoring of anti-IgE therapy are described separately. (See "Anti-IgE therapy", section on 'Dosing and administration'.)

The use of anti-IgE therapy (omalizumab) has been described in a few patients with poorly-controlled asthma despite guideline-based pharmacologic therapy who were unable to change their work environment [34,35,37,38]. In the largest series, 10 patients with severe, uncontrolled OA due to high and low molecular weight agents were treated with anti-IgE therapy and concomitant reduction in workplace exposures [38]. Nine patients exhibited lower rates of exacerbation and a reduced requirement for oral or inhaled glucocorticoids, although two of these eventually left the workplace. As the study was not controlled, the relative contributions of workplace modifications and anti-IgE therapy to the observed improvement in asthma control are not known.

For patients with OA who have left the workplace, the indications for anti-IgE therapy are the same as for those with asthma not related to occupational exposure. (See "Anti-IgE therapy", section on 'Indications and patient selection'.)

The follow-up of asthmatic patients who are removed from exposure does not differ from asthmatic patients without OA. There is no published recommendation regarding the monitoring of patients who remain exposed to the offending agent at their workplace. However, it appears reasonable to perform at least a yearly follow-up including spirometry of those patients to ensure that their asthma remains adequately controlled. The frequency of assessment needs to be tailored according to their asthma severity and control. Whether or not a yearly monitoring of airway

responsiveness/inflammation can provide guidance on a complete removal from exposure by detecting a worsening asthma in this population has never been studied.

DISABILITY

Workers with severe occupational asthma (OA) may be unable to work for several months or longer even after cessation of exposure to the culprit agent. The assessment of disability is based on the degree of bronchial obstruction and hyperresponsiveness as well as the need for anti-asthma medication for assuring control. The criteria for and evaluation of pulmonary disability in the United States are discussed separately. (See "Disability assessment and determination in the United States" and "Evaluation of pulmonary disability".)

PROGNOSIS

Improvement of occupational asthma (OA) is typically gradual after cessation of exposure and reaches a plateau after approximately two years [39], although some studies suggest that further improvement may occur later at slower rates [40,41]. Most patients show incomplete resolution of asthma, airway responsiveness, and inflammation, even many years following cessation of exposure [42]. However, a shorter duration of exposure prior to removal from the workplace may be associated with a higher rate of resolution of sensitization and bronchial hyperresponsiveness [43-45].

- In a systematic review of OA studies (1681 participants) with a median duration of follow-up of 31 (range 6 to 240) months, complete recovery from asthma was noted in approximately 32 percent (95% CI 26-38 percent), while bronchial hyperresponsiveness was persistent in approximately 73 percent (95% CI 66-79 percent) of subjects [44].

- In a retrospective study of 997 participants with OA, 162 were classified as having severe OA [46]. Severe OA was associated with persistent exposure to the causal agent (odds ratio 2.78, 95% CI 1.50-5.60), longer duration of disease, lower educational level, childhood asthma, and sputum production. Among those with severe asthma despite cessation of exposure, obesity was identified as a potentially modifiable risk factor.

Even if asthma control improves with complete avoidance of exposure to the sensitizing agent, approximately one-half of workers with OA have persistent problems with depression and anxiety that are more severe than patients with a similar severity of non-work-related asthma [47,48].

PREVENTION

Control of the level of exposure to workplace respiratory sensitizers can reduce the number of workers who become sensitized and is the most important method of primary prevention [17,49]. The efficacy of reducing exposure levels has been demonstrated for acid anhydrides, detergent enzymes, isocyanates, laboratory animals, and latex [50-55]. As examples, a threshold for flour exposure of 0.2 mcg/m^3 has led to a reduction in the risk of sensitization [56], and the incidence of occupational asthma (OA) due to isocyanates has decreased in association with better workplace exposure practices [57,58].

The use of respiratory protective equipment (RPE) decreases worker exposure levels and reduces the incidence, but does not completely protect against development of OA [17,59]. As an example, among 66 new hires at a plant using hexahydrophthalic anhydride, the use of RPE was associated with a decrease in the rate of developing occupational respiratory disease, including OA, from 10 to 2 percent [60].

Exposure monitoring, combined with medical surveillance of exposed workers, enables early identification of sensitization and removal from exposure for those who develop OA [61-63]. Continuous monitoring of ambient levels of several low-molecular-weight chemicals, including isocyanates and formaldehyde, is now available. In addition, immunochemical techniques have been developed for quantifying ambient levels of high-molecular-weight allergens. Unfortunately, the very low concentration of antigen required to provoke bronchospasm once sensitization has occurred is often below the limits of detection.

Because of the low predictive value of atopy for the development of OA and because nearly 50 percent of young adults are atopic, atopic subjects should not be excluded from high-risk workplaces. However, atopic individuals who enter high-risk workplaces with ambient exposure to protein allergens (eg, detergent enzymes) require regular follow-up examinations for early detection of sensitization and/or bronchial hyperresponsiveness. Diagnostic models including work-related respiratory symptoms, allergic symptoms, and characteristics of the job may be helpful to predict the occurrence of OA among bakers at high risk of sensitization to bakery allergens [64]. (See "Occupational asthma: Definitions, epidemiology, causes, and risk factors", section on 'Atopy'.)

Smoking cessation should be advised for general health reasons and may also decrease the risk of antigenic sensitization in the workplace [17,65].

It may be possible in the future to screen chemicals for their potential to induce respiratory allergy prior to their introduction into industry because studies have shown that the capacity for a chemical to cause sensitization is related to its structure [66,67].

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Occupational asthma".)

SUMMARY AND RECOMMENDATIONS

- For patients who are diagnosed with occupational asthma (OA) induced by a sensitizing agent, the most important intervention is prompt and complete removal of the worker from further exposure. Patients with OA generally have progressive deterioration in lung function if they remain in the working environment. (See 'Management' above.)
- As an exception, for workers with mild OA (mild symptoms and minimal physiologic impairment) who have a strong preference for remaining in the workplace, reducing exposure via engineering controls or respiratory protective devices may be effective, but evidence is conflicting and "safe" levels of exposure have not been established. Careful ongoing surveillance is advised to detect any further deterioration in lung function. (See 'Exposure reduction' above and 'Respiratory protection devices' above.)
- Pharmacologic treatment of OA follows the same guidelines as non-occupational asthma, but cannot replace exposure prevention. (See 'Approach to treatment' above and "An overview of asthma management", section on 'Pharmacologic treatment'.)
- For the majority of patients with OA, there is insufficient evidence of benefit in the setting of ongoing workplace exposure to advise the use of either subcutaneous immunotherapy (SCIT) or anti-IgE therapy (eg, omalizumab). However, for workers who have OA caused by sensitization to house dust mite, cat, or dog allergens and unavoidable workplace exposure, we suggest SCIT with the appropriate extract (**Grade 2C**), except for workers whose asthma is uncontrolled or severe because they are at increased risk of injection-related anaphylaxis. (See 'Immunotherapy' above and 'Anti-IgE therapy' above and "Subcutaneous immunotherapy for allergic disease: Indications and efficacy", section on 'Severe or unstable asthma'.)
- Improvement of OA after cessation of exposure is typically gradual and reaches a plateau approximately two years after cessation of exposure. Most patients show incomplete resolution of asthma, airway responsiveness, and inflammation, even many years following cessation of exposure. (See 'Prognosis' above.)
- For many occupational sensitizers, control of the level of exposure to the sensitizing agent reduces the number of workers who become sensitized and is the most important method of prevention. (See 'Prevention' above.)

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REFERENCES

1. Bernstein IL, Bernstein DI, Chan-Yeung M, Malo JL. Definition and classification of asthma in the workplace. In: Asthma in the workplace, 4th ed, Malo JL, Chan-Yeung M, Bernstein DI (Eds), CRC Press, Boca Raton, FL 2013. p.1-5.
2. Mapp CE, Boschetto P, Maestrelli P, Fabbri LM. Occupational asthma. Am J Respir Crit Care Med 2005; 172:280.
3. Fishwick D, Barber CM, Bradshaw LM, et al. Standards of care for occupational asthma: an update. Thorax 2012; 67:278.
4. Baur X, Sigsgaard T, Aasen TB, et al. Guidelines for the management of work-related asthma. Eur Respir J 2012; 39:529.
5. Kim M-H, Jung J-W, Kang H-R. The Usefulness of Job Relocation and Serum Eosinophil Cationic Protein in Baker's Asthma. Int Arch Allergy Immunol 2013; 161:252.
6. Tarlo SM, Lemiere C. Occupational asthma. N Engl J Med 2014; 370:640.
7. Descatha A, Leproust H, Choudat D, et al. Factors associated with severity of occupational asthma with a latency period at diagnosis. Allergy 2007; 62:795.
8. Cote J, Kennedy S, Chan-Yeung M. Outcome of patients with cedar asthma with continuous exposure. Am Rev Respir Dis 1990; 141:373.
9. Moscato G, Dellabianca A, Perfetti L, et al. Occupational asthma: a longitudinal study on the clinical and socioeconomic outcome after diagnosis. Chest 1999; 115:249.
10. Pisati G, Baruffini A, Zedda S. Toluene diisocyanate induced asthma: outcome according to persistence or cessation of exposure. Br J Ind Med 1993; 50:60.
11. Ortega HG, Kreiss K, Schill DP, Weissman DN. Fatal asthma from powdering shark cartilage and review of fatal occupational asthma literature. Am J Ind Med 2002; 42:50.
12. de Groene GJ, Pal TM, Beach J, et al. Workplace interventions for treatment of occupational asthma. Cochrane Database Syst Rev 2011; :CD006308.

13. Vandenplas O, Dressel H, Nowak D, et al. What is the optimal management option for occupational asthma? Eur Respir Rev 2012; 21:97.

14. Tarlo SM, Balmes J, Balkissoon R, et al. Diagnosis and management of work-related asthma: American College Of Chest Physicians Consensus Statement. Chest 2008; 134:1S.

15. Dumas O, Le Moual N. Do chronic workplace irritant exposures cause asthma? Curr Opin Allergy Clin Immunol 2016; 16:75.

16. Vandenplas O, Dressel H, Wilken D, et al. Management of occupational asthma: cessation or reduction of exposure? A systematic review of available evidence. Eur Respir J 2011; 38:804.

17. Nicholson PJ, Cullinan P, Taylor AJ, et al. Evidence based guidelines for the prevention, identification, and management of occupational asthma. Occup Environ Med 2005; 62:290.

18. Obase Y, Shimoda T, Mitsuta K, et al. Two patients with occupational asthma who returned to work with dust respirators. Occup Environ Med 2000; 57:62.

19. Müller-Wening D, Neuhauss M. Protective effect of respiratory devices in farmers with occupational asthma. Eur Respir J 1998; 12:569.

20. Taivainen AI, Tukiainen HO, Terho EO, Husman KR. Powered dust respirator helmets in the prevention of occupational asthma among farmers. Scand J Work Environ Health 1998; 24:503.

21. Slovak AJ, Orr RG, Teasdale EL. Efficacy of the helmet respirator in occupational asthma due to laboratory animal allergy (LAA). Am Ind Hyg Assoc J 1985; 46:411.

22. Laoprasert N, Swanson MC, Jones RT, et al. Inhalation challenge testing of latex-sensitive health care workers and the effectiveness of laminar flow HEPA-filtered helmets in reducing rhinoconjunctival and asthmatic reactions. J Allergy Clin Immunol 1998; 102:998.

23. National Asthma Education and Prevention Program: Expert panel report III: Guidelines for t he diagnosis and management of asthma. Bethesda, MD: National Heart, Lung, and Blood I nstitute, 2007. (NIH publication no. 08-4051). Full text available online: www.nhlbi.nih.gov/gui delines/asthma/asthgdln.htm (Accessed on June 27, 2017).

24. Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Preventio n: Updated 2019. Full text available online at: http://www.ginasthma.org (Accessed on Augus t 19, 2019).

25. Moscato G, Pala G, Sastre J. Specific immunotherapy and biological treatments for occupational allergy. Curr Opin Allergy Clin Immunol 2014; 14:576.

26. Varney VA, Edwards J, Tabbah K, et al. Clinical efficacy of specific immunotherapy to cat dander: a double-blind placebo-controlled trial. Clin Exp Allergy 1997; 27:860.

27. Sundin B, Lilja G, Graff-Lonnevig V, et al. Immunotherapy with partially purified and standardized animal dander extracts. I. Clinical results from a double-blind study on patients with animal dander asthma. J Allergy Clin Immunol 1986; 77:478.

28. Armentia A, Martin-Santos JM, Quintero A, et al. Bakers' asthma: prevalence and evaluation of immunotherapy with a wheat flour extract. Ann Allergy 1990; 65:265.

29. Lent AM, Harbeck R, Strand M, et al. Immunologic response to administration of standardized dog allergen extract at differing doses. J Allergy Clin Immunol 2006; 118:1249.

30. Nelson HS. Advances in upper airway diseases and allergen immunotherapy. J Allergy Clin Immunol 2007; 119:872.

31. Leynadier F, Herman D, Vervloet D, Andre C. Specific immunotherapy with a standardized latex extract versus placebo in allergic healthcare workers. J Allergy Clin Immunol 2000; 106:585.

32. Sastre J, Fernández-Nieto M, Rico P, et al. Specific immunotherapy with a standardized latex extract in allergic workers: a double-blind, placebo-controlled study. J Allergy Clin Immunol 2003; 111:985.

33. Armentia A, Arranz M, Martin JM, et al. Evaluation of immune complexes after immunotherapy with wheat flour in bakers' asthma. Ann Allergy 1992; 69:441.

34. Leynadier F, Doudou O, Gaouar H, et al. Effect of omalizumab in health care workers with occupational latex allergy. J Allergy Clin Immunol 2004; 113:360.

35. Pérez Pimiento A, Bueso Fernández A, García Loria J, et al. Effect of omalizumab treatment in a baker with occupational asthma. J Investig Allergol Clin Immunol 2008; 18:490.

36. Cox L, Nelson H, Lockey R, et al. Allergen immunotherapy: a practice parameter third update. J Allergy Clin Immunol 2011; 127:S1.

37. Olivieri M, Biscardo CA, Turri S, Perbellini L. Omalizumab in persistent severe bakers' asthma. Allergy 2008; 63:790.

38. Lavaud F, Bonniaud P, Dalphin JC, et al. Usefulness of omalizumab in ten patients with severe occupational asthma. Allergy 2013; 68:813.

39. Malo JL, Cartier A, Ghezzo H, et al. Patterns of improvement in spirometry, bronchial hyperresponsiveness, and specific IgE antibody levels after cessation of exposure in occupational asthma caused by snow-crab processing. Am Rev Respir Dis 1988; 138:807.

40. Perfetti L, Cartier A, Ghezzo H, et al. Follow-up of occupational asthma after removal from or diminution of exposure to the responsible agent: relevance of the length of the interval from cessation of exposure. Chest 1998; 114:398.

41. Malo JL, Ghezzo H. Recovery of methacholine responsiveness after end of exposure in occupational asthma. Am J Respir Crit Care Med 2004; 169:1304.

42. Maghni K, Lemière C, Ghezzo H, et al. Airway inflammation after cessation of exposure to agents causing occupational asthma. Am J Respir Crit Care Med 2004; 169:367.

43. Gautrin D, Ghezzo H, Infante-Rivard C, et al. Long-term outcomes in a prospective cohort of apprentices exposed to high-molecular-weight agents. Am J Respir Crit Care Med 2008; 177:871.

44. Rachiotis G, Savani R, Brant A, et al. Outcome of occupational asthma after cessation of exposure: a systematic review. Thorax 2007; 62:147.

45. Miedinger D, Malo JL, Ghezzo H, et al. Factors influencing duration of exposure with symptoms and costs of occupational asthma. Eur Respir J 2010; 36:728.

46. Vandenplas O, Godet J, Hurdubaea L, et al. Severe Occupational Asthma: Insights From a Multicenter European Cohort. J Allergy Clin Immunol Pract 2019.

47. Yacoub MR, Lavoie K, Lacoste G, et al. Assessment of impairment/disability due to occupational asthma through a multidimensional approach. Eur Respir J 2007; 29:889.

48. Malo JL, Boulet LP, Dewitte JD, et al. Quality of life of subjects with occupational asthma. J Allergy Clin Immunol 1993; 91:1121.

49. Cullinan P, Tarlo S, Nemery B. The prevention of occupational asthma. Eur Respir J 2003; 22:853.

50. Liss GM, Bernstein D, Genesove L, et al. Assessment of risk factors for IgE-mediated sensitization to tetrachlorophthalic anhydride. J Allergy Clin Immunol 1993; 92:237.

51. Cathcart M, Nicholson P, Roberts D, et al. Enzyme exposure, smoking and lung function in employees in the detergent industry over 20 years. Medical Subcommittee of the UK Soap and Detergent Industry Association. Occup Med (Lond) 1997; 47:473.

52. Drexler H, Schaller KH, Nielsen J, et al. Efficacy of measures of hygiene in workers sensitised to acid anhydrides and the influence of selection bias on the results. Occup Environ Med 1999; 56:202.

53. Fisher R, Saunders WB, Murray SJ, Stave GM. Prevention of laboratory animal allergy. J Occup Environ Med 1998; 40:609.

54. Allmers H, Schmengler J, Skudlik C. Primary prevention of natural rubber latex allergy in the German health care system through education and intervention. J Allergy Clin Immunol 2002; 110:318.

55. Tarlo SM, Easty A, Eubanks K, et al. Outcomes of a natural rubber latex control program in an Ontario teaching hospital. J Allergy Clin Immunol 2001; 108:628.

56. Malo JL, Chan-Yeung M. Agents causing occupational asthma. J Allergy Clin Immunol 2009; 123:545.

57. McDonald JC, Keynes HL, Meredith SK. Reported incidence of occupational asthma in the United Kingdom, 1989-97. Occup Environ Med 2000; 57:823.

58. Tarlo SM, Liss GM, Yeung KS. Changes in rates and severity of compensation claims for asthma due to diisocyanates: a possible effect of medical surveillance measures. Occup Environ Med 2002; 59:58.

59. Petsonk EL, Wang ML, Lewis DM, et al. Asthma-like symptoms in wood product plant workers exposed to methylene diphenyl diisocyanate. Chest 2000; 118:1183.

60. Grammer LC, Harris KE, Yarnold PR. Effect of respiratory protective devices on development of antibody and occupational asthma to an acid anhydride. Chest 2002; 121:1317.

61. Fishwick D, Barber CM, Bradshaw LM, et al. Standards of care for occupational asthma. Thorax 2008; 63:240.

62. Tarlo SM, Liss GM. Prevention of occupational asthma. Curr Allergy Asthma Rep 2010; 10:278.

63. Wild DM, Redlich CA, Paltiel AD. Surveillance for isocyanate asthma: a model based cost effectiveness analysis. Occup Environ Med 2005; 62:743.

64. Jonaid BS, Rooyackers J, Stigter E, et al. Predicting occupational asthma and rhinitis in bakery workers referred for clinical evaluation. Occup Environ Med 2017; 74:564.

65. Siracusa A, Marabini A, Folletti I, Moscato G. Smoking and occupational asthma. Clin Exp Allergy 2006; 36:577.

66. Graham C, Rosenkranz HS, Karol MH. Structure-activity model of chemicals that cause human respiratory sensitization. Regul Toxicol Pharmacol 1997; 26:296.

67. Jarvis J, Seed MJ, Elton R, et al. Relationship between chemical structure and the occupational asthma hazard of low molecular weight organic compounds. Occup Environ Med 2005; 62:243.

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GRAPHICS

Major causes of occupational asthma and rhinitis

	Occupation at risk
Low molecular weight chemicals	
Isocyanates (eg, toluene diisocyanate, diphenylmethane diisocyanate, hexamethylene diisocyanate, naphthalene diisocyanate)	Polyurethane workers, roofers, insulators, painters
Anhydrides (eg, trimellitic anhydride, phthalic anhydride)	Manufacturers of paint, plastics, epoxy resins
Metals (eg, chromic acid, potassium dichromate, nickel sulfate, vanadium, platinum salts)	Platers, welders, metal and chemical workers
Drugs (eg, beta-lactam agents, opiates, other)	Pharmaceutical workers, farm workers, health professionals
Wood dust (eg, Western red cedar, maple, oak, exotic woods)	Carpenters, woodworkers
Dyes and bleaches (eg, anthraquinone, carmine, henna extract, persulfate, reactive dyes)	Fabric and fur dyers, hairdressers
Amines (eg, chloramine, quaternary amines)	Chemists, cleaners, plastic manufacturers
Glues and resins (eg, acrylates, epoxy)	Plastic manufacturers
Miscellaneous (eg, formaldehyde, glutaraldehyde, ethylene oxide, pyrethrin, polyvinyl chloride vapor)	Laboratory workers, textile workers, paint sprayers, health professionals
High molecular weight organic materials	
Animal proteins (eg, domestic and laboratory animals, fish and seafood)	Farmers, veterinarians, poultry processors, fish and seafood processors
Flours and cereals	Bakers, food processors, dock workers
Enzymes (eg, pancreatic extracts, papain, trypsin, *Bacillus subtilis*, bromelain, pectinase, amylase, lipase)	Bakers, food processors, pharmaceutical workers, plastic workers, detergent manufacturers
Plant proteins (eg, wheat, grain dust, coffee beans, tobacco dust, cotton, tea, latex, psyllium, various flours)	Bakers, farmers, food and plant processors, health professionals, textile workers

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Contributor Disclosures

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Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

Conflict of interest policy