

# Occupational asthma in the commercial fishing industry: a case series and review of the literature

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## ABSTRACT

We present a case series of snow crab-induced occupational asthma (OA) from a fishing and processing vessel, followed by a review of OA in the commercial fishing industry. OA is typically caused from an IgE-mediated hypersensitivity reaction after respiratory exposure to aerosolized fish and shellfish proteins. It more commonly occurs due to crustaceans, but molluscs and fin fish are implicated as well. Standard medical therapy for asthma may be used acutely; however, steps to reduce atmospheric allergen concentrations in the workplace have proven to be preventive for this disease.

**Key words: occupational asthma, snow crab, case series, review**

## INTRODUCTION

Occupational asthma (OA) accounts for 10–15% of all cases of adult onset asthma [1] and occurs in a variety of industries. OA has been well described in the commercial fishing industry, particularly in the handling and processing of crustaceans. As the exponential growth of the world population has led to rising food protein demands and subsequent increases in commercial fishing, OA incidence has the potential to increase [2]. The purpose of this paper is to review the causes, risk factors, and prevention strategies for occupational asthma in the commercial fishing industry. This will help physicians and others involved in maritime health to effectively manage this clinical entity.

## MATERIAL AND METHODS

The authors searched all articles from 1960 to 2010 in Pub-Med and the Pascal French database with the following key-words: occupational asthma, occupational allergies, occupational dermatitis, seafood, and fishery industry. Ad-

ditionally, case records from a maritime health clinic in Brest, France and a maritime telemedicine service in Washington, DC, USA were searched for illustrative cases of OA.

## CASE SERIES

A search was made of case records of a maritime telemedicine service in Washington, DC, and four cases of occupational asthma were identified aboard a snow crab processing vessel off the coast of Alaska. A search was made of case records of a maritime health clinic service in Brest, France, and no cases of OA in workers in the commercial fishing industry were found.

The first case was that of a 20-year-old man with a history of shellfish allergy (which escaped the notice of the pre-employment screening process) and asthma who had onset of shortness of breath and itching skin within 6 hours of starting duty on his first day on board. He also experienced vomiting and tachycardia. At the suggestion of his co-workers, he changed clothing when away from work and

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his symptoms improved. However, his symptoms recurred whenever he approached the door of the processing plant. He was treated with albuterol and diphenhydramine with some improvement. He was repatriated off the vessel and no other follow-up information was available.

The second case was that of a 34-year-old man with symptoms of an upper respiratory tract infection associated with dyspnea. He had no rash or wheezing, and no history of shellfish allergy. He had normal vital signs and his oxygen saturation was 99% in room air. He was treated on board with nebulised albuterol with some relief, as well as prednisone and amoxicillin. Although he subsequently had a negative allergy panel at the clinic in Dutch Harbor, Alaska, his symptoms recurred whenever working in the processing plant, making the diagnosis of OA very likely.

The third case was that of a 26-year-old man who presented with shortness of breath and wheezing. His symptoms improved temporarily with diphenhydramine and albuterol, but his symptoms then progressively worsened until he was symptomatic wherever he was onboard. At time of evacuation he was unable to walk due to his marked dyspnea and had oxygen saturations from 80% to 85%. Within minutes of evacuating the ship, his symptoms resolved, and he then declined further medical evaluation when ashore. No follow-up information was available.

The fourth case was that of a 39-year-old man who presented with dry cough and shortness of breath. His symptoms decreased at night but were more marked during the day while working and were associated with visible respiratory distress. On examination, he was wheezing and had oxygen saturation of 97% in room air and a pulse of 80 bpm. He received diphenhydramine, oxygen, albuterol, and azithromycin with improvement and was transported ashore.

## DISCUSSION

### AETIOLOGY

The case series presented above is an example of snow crab asthma, one of the more well-described causes of OA in the fishing industry. The snow crab is a species of crab fished and processed mainly in the Arctic waters of Canada, Alaska, and Russia. In 1979 Orford described 17 cases of asthma and allergic rhinitis in a queen crab plant (synonym of the snow crab) [3, 4]. Subsequent studies in multiple snow crab processing plants revealed a prevalence range from 9 to 50 percent. In offshore crab-processing ships asthma-like symptoms occur in up to 16 percent of fishermen [5–7].

Other crustaceans and molluscs have been found to cause OA in the fishing industry. Occupational king crab exposure was reported to be associated with wheezing in a case series of 47 patients with a prevalence of 9% of king crab workers in Alaska [8]. Other crustaceans reported to

cause OA include the Atlantic rock crab [9], lobster [10–12], prawn [13, 14], and shrimp [12, 15, 16]. Of note, there is a high prevalence (36–57%) of OA in shrimp processing plants [17].

Molluscs are also implicated in OA; however, with a prevalence well below that of crustaceans. *Perna Cannaliculus* (New Zealand green-lipped mussel) is described as causing a 16.5% prevalence for OA in a population of 223 workers. But the diagnostic criteria in this study for OA was not well controlled [18]. Other data on mollusc-induced OA are limited to case reports related to exposure to clams [15, 19], scallops in restaurant workers [20], cuttlefish in Polish deep sea fisherman [21], and abalone in a diver [22].

Fin fish are also implicated in OA. In a Polish study, fish allergen-induced asthma was suspected in fish-processing plant workers with a prevalence of 2% [23]. Fin fish species implicated in OA include salmon, tuna, hake, and trout [24–27]. A more recent review reports a prevalence of work-related asthma-like symptoms as high as 7% in bony fish processing workers [28].

OA is not always caused by allergens from fish products themselves, but also from parasites or other contaminants encountered in fish processing. Parasites such as *Anisakis* simplex have been implicated in causing OA in fishmongers, chicken farm workers who use fish protein-based chicken feed, and in frozen fish processing workers [29–31]. Red coral is now well known in Japan to be responsible for asthma in lobster fishermen [32]. Respiratory exposure to a tiny oyster parasite named *hoya* caused OA in up to 29% of Japanese oyster farm workers [33].

Preservatives used in fish and seafood processing may also cause OA: Sodium metabisulfite is one chemical preservative used in crustacean processing that has been found to probably be responsible for OA in fishermen and shrimp-processing workers [34]. Even “natural” additives such as garlic, mustard, and anise are well-known occupational asthma triggers and are often used in the fishery industry [35, 36].

### PATHOPHYSIOLOGY

Snow crab asthma is an allergic asthma mediated by IgE after exposure to aerosolized thermo-stable proteins. The rate of immunologic sensitization in workers exposed to snow crabs is very high. In a study of 119 exposed workers, 97% had a positive radioallergosorbent test (RAST) for IgE antibodies against snow crab proteins [37]. Although not every patient with a positive RAST will develop OA, there is a positive relation between the occurrence of OA and the positivity of RAST tests. An alternative pathophysiology of snow crab-related lung disease may be hypersensitivity pneumonitis caused by dinoflagellate contamination rather than snow crab allergens themselves [7].

The pathophysiology of OA stems from immune sensitization to seafood proteins (from meat, endolymph, exoskeleton, blood) via respiratory exposure when those proteins are aerosolized during the work process [38]. Most of these allergens are high molecular weight proteins such as tropomyosin in shrimp, prawns, and scallops and parvalbumin from fish [39]. Cross-reactivity can occur causing patients to be allergic to multiple species of seafood. This may be important in job reassignment as part of the treatment plan for seafood workers with OA. Classic OA stems from an IgE-mediated hypersensitive reaction leading to airway inflammation and bronchospasm. However, IgG-mediated mechanisms are implicated in some cases of coral exposure and from prawn and salmon processing [13, 14, 24, 40].

Typical exposure and subsequent sensitization comes from wet aerosols encountered in the processing of fresh seafood products. However, exposure may also occur by vaporized allergens inhaled during the cooking of crab and lobster [9, 10, 13, 20, 24, 41, 42]. Furthermore, dry aerosol exposures have been described for shrimp, clam, fish, and *anisakis simplex* [15, 16, 19, 25, 29]. These are summarized in tables 1 and 2.

Atmospheric allergen concentration is a major professional risk factor responsible for the development of OA in the commercial fishing industry [39]. The most high-risk work stations for snow crab workers are boiling, butchering stations body leg stations; concentrations in those stations on vessels have been measured at 1 657 ng/m<sup>3</sup>, 7 443 ng/m<sup>3</sup> and 5 061 ng/m<sup>3</sup> respectively [7, 37, 41]. Although butchering stations account for only 25% of snow crab plant workers, this role represents 70% of asthma cases, highlighting

the importance of atmospheric allergen concentrations [7, 37, 41, 42].

Across seafood industries, high-risk work stations include butchering, de-gilling, cracking, and boiling stations for crab; blowing of prawns; washing of shellfish; tailing and cooking of lobster; degutting and cooking of fish; and handling fish food [38, 39]. The loading and bagging of fish-meal made from pilchards and anchovies may also result in high atmospheric allergen concentrations [38].

The proteins implicated in crustacean associated OA have similar molecular weights as those implicated in non-seafood OA such as flour (24%), laboratory animals (11.7%), or papad'n (34.5%) [43]. In both seafood and non-seafood OA, the pathophysiology appears to be IgE-mediated and from pulmonary exposure due to mechanized processes releasing atmospheric allergens in the workplace. Thus, the higher incidence of OA due to crustacean exposure compared to molluscs or other seafood species may be related to the work processes promoting aerosolization and not just to the type of protein itself. For example, the snow crab season is fairly short, but with fisherman and processors working intensive, extended hours. Additionally, post-catch processing for crab, shrimp, and prawns may aerosolize proteins. This gives a more concentrated exposure of allergens to the worker. This contrasts with the less intense fishing practices and minimal post-catch processing for molluscs, such as scallops and abalone, where the incidence of OA is less. This concept is further supported by reports of OA in cuttlefish fishermen. Those that develop OA are those that process cuttlefish in the holds of the fishing vessel with little ventilation [21]

**Table 1.** Routes of respiratory allergen exposure for species causing OA

Wet Aerosols from fresh products	Vapours during cooking	Dry Aerosols
Crab	Crab	Shrimp
Prawn	Lobster	Clam
Cuttlefish	Mussel	Fish
Fish (salmon, hake)		Anisakis
Anisakis		
Coral		
Hoya		

**Table 2.** Host risk factors for the development of OA

Atopy	Smoking habits
Snow crab	Prawns
Prawns	Snow crab
Shrimps	Mussels
Clams	Salmons
Lobsters	

## PREVENTION AND TREATMENT

Prevention strategies involve adequate ventilation and work process alterations that limit human respiratory exposure to seafood allergens. In one published report, reducing the respirable particulate ranges of allergens from a mean of 5 mg/m<sup>3</sup> to 0.01 mg/m<sup>3</sup> in the workplace reduced the prevalence of OA in a salmon processing plant from 8.2% to zero [23]. Additionally, in a prawn-processing factory, improvements in the ventilation that cut the atmospheric allergen concentration ten-fold resulted in the elimination of new cases of OA when the prevalence had previously been 36% [13]. Gautrin demonstrated that a high cumulative exposure to crab allergens was associated with OA, further supporting the theory that daily respiratory allergen exposure should be minimized [44].

When evaluating cases of potential OA, patient-related factors are important for consideration as well. These are summarized in table 2. Smoking is found to be a risk factor in developing OA after exposure to prawns, snow crabs, mussels, and salmon [5, 14, 18, 24]. Also, the presence of other previous or concurrent atopic conditions may predis-

pose the development of OA from snow crabs, prawns, shrimps, clams, and lobsters [5, 13, 15, 39]. Thus, smoking cessation, optimizing treatment of other atopic conditions, or job reassignment for workers with these predisposing conditions may be useful. Otherwise standard medical therapy is recommended for treatment and allergen avoidance as a prophylactic measure.

Snow crab asthma has a high clinical and social impact as the effects may remain long after exposure. In a 5-year follow-up of 31 cases, Malo demonstrated a slow improvement in FEV1 in the first year followed by a plateau of bronchial hyperresponsiveness at 2 to 5 years. Additionally, IgE levels are high at 2 years for 29% and 16% at 5 years. At the end of the follow-up, one-third of cases had an ongoing requirement for asthma medication [45]. This phenomenon was not demonstrated in our study since follow-up information was not typically available to the telemedicine service, which mainly treated acute cases.

## CONCLUSIONS

Occupational asthma is a significant problem in the commercial fishing and fish-processing industry. Crustaceans such as snow crabs, prawns, and molluscs are more common than fin fish in causing this disorder. Most cases result from an IgE-mediated hypersensitivity reaction after respiratory exposure to aerosolized fish and shellfish proteins. Preventive strategies such as ventilation improvements and work process changes that reduce atmospheric allergen concentrations have been shown to be extremely effective in reducing the burden of this occupational disease. In addition to standard medical therapy for asthma, special considerations may need to be made for patients who are smokers or who have other pre-disposing atopic conditions.

## REFERENCES

- Gautrin D, Newman-Taylor AJ, Nordman H, Malo JL. Controversies in epidemiology of Occupational asthma. *Eur Respir J* 2003; 22: 551–559.
- Lopata AL, Baatjies R, Throwser SJ, Jeebhay MF. Occupational allergies in seafood industry — a comparative study of Australian and South African workplaces. *Int Marit Health* 2004; 55: 61–73.
- Orford RR, Wilson JT. Epidemiologic and immunologic studies in process of the king crab. *Am J Ind Med* 1985; 7: 155–169.
- Endelman PA. Exposure, assessment and prevalence of asthma among maritime crab processing personnel. Paper presented at the American Hygiene Conference and Exposition 1994 May, Los Angeles, California.
- Cartier A, Malo JL, Forest F, Lafrance M et al. Occupational asthma in snow-crab processing workers. *J Allergy Clin Immunol* 1984; 74: 261–269.
- Cartier A, Lehrer SB, Horth-Susin L, Swabson M et al. Prevalence of crab asthma in crab plants workers in Newfoundland and Labrador. *Int J Circumpolar Health* 2004; Suppl 2: 333–336.
- Dorsett DD, Sechena R. Arctic snow crab-related lung disease. *Int J Circumpolar Health* 1998; 57 Suppl 1: 601–608.
- Anonymous. Morbidity and mortality weekly report. NIOSH publication 1982; 31: 95–96.
- Cartier A, Hunt B, Weytjens K et al. Occupational asthma to Atlantic rock crab processing workers in Eastern North America. *J Allergy Clin Immunol* 1999; 103: 179.
- Burel A, Camus F, Leroyer C, Dewitte JD. Allergies respiratoires dues aux homards chez un cuisinier. 1ères journées thématiques de la Société française de Médecine du Travail Paris- 28/01/95. *Arch Mal Prof* 1996; 294–296.
- Prakash C, Patel CP, Cockcroft DW. Occupational asthma caused by exposure to cooking lobster in the work environment: a case report. *Ann All* 1992; 68: 360–361.
- Lemière C, Desjardins A, Lehrer S, Malo JL. Occupational asthma to lobster and shrimp. *Allergy* 1996; 51: 272–273.
- Gaddie J, Legge JS, Reid TMS. Pulmonary hypersensitivity in prawn workers. *Lancet* 1980; 1350–1353.
- Mc Sharry C, McKay IC, Colloff M et al. The IgE and IgG antibody responses to aerosols of Nephrops Norvegicus (Prawn) antigens: the association with clinical hypersensitivity and with cigarette smoking. *Clin Exp Immunol* 1994 Sep; 97: 499–504.
- Desjardins A, Malo JL, L'archevêque J et al. Occupational IgE sensitization and asthma caused by clam and shrimp. *J Allergy Clin Immunol* 1995; 96: 608–617.
- Baur X, Huber H, Chen Z. Asthma to Gammarus shrimp. *Allergy* 2000; 55: 96.
- Musmand JJ, Daub CB, Lehrer SB. Crustacea allergy. *Clin Exp allergy* 1993; 23: 722–732.
- Glass WI, Power P, Burt R et al. Work-related respiratory symptoms and lung function in New-Zealand mussel openers. *Am J Ind Med* 1998; 163–168.
- Karlin JM. Occupational asthma to clam's liver extract. *J Allergy Clin Immunol* 1979; 63: 197.
- Goetz DW, Whisman BA. Occupational asthma in a seafood restaurant worker: cross-reactivity of shrimp and scallops. *Ann Allergy Asthma Immunol* 2000; 85: 431–433.
- Tomaszunas S, Weclawik Z, Lewinski M. Allergic reactions to cuttlefish in deep-sea fishermen. *Lancet* 1988; 1: 1116–1117.
- Clarke PS. Immediate respiratory hypersensitivity to abalone. *Medical Journal of Australia* 1979; 1: 623.
- Drosczcz W, Kowalski J, Piotrowska B, Pawlowicz A, Pietruszewska E. Allergy to fish in fish meal factory workers. *Int Arch Occup Environ Health* 1981; 49: 13–19.
- Douglas JD, McSharry C, Blaikie L, Morrow T, Miles S, Franklin D. Occupational asthma caused by automated salmon processing. *Lancet* 1995; 346: 737–740.
- Jeebhay MF, Robins TG, Lopata AL. World at work: fish processing workers. *Occup Environ Med* 2004; 61: 471–474.
- Rodriguez J, Reano M, Vives R et al. Occupational asthma caused by fish inhalation. *Allergy* 1997; 52: 866–869.
- Sherson D, Hansen I, Sigaard T. Occupationally related respiratory symptoms in trout-processing workers. *Allergy* 1989; 44: 336–341.
- Jeebhay MF, Robins TG, Miller ME, Bateman E et al. Occupational allergy and asthma among salt water fish processing workers. *Am J Ind Med* 2008; 51: 899–910.
- Armentia A, Lombardero M, callejo A et al. Occupational asthma by Anisakis simplex. *J Allergy Clin Immunol* 1998; 102: 831–834.
- Pulido-Marrero Z, Gonzales-Mancebo E, Alfaya-Arias T et al. Unusual sensitization to Anisakis simplex. *Allergy* 2000; 55: 586.
- Scala E, Giani M, Pirrota L, Guerrea EC et al. Occupational generalised urticaria and allergic airborne asthma due to Anisakis simplex. *Eur J Dermatol* 2001; 11: 249–250.

32. Onizuka R, Inoue K, Kamiya H. R-induced allergic symptoms observed in spiny lobster fishermen. *Aerugi* 1990; 39: 339–347.
33. Jyo T, Komoto K, Tsuboi T et al. Sea squirt asthma-occupational induced by inhalation of antigens substances contained in sea squirt body fluid. *Allergy Immunology (Leipzig)* 1974/75; 20/21: 435–448.
34. Madsen J, Sherson D, Kjoller H, Rasmussen K. Occupational asthma caused by sodium disulphite in Norwegian lobster fishing. *Occup Environ Med* 2004; 61: 873–874.
35. Fraj J, Lezaun A, Colas C, Duce F, Dominguez MA, Alonso MD. Occupational asthma induced by aniseed. *Allergy* 1996; 51: 337–339.
36. Bessot JC, Moreau L' Asthme aux allergènes d'origine végétale. In: Bessot JC, Pauli G, ed «l'asthme professionnel». Paris: Margaux Orange 1999; 231–264.
37. Cartier A, Malo JL, Ghezze H, Mccants M, Lehrer SB. IgE sensitization in snow crab processing workers. *J Allergy Clin Immunol* 1986; 344–348.
38. Jeebhay MF, Robins TG, Seixas N et al. Environmental exposure characterisation of fish processing workers. *Ann Occup Hyg* 2005; 49: 423–437.
39. Jeebhay MF, Robins TG, Lehrer SB, Lopata AL. Occupational sea-food allergy: a review. *Occup Environ Med* 2001; 58: 553–562.
40. Onizuka R, Kamiya H, Muramoto K et al. Purification of the major allergen of Red-Soft Coral. *Int Arch Allergy Immunol* 2001; 125: 135–143.
41. Malo JL, Chrétien P, McCants M, Lehrer S. Detection of snow-crab antigens by air sampling of a snow-crab production plant. *Clin Exp Allergy* 1997; 27: 75–78.
42. Beaudet N, Brodtkin CA, Stover B et al. Crab allergen aboard five crab-processing vessels. *AIHA Journal* 2002; 63: 605–609.
43. Becklake MR. Epidemiology: prevalence and determinants. In: Bernstein, Chan-Yeung, Malo, Bernstein, eds. *Asthma in the workplace*. New York: Marcel Decker, 1993: 29–59.
44. Gautrin D et al. Occupational asthma and allergy in snow crab processing in Newfoundland and Labrador. *Occup Environ Med* 2010; 67: 17–23.
45. Malo JL, Cartier A, Ghezze H et al. Patterns of improvement in spirometry, bronchial hyperresponsiveness, and specific IgE antibody levels after cessation of exposure in occupational asthma by snow-crab processing. *Am Rev Respir Dis* 1998; 138: 807–812.