

Surfer's asthma

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ABSTRACT

Common asthma triggers during recreational activities include allergen exposure, concomitant viral infection, and exercise. We present the case of a 42-year-old man with a 2-year history of wheezing, chest tightness, and upper respiratory symptoms that were associated with surfing. He denied symptoms with other forms of exercise and had no personal history of asthma. His physical exam was unremarkable and his pre- and postbronchodilator spirometry was normal. After detailed history and keen observation on the patient's part, a diagnosis was made and he enjoyed good response to the therapy for this condition. Underrecognized asthma triggers and exposures in the recreational environment should be investigated.

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Key words: Allergic, asthma, brevetoxin, environmental exposures, harmful algae, irritant asthma, recreational exposures, red tide, rhinitis, surfing

CASE PRESENTATION

Chief Complaint

Wheezing and chest tightness

History of Present Illness

A 42-year-old male university researcher and professor in San Diego presented with a complaint of wheezing and chest tightness. He has been an avid surfer from childhood; from his mid-30s, he noticed a feeling like he “caught a cold” with nasal ocular symptoms, chest tightness, and wheezing associated with days when he surfed. He had no difficulties while he surfed, however, he would note the symptoms ~2–3 hours later. This syndrome would last ~1–2 days and then self-resolve. He did not develop these symptoms after other forms of exercise.

Because he lives in close proximity to the beach, he has been able to observe the bioluminescent glow of the red tides in the evenings. Over an approximate 2-year time span, he noticed the association with symptom that would occur on days when he saw the red tide glow and less so during seasons that were not associated with red tides (Figs. 1 and 2).

Medical History

Medical history was notable for perennial allergic rhinitis, with skin test positive to pollen, dust mites, and cockroaches. He denied history of asthma or wheezing associated with exercise or viral infections and he was a lifelong nonsmoker. He was not taking any medications. Family history was noncontributory. Social history did not reveal any exposure to sick contacts.

Physical Examination

Vital signs were normal. The patient's conjunctivae were clear, his nasal passages showed normal pink turbinates, and his ear canals showed exostosis, consistent with his many years of surfing in cold wind and water. There was no lymphadenopathy. His lungs were clear without wheezes, rales, or ronchi. The rest of his exam was unremarkable.

Diagnostic Studies

At baseline, his pulmonary function testing was normal with a forced expiratory volume at 1 second of 4.39 L, which is 102% predicted. No reversibility was seen after a bronchodilator treatment. Methacholine challenge was deferred.

QUESTION 1

What is the differential diagnosis of these respiratory complaints?

- a. Exercise-induced asthma
- b. Allergic asthma
- c. Recurrent viral infection and asthma
- d. Irritant or toxin-induced asthma

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Disclaimers: None

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Figure 1. Red Tide caused by Dinoflagellates off the Scripps Institution of Oceanography Pier, La Jolla, California. (Credit: Wikipedia)

QUESTION 2

Are There Any Additional Diagnostic Studies That Would Be Helpful in Arriving at the Diagnosis?

Given his observations, exposures during surfing, and duration of symptoms, spirometry within 24 hours of surfing would be helpful. However, there was scheduling difficulty in obtaining one. Our presumptive diagnosis of red tide-associated asthma would have been validated by challenge with the toxin associated with red tides; however, the toxin is not commercially available for testing.

Clinical Course

He did not want to stop surfing but wanted to prevent the symptoms associated with the red tides. Prophylactic inhaled fluticasone/salmeterol 250/50 was prescribed, which he used twice daily starting 2 days before surfing in red tides with prevention of symptoms.

DISCUSSION

Asthma is a heterogeneous disease in which environmental factors are strongly associated with disease manifestation. Despite the increasing prevalence of asthma worldwide, recreational exposures are often overlooked. One less commonly known and recognized trigger is exposure to aerosolized brevetoxin, produced by the marine dinoflagellate *Karenia brevis*.

Red tides are harmful algal blooms of *K. brevis* and other regional dinoflagellates, which occur annually in the Gulf of Mexico and in many other parts of the world. They have gained notoriety in the media and literature in association with neurological and gastrointestinal illness from ingestion of the heat stable toxin, which causes neurotoxic shellfish poisoning; it is less commonly known for the effects on upper and lower airways.^{1,2} Cases of brevetoxin associated syndromes have been described mostly in Florida where the blooms may last for months along the entire coastline. However, many coastal communities around the world have described these occurrences, including the Mediterranean coast, New Zealand, and Japan.^{3,4}

In humans, exposure to aerosolized brevetoxin results in conjunctival irritation, and inhalation may cause rhinorrhea, wheezing, cough, and chest tightness; individuals with underlying airway disease, *i.e.*, asthmatic patients, are particularly susceptible, but healthy individuals may also be affected. Both allergic and nonallergic subjects react to red tide exposures.⁵⁻⁷

Brevetoxins are potent lipid-soluble polyether neurotoxins with at least nine structurally related forms isolated. They are depolarizing substances that activate voltage-sensitive sodium channels; this can cause uncontrolled sodium influx and excitability of affected cells.¹ In the lower airways, this can equate to significant bronchoconstriction; *ex vivo* human bronchial smooth muscle cells contract with exposure to brevetoxins and *in vivo* animal models also show significant bronchoconstriction. Picograms of brevetoxins have been found to be equally potent to micrograms of leukotriene D₄, which is considered one of the most potent bronchoconstrictors in asthma.^{7,8}

Additional studies have shown that brevetoxin-induced bronchoconstriction may be blocked by atropine, cromolyn, topical corticosteroids, leukotriene modifying drugs, and H₁-antagonist; therefore, brevetoxin appears to be a potent toxin acting by both cholinergic and histamine (H₁)-related mechanisms (see Fig. 3). The β_2 -adrenergic agents will rapidly reverse the bronchoconstriction after exposure to near baseline levels (see Fig. 4). Recently, bradykinin B₂-receptor antagonist (HOE-140) was also found to decrease the response to brevetoxin, suggesting that kinins are released after toxin inhalation and may be involved in this process.⁹

Fleming *et al.*^{5,6} recently published a study of physician-diagnosed asthmatic patients showing statistically significant decrease in forced expiratory volume at 1 second and increased symptomatology after spending 1 hour walking on the beach during active red tides compared to when there was no active red tide. In

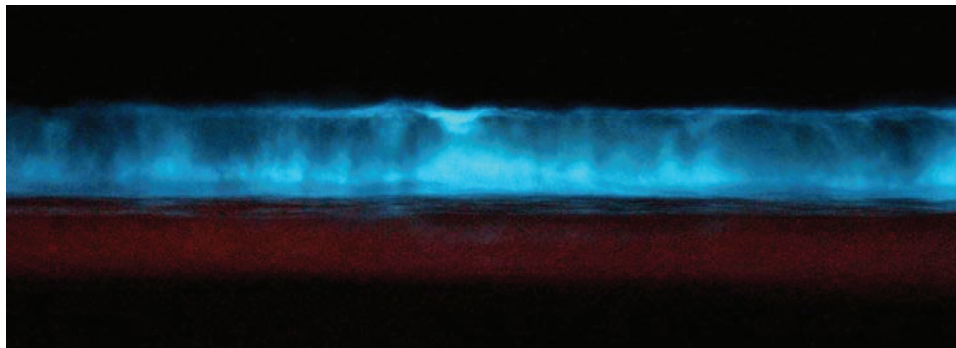


Figure 2. Image of bioluminescent red tide event of 2005 at a beach in Carlsbad, California. (Credit: Wikipedia)

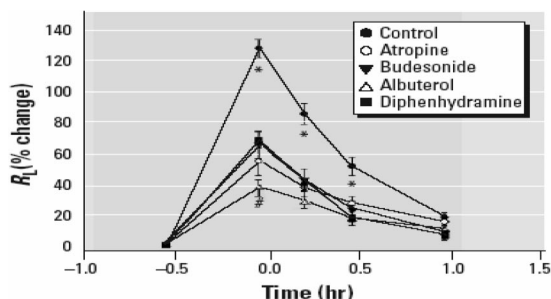


Figure 3. Effect of pharmacologic agents on brevetoxin-induced bronchoconstriction. Crude brevetoxins produced an immediate increase in R_L , which then returned to baseline values within 1 hour. Pretreatment with atropine, budesonide, albuterol, and diphenhydramine all reduced the toxin-induced response. Values are mean $\pm$ SE for five sheep. * $p < 0.05$ versus all others; # $p < 0.05$ albuterol versus diphenhydramine. (Reproduced with permission from Ref. 9.)

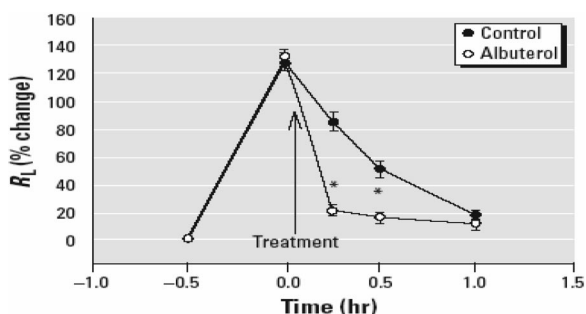


Figure 4. Reversal of crude brevetoxin-induced bronchoconstriction with albuterol. Values are * $p < 0.05$ versus untreated. (Reproduced with permission from Ref. 9.)

Florida, where this is an annual occurrence, there is much interest and environmental monitoring for red tides. However, in other parts of the world, where red tides may be more intermittent, such as in southern California, there is no monitoring and, therefore, less awareness of when this toxin may be affecting individuals who are coastal residents or frequent the beaches for both recreational or occupational reasons, such as lifeguards and the military (i.e., navy seals, marines, etc.). Because occupational asthma comprises 9–15% of

adult asthma, brevetoxin should be an etiologic consideration in exposed patients.¹⁰ Backer examined this effect in healthy lifeguards in Florida showing increased upper respiratory symptoms and decreases in spirometry during exposed periods compared with unexposed periods after 8-hour shifts; she also evaluated and saw similar trends in recreational beachgoers.^{11,12} In addition, studies show that aerosols of brevetoxins have been measured ≥ 1 mile inshore. A recent study also indicated an increased rate of respiratory-related complaints in the local emergency department during the red tides.¹³

Because the red tides are quite variable, morbidity may be associated with the levels of toxin, length of exposure, and preexisting respiratory disease. Given the variability and lack of knowledge on the levels of toxin in the environment and lack of readily available diagnostic testing for brevetoxin, health care professionals and the general population should be educated on this potential health risk and exposure.¹ Long-term consequences of repeated exposure are unknown. The possibility of this toxic exposure should be considered in patients who live near the beach or spend time on the beach. At this time, there is no known monitoring for red tides in San Diego and it is, therefore, difficult to assess the degree of concern for this toxin. Furthermore, the winds and waves are more powerful along the Pacific coastline, which may result in increased release and exposure further inland. More studies and awareness may be needed to better assess the health impact of brevetoxin and other harmful algal blooms.

Final Diagnosis

Red tide (brevetoxin)-associated asthma.

SUMMARY/CONCLUSION

Exposure to aerosolized brevetoxins during red tides is an underrecognized trigger for asthma. It can produce upper and lower respiratory symptoms that may be prevented and treated with standard pharmacotherapeutics for allergies and asthma.

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