

Exacerbation of Asthma by Florida “Red Tide” During an Ocean Sailing Trip

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A 36-year-old man with adult-onset nonallergic triad asthma developed acute bronchospasm and copious sputum production during an offshore sailing excursion on the Gulf Coast of Florida. Symptoms were linked to proximity to blooms of the marine dinoflagellate *Karenia brevis* (“red tide”) and heavy aerosolized brevetoxin exposure, and symptoms recurred during rechallenge. Patients with respiratory disease who are planning a visit to red tide-prone seaside areas should be cautioned to bring their pulmonary medications, and clinicians should be aware that reactive airway symptoms may be triggered by exposure to red tide.

Mayo Clin Proc. 2007;82(9):1128-1130

Because of overgrowth of marine dinoflagellates, “red tides” occur regularly in the Gulf of Mexico and other coastal areas, forming patchy greenish-brown or dark-brown slicks on the surface of the sea that may stretch many miles.^{1,2} Along Florida’s Gulf Coast, red tides are an annual event caused by blooms of the marine dinoflagellate *Karenia brevis*, resulting frequently in fish kills and occasionally in marine mammal deaths (eg, dolphins and the endangered West Indian manatee).³

Although dinoflagellate communal growth patterns are poorly understood, the fragile *K brevis* organisms are now recognized to release highly potent natural polyether toxins, known as brevetoxins, that can activate mammalian voltage-sensitive epithelial sodium channels.³⁻⁶ In addition to the well-documented neurotoxicity of these organisms’ waterborne toxins, aerosolized brevetoxins have been shown to cause upper and lower respiratory irritation in both in vitro and live animal studies.⁶⁻¹² Anecdotal evidence (eg, from increased respiratory complaint–related emergency department admissions in affected areas during periods of high red tide growth¹³) also suggests that brevetoxins may cause respiratory problems in beachgoers, particularly in those with chronic pulmonary disease.^{4,14-16} However, only a few controlled human studies of inhalational brevetoxin exposure have been conducted: in 1 trial in healthy persons, no effect on pulmonary function was demonstrated, whereas studies of patients with typical asthma documented increased symptoms after a 1-hour beach stay during red tide blooms, accompanied by small but statisti-

cally significant postexposure decreases in forced expiratory volume in 1 second (FEV₁), forced expiratory flow between 25% and 75% of lung volume, and peak expiratory flow.¹⁷⁻¹⁹

In view of the potential health effects of inhalational brevetoxin exposure, some visitor and convention bureaus recommend that asthmatic patients bring a rescue inhaler on trips to red tide-prone areas of Florida, but the issue has long been downplayed by local tourism officials, especially because most healthy persons on the beach apparently experience the windborne aerosolized toxins as only mild mucosal irritants.¹⁴ Perhaps as a consequence, physicians may be more familiar with acute gastroenteritis or neurologic symptoms (including paralysis) after ingestion of toxin-contaminated shellfish^{2,20} than with brevetoxin-induced respiratory complications, and research on aerosolized dinoflagellate toxins has lagged behind studies focused on waterborne toxin transmission.^{4,21} In addition, clinical reports have been limited primarily to symptoms that develop in beachgoers or in workers with occupations that bring them near beaches.^{15,18} I report a case of exacerbation of nonallergic intrinsic asthma that is clearly associated with close contact with red tide blooms while the patient was aboard a sailing vessel—a novel “vehicle of exposure.”

REPORT OF A CASE

A 36-year-old Minnesota man returned from a trip to Sarasota, FL, and presented to Mayo Clinic Rochester complaining of wheezing, chest tightness, and cough productive of clear sputum that began during a coastal ocean sailing excursion. The patient’s general health was good, but he had a 2-year history of mild adult-onset nonallergic triad intrinsic asthma (Widal syndrome—nasal polyposis, asthma, and nonsteroidal anti-inflammatory drug sensitivity²²), a diagnosis that had been based on a consistent clinical history and physical examination supported by documentation of sputum eosinophilia and abnormal methacholine-challenge spirometry (FEV₁ and maximal forced expiratory flow rate 90% and 108% of predicted, respectively, obtained during an asymptomatic period, but with a 31% decrease in FEV₁ and reproduction of symptoms after inhalation of 25 mg/mL of methacholine, and complete recovery after bronchodilator use). No peripheral

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blood eosinophilia was observed, the patient's IgE level was not measured, and both the chest radiograph and a contrast agent-enhanced chest computed tomogram obtained at the time of diagnosis were unremarkable.

Before the sailing excursion, the patient's symptoms were well controlled with oral montelukast sodium, nasal fluticasone spray, inhaled fluticasone propionate/salmeterol xinafoate, and rare use of albuterol (ie, approximately once per month), along with strict avoidance of aspirin and nonsteroidal anti-inflammatory drugs. Skin prick testing for allergic sensitization to 48 common mold, tree, weed, grass, and animal/insect allergens had been entirely negative on 2 occasions. The patient had a distant history of eczema, no history of childhood asthma, and a strong family history of asthma (3 affected first-degree relatives). He had visited an emergency department only once with respiratory symptoms and had never required inpatient hospitalization. At the time of the sailing excursion, the patient had been completely asymptomatic for more than a month.

The patient sailed on a 41-foot ketch-rigged vessel through Sarasota Bay, around the barrier keys, and out into the Gulf of Mexico. Weather conditions on the day of exposure included Beaufort 1 to 3 seas, steady winds at 5 to 10 knots out of the northeast (ie, blowing off the land rather than over water and therefore expected to result in few complaints among beachgoers), air temperatures of 33°C to 34°C, and high ambient humidity (>90%). The Florida Fish and Wildlife Conservation Commission and the Sarasota County Department of Health reported very high levels of *K brevis* organisms (>1 million cells/L) in the waters of Sarasota Bay during the week of the patient's travel (www.floridamarine.org) with large areas of surface discoloration from marine blooms. The patient claimed that he had never seen red tide before, had no previous exposure to Florida's Gulf Coast, and was unaware of a possible connection between dinoflagellates and respiratory irritation.

Shortly after leaving shore, the patient's boat approached a patch of sea that was discolored by a thick bloom of red tide, demarcated by a long line of limp dead fish. The vessel's passengers began to cough and complain of eye and throat irritation. Once the area of the red tide bloom had been passed, symptoms dissipated quickly. All day long, as the boat tacked and jibed across areas of red tide, this symptom pattern repeated, with the patient's symptoms beginning about 20 meters from the edge of the bloom and diminishing a few minutes after crossing the discolored area. When red tide was encountered, the patient developed symptoms even when he was below deck and could not see the ocean; "going above" confirmed that a red tide area had again been entered. Eventually, the patient began to wheeze audibly and produce copious sputum, symptoms that required repeated use of a short-acting in-

haled bronchodilator (albuterol) and that no longer quickly regressed after passing the red tide line. Returning to the marina, the boat crossed a final, particularly long red tide bloom, and the patient became severely symptomatic. He continued to cough and wheeze after disembarking. His symptoms became tolerable only after he used his short-acting bronchodilator multiple times, ingested caffeine, and returned to an air-conditioned environment. The patient did not seek local medical attention in Florida because of concerns about health care reimbursement. His breathing returned to normal after approximately 48 hours.

DISCUSSION

The pathophysiology of adult-onset nonallergic triad asthma may be distinct from more typical atopic asthma, but nonspecific mucosal irritants can trigger symptoms in either setting.^{23,24} The mechanism of action of brevetoxin-induced bronchospasm, which is independent of T-cell-mediated pathways, might be expected to cause symptoms in persons with sensitive respiratory epithelia of any etiology. Atropine- and diphenhydramine-mediated protection from brevetoxin effects in an *Ascaris* airway-hypersensitive sheep model suggests that both cholinergic (vagal) and histamine-mediated pathways contribute to the bronchoconstriction.^{9,18} Among the various harmful algal blooms found around the world's oceans, Florida red tide poses particular respiratory risks because *K brevis*, which is extremely fragile, can be easily ruptured and aerosolized in the crashing surf and because it produces toxins that can trigger mast cell histamine release.^{9,25}

One unique aspect of the current case is that the patient involved had no exposure to the beach environment, the typical vector, instead encountering red tide toxins while aboard a small sailing vessel. Indeed, given the steady winds blowing off the land, beachgoers would have been expected to be relatively free of symptoms, and a boat was the only straightforward way to encounter the aerosolized red tide toxin. Described risks of recreational or competitive sailing have generally been limited to musculoskeletal injuries, hypothermia and skin injury from exposure to the elements, accidental drowning, and illnesses transmitted from person to person or related to dietary deficiency or excessive alcohol consumption.²⁶ To my knowledge, this is the first report in the medical literature that describes respiratory illness in a sailor from inhaled marine biotoxins.

CONCLUSION

Toxins produced by Florida red tide organisms can cause symptoms in susceptible patients, especially those with reactive airways. Physicians who learn that asthmatic pa-

tients are planning a holiday (including a cruise) in Florida or another red-tide-prone area²⁷ should consider warning them about the possibility of red-tide-induced respiratory symptoms and encourage them to bring adequate supplies of pulmonary medications, including short-acting bronchodilators if indicated.

I thank the patient for permission to report his case.

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