What Is Your Diagnosis?

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Aquarism: An Innocent Leisure Activity?

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Case Report

Two men and 1 woman aged between 21 and 23 years were admitted to the hospital in the 2 h following the new installation of a home aquarium due to dyspnea at rest, dry cough, nausea, headache, fever and chills. The bottom of the aquarium had been covered with coral sand, filled with fresh water and finally commercially available sea salt had been added, which created some foam and mist. Lastly, they placed a piece of dead coral decorated with crust sea anemones on the bottom. A few minutes later the 3 subjects developed an itchy nose and the symptoms described above. The use of illicit drugs or occupational exposures to inhalation agents was denied by all subjects. One subject suffered seasonal asthma treated with an on-demand short-acting bronchodilatator and another reported to be an occasional cigarette smoker.

Representative of the 3 patients, we describe the physical examination and findings of the 23-year-old nonsmoking male. He appeared sick on admission, his blood pressure was normal and heart and respiratory rates were 121 beats/min and 25 breaths/min, respectively. Arterial oxygen saturation breathing room air was 93% and body temperature was 40°C. Fine crackles were heard on both lung bases without wheezing. Skin and oropharyngeal mucosa inspection were unremarkable, as was the remainder of the physical examination. The arterial blood gas analysis breathing room air showed severe hypoxemia (pH 7.36, PaO_2 5.6 kPa, $PaCO_2$ 6.4 kPa). A similar level of hypoxemia was present in the 2 other subjects. All 3 patients presented a marked leukocytosis and a mild increase of the lactate dehydrogenase plasma level. The chest x-rays on admission were normal. Because of the further worsening of the respiratory failure, a CT scan of the chest was performed (day 2). This showed similar changes in all subjects consisting of zones of patchy, pleural-based consolidation at both lung bases (fig. 1). On the second day, fever persisted and inflammatory parameters rose further (C-reactive protein to 193.3 mg/l, procalcitonin to 12.82 ng/ml and leukocytosis to 27.6 × 10^9/l). Although the criteria for systemic inflammatory response syndrome were fulfilled, antibiotic treatment had been withheld in consideration of the low likelihood of bacterial infection. A pulmonary function test (day 3) showed a restrictive ventilatory pattern and a normal diffusion capacity (fig. 2).

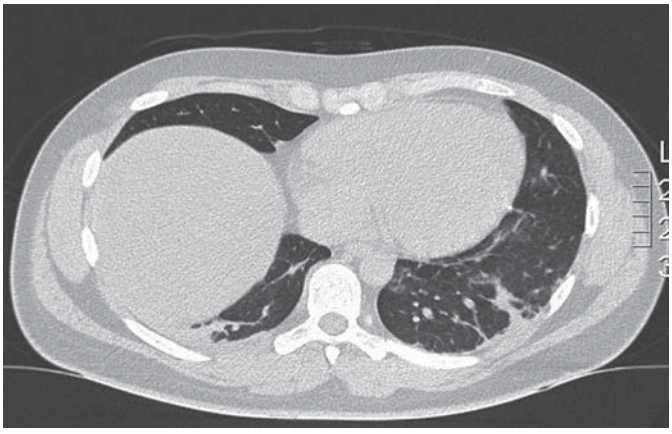

Fig. 1. High-resolution computed tomography of the chest (day 2).

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Table 1. Body plethysmography and spirometry of the reference patient 3 days after admission and at the follow-up visit (day 15)

	Predicted	Day 3	% of predicted	Day 15	% of predicted
Vital capacity, liters	5.45	3.26	59.8	4.89	89.8
TLC, liters	7.06	4.27	60.5	5.61	79.4
RV/TLC, %	23.71	23.74	100.1	12.79	53.9
VCmax, liters	5.45	3.26	59.8	4.87	89.4
Forced vital capacity, liters	5.21	3.26	62.6	4.83	92.8
FEV_1, liters	4.40	2.76	62.8	4.30	97.9
FEV_1/VC_{max}, %	82.71	84.74	102.5	88.37	106.8
Peak flow, l/s	9.94	7.00	70.4	12.45	125.3
$DLCO_c$, mmol/min/kPa	11.98	10.21	85.2	10.14	84.6
$DLCO_c$/VA, mmol/min/kPa/l	1.70	2.38	140.1	1.81	106.7
VA, liters	6.91	4.30	62.2	5.60	81.1

RV = Residual volume; TLC = total lung capacity; VCmax = maximal vital capacity; FEV1 = forced expiratory volume in 1 s; DLCOc = diffusion capacity for carbon monoxide corrected for hemoglobin; VA = alveolar volume.

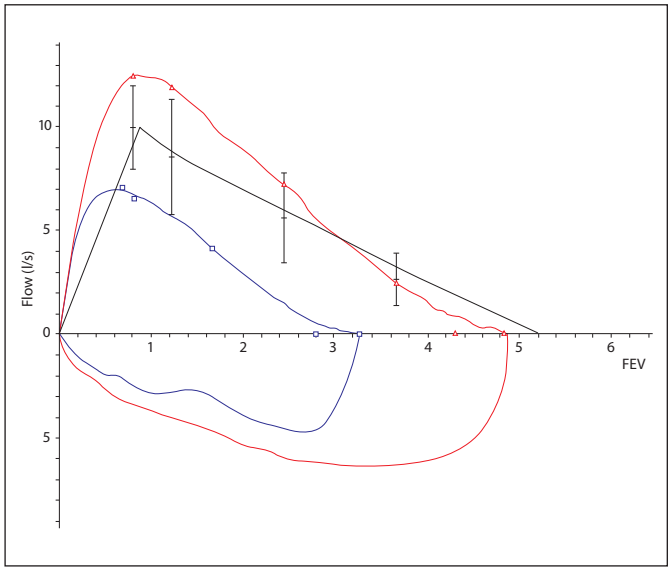

Fig. 2. Flow-volume curves at day 3 (blue curve) and day 15 (red curve). Predicted flow-volume curve is in black.

Fig. 3. Photograph provided by the patients of the aquarium showing anemones of the *Palythoa* species placed on a coral block.

Flexible bronchoscopy (day 3) revealed mild diffuse bronchial swelling with clear bronchial secretion. The bronchoalveolar lavage was slightly turbid and showed an elevated cell count with a predominant granulocytic inflammation pattern (absolute count 705 10^9/l; alveolar macrophages 46%, neutrophils 49%, lymphocytes 2%, eosinophils 3%). The cultures from this sample remained sterile and polymerase chain reactions for respiratory viruses were negative. The respiratory symptoms resolved completely on day 3 and all patients were discharged the next day. The lung function test had returned to the normal range at the follow-up visit 2 weeks later (fig. 2; table 1).

The patients were asked to precisely review the sequence of events prior to the development of the symptoms. On an Internet blog for aquarists, they found other people reporting similar complaints and linked them to the crust anemones they had used as decorative elements in the aquarium. They also provided a photograph of the crust anemones from their aquarium (fig. 3).

What is your diagnosis?

Diagnosis: Palytoxin-Induced Acute Pneumonitis

The history and sequence of events suggest an inhalative exposure as the cause of the severe respiratory failure. The short time between exposure and the development of symptoms make an infectious etiology very unlikely. Moreover, the simultaneous affliction of three people after a single exposure and the predominant neutrophils in the bronchoalveolar lavage with very low eosinophil counts make an extrinsic allergic alveolitis unlikely too. The fast recovery after withdrawal of the causative agent suggested a toxic pathogenesis. Toxic reactions to inhalation of highly concentrated salt aerosols or salt contaminated by organic toxins can be supposed, but to our knowledge, has not been reported thus far.

With the help of a marine biologist, we could identify the crust anemones as belonging to the *Palythoa* species. Anemones are polyps which live at the bottom of the sea and form colonies and build crusts and massive skeletons, and are therefore used for decorative purposes by aquarists. *Palythoa* anemones carry palytoxin (PLTX), which is thought to be the most deadly nonproteinaceous toxin ever isolated. In fact, the median lethal intravenous dose to kill 50% of exposed animals (LD50) ranges between 0.03 and 0.45 μg/kg in mammals, putting it in the same class of toxicity as botulin. PLTX was first isolated and described in 1971 from *Palythoa toxica.* Subsequently, it was found in different members of the *Palythoa* species and other marine animals. Even though PLTX was first found in *Palythoa* anemones, its primary source may be weed of the *Ostreopsis algae* species [1]. PLTX is a large nonproteinaceous molecule that converts the Na-K-ATPase into a cation-selective ion channel allowing passive transport of sodium and potassium, thereby destroying the ion gradients and membrane resting potential. Secondary calcium influx leads to depolarization and cell dysfunction [2]. In animal models, PLTX was extremely potent by intravenous, intraperitoneal and intratracheal exposure [3] causing respiratory distress and paralysis. Despite its high toxicity in terrestrial animals, PLTX does not cause deleterious effects in maritime predators, who feed on anemones. Therefore, PLTX accumulates within the maritime food chain [1, 4, 5] and reports of human poisonings after fish meals have been reported. Patients usually present a few hours after these meals with dyspnea, chest pain and myalgia, often suffering from severe rhabdomyolysis [6]. There are also concerns of direct myocardial and brainstem damage leading to cardiorespiratory arrest. Besides oral intake, transdermal [7] and respiratory routes of intoxication have been reported. Gallitelli et al. [8] described 28 subjects suffering from rhinorrhea, cough, dyspnea and fever after bathing at the beach of Bari, Italy, while there was a bloom of *Ostreopsis* algae. In July 2005, having spent time on beaches around the city of Genoa, about 200 people sought medical treatment for respiratory symptoms and PLTX was detected in the coastal waters [9].

We have reported the first case series of 3 subjects developing a potentially life-threatening respiratory failure after exposure to an aerosol resulting from the manipulation of anemones of the *Palythoa* species after the installation of an aquarium. We have described a restrictive ventilatory pattern with a predominantly granulocytic acute alveolar inflammation causing significant hypoxemia [10]. The detection of PLTX remains challenging and not widely available. Liquid chromatography is a valuable tool for detection but optimization and validation of the test are still necessary. This method was unfortunately not available in our setting. Little doubt remains, however, about the causative agent due to the presence of *Palythoa* anemones known to produce PLTX.

The treatment of PLTX poisoning is supportive. Unfortunately, an antidote against PLTX is not available and specific treatment options have not been tested on humans. In animal studies, however, sublethal doses of PLTX given intragastrically and intravenously have produced elevated plasma cortisol concentrations and protect against subsequent lethal intravenous challenge. Pretreatment with hydrocortisone has also provided partial protection against lethal doses of the toxin. This data suggests at least a partial effectiveness of steroids against PLTX toxicity.

Worldwide (including Switzerland), the trade of animals for aquaria is mostly regulated based on CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Potential toxicity is not taken into account before the sale. This is confirmed by a recent study assessing the availability and potential exposure of PLTX to marine aquarium hobbyists performed in the USA: PLTX was isolated in a dangerous concentration from a relevant number of species of anemones commonly sold in the home aquarium trade [11].

In conclusion, we underline the dangers linked to the use of anemones as decorative species for aquaria. The trade of these animals, which may cause potentially life-threatening intoxication, is not regulated on the basis of their toxicity. The dangers are mostly unrecognized and underestimated by aquarists and aquarium store owners. The inhalative exposure to waters or aerosols containing PLTX can induce severe toxic reactions leading to hospi-

tal admission and life-threatening conditions. Better customer information and regulations are required. Furthermore, every endeavor should be undertaken in order to minimize the possibility of contact to the toxin. Considering the extremely high toxicity and described means of intoxication, we advise against handling anemones when having skin wounds and recommend always using protective gloves and a facemask.

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Financial Disclosure and Conflicts of Interest

No authors have any actual or potential conflict of interest including any financial, personal or other relationships that can influence or bias this work.

Key Words

Palythoa anemones · Palytoxin · Hypoxemia

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