Florida Red Tide and Human Health: Medical Perspectives

Top 10 Questions facing Health Professionals

Prepared for the
Aquatic Toxins Program
Division of Environmental Health
Florida Department of Health
under
Centers for Disease Control and Prevention
Grant #U50-CCU423360-01

by
Mote Marine Laboratory
Center for Ecotoxicology
Environmental Health Program
Sarasota, Florida

September, 2004

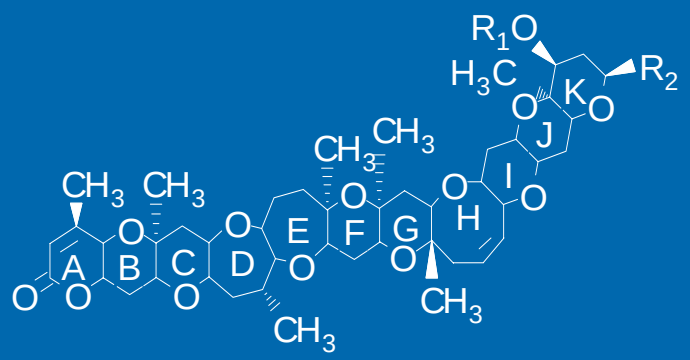
Aerial Photograph of Florida Red Tide in SW Florida Gulf of Mexico

Florida Red Tide Organism

Karenia brevis
(Gymnodinium breve)

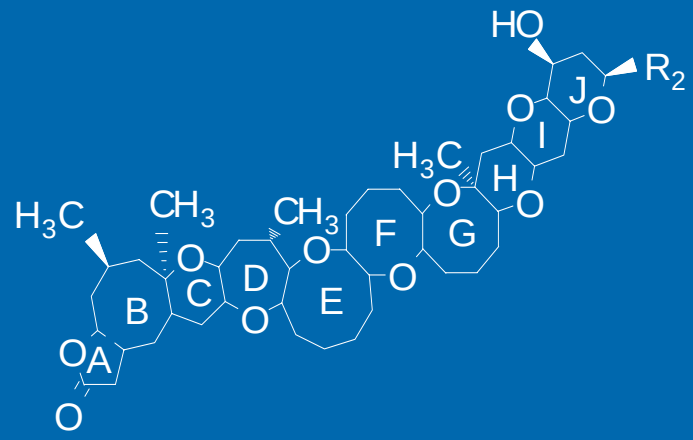
- Photosynthetic – produces oxygen
- Blooms - millions of cells / liter
- Annual blooms in Gulf of Mexico
- Swims upward, sinks downward
- Produces a chemical/toxin
- Wind and wave action aerosolize toxins

Florida Red Tide Toxins called Brevetoxins



PbTx-2

	R1	R2
PbTx-2:	H	$CH_2C(=CH_2)CHO$
PbTx-3:	H	$CH_2C(=CH_2)CH_2OH$
PbTx-5:	CH_3CO	$CH_2C(=CH_2)CHO$
PbTx-6:	H	$CH_2C(=CH_2)CHO$ 27,28 epoxide
PbTx-8:	H	$CH_2C(=CH_2)COCH_2Cl$
PbTx-9:	H	$CH_2CH(CH_3)CH_2OH$



PbTx-1

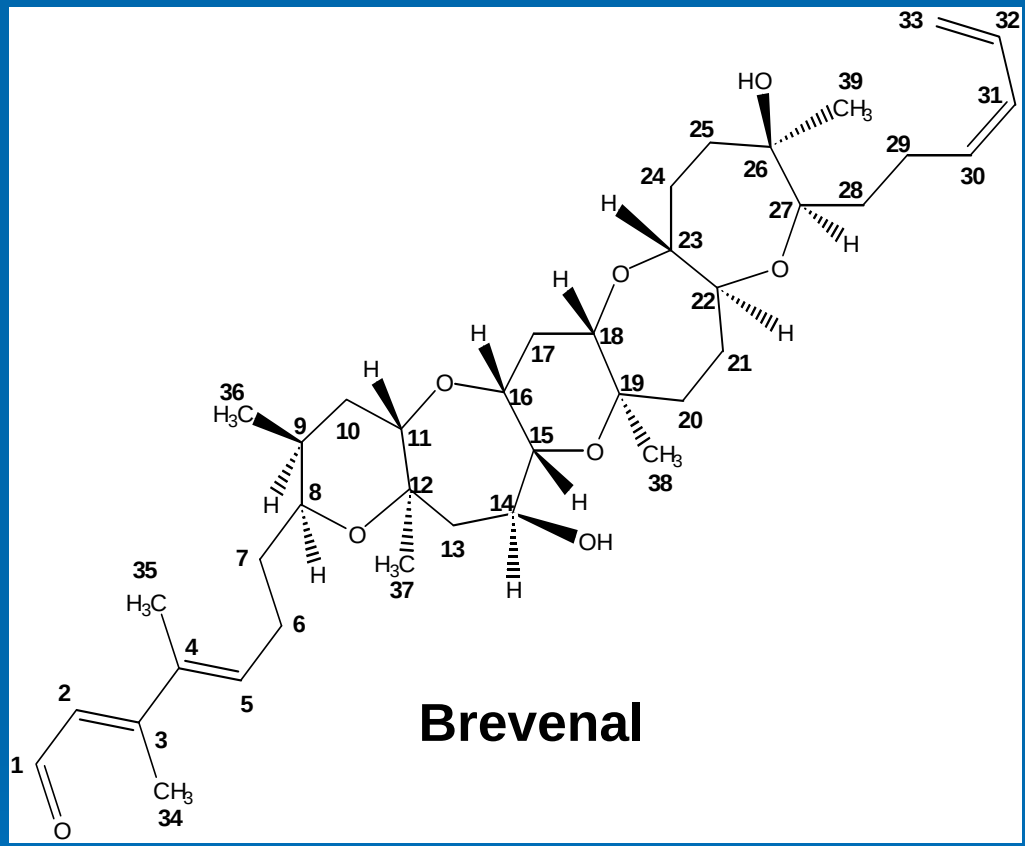
	R1	R2
PbTx-1:	H	$CH_2CH(CH=CH_2)CHO$
PbTx-7:	H	$CH_2CH(CH=CH_2)CH_2OH$
PbTx-10:	H	$CH_2CH(CH_3)CH_2OH$

Comparison of Potency†

Toxin	Vital Site	Potency Oral Inhalation
Tetrodotoxin, Saxitoxin	Na Channel Site 1	< 0.3 μMol/kg NA < 0.3 μMol/kg NA
Brevetoxin, Ciguatoxin	Na Channel Site 5 (depolarizer)	~0.22 μMol/kg 1fMol/L air ~0.0003 μMol/kg NA
Okadaic Acid, Microcystin	Protein Phosphatase 1*, 2a**	~0.25 μMol/kg NA ~14.0 μMol/kg NA
Domoic Acid, Kainic Acid	CNS GLuR5/6 & KA1/2 Receptors	~40 μMol/kg NA ~40 μMol/kg NA

†from Botana "Seafood and Freshwater Toxins", Marcel Dekker, 2000

Toxin Derivatives



- Natural Antagonists (3-7 rings, common side chains)
- Photodecomposition products (relevant to aerosols)

Question 10

- Is it safe to eat fish during a Florida red tide?

YES!!

✓ As long as the fish acts ‘normal’ on the hook- vigorous/fighting

✓ Eat ONLY the filleted meat – no organs/entrails

Question 9

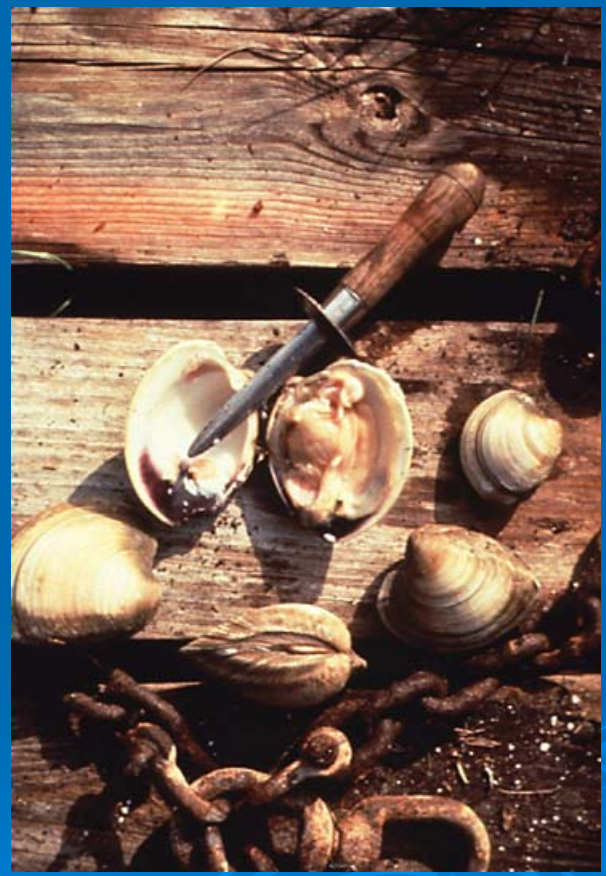
Can I order/eat seafood in a restaurant when there is a red tide?

YES!!!!

The United States has an extremely effective shellfish monitoring program and commercially purchased shellfish is safe for toxins.

NSP- Neurotoxic Shellfish Poisoning

- ✓ Ingestion of contaminated seafood (bivalves- oysters and clams)
- ✓ Symptoms include tingling and/or numbness of the lips, tongue, throat, hands, and feet
- ✓Neurologic; GastroIntestinal
- ✓Acute Onset (30 min-3 hr)
- ✓ Short Duration (days)



Reportable Disease

Aquatic Toxins Hotline 1-888-232-8635

Question 8

Can I go out shell fishing during a red tide?

NO! During red tides, the local shellfish beds are closed by the state. To know areas affected, see the state website at:

www.floridamarine.org

Question 7

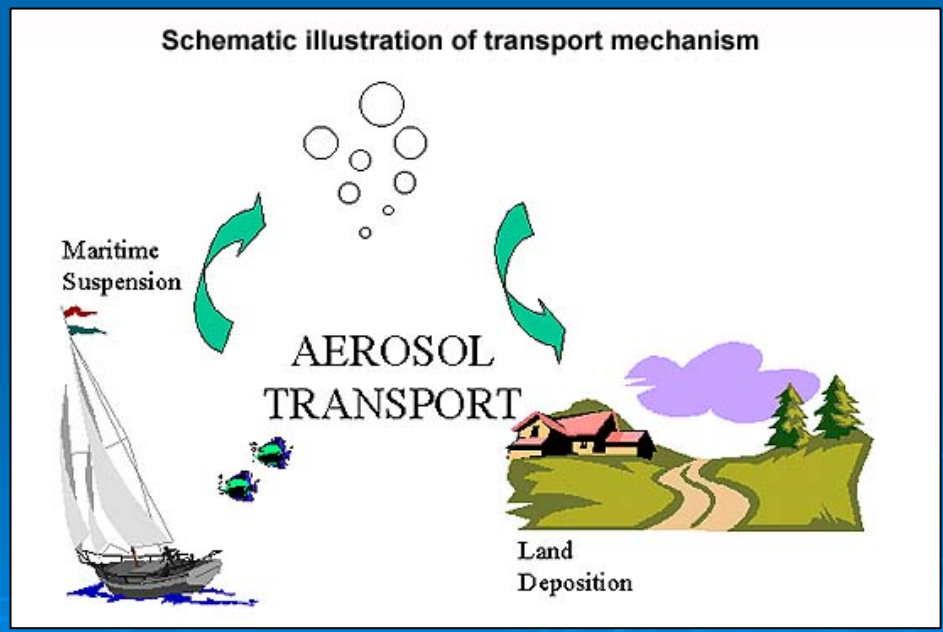
If I cook the seafood, will heat deactivate the toxin?

NO! The toxins are resistance to heat and storage – so if the shellfish have toxins in them – you will get sick.

Question 6

How far inland do the red tide toxins travel?

Stayed tuned- research to be conducted in the next year or two!



Question 5

Is it OK to swim during a red tide?

A qualified yes. The red tide toxin MAY cause a skin rash- if so, leave the water and shower off in freshwater as soon as possible. Also, its unknown what bacteria are in the water if there is a lot of dead fish in the water.

Question 4

Is there a time of day when there is less red tide in the air?

Check the marine forecast. When winds are OFFSHORE less toxins will be in the air.

Question 3, 2, 1

3. My husband and I are both healthy people, but when we go to the beach during red tides, we cough a lot. Is the red tide affecting our lungs?
2. My neighbor jogs every day on the beach, even during red tide. Is it safe?
1. My sister has asthma, should she go to the beach during red tide?

The Florida Department of Health and its Collaborators are trying to Answer these Questions through Health Research Studies

- Centers for Disease Control and Prevention
- Lovelace Respiratory Research Institute
- Mote Marine Laboratory
- Mount Sinai Medical Center
- University of Miami Rosenstiel School of Atmospheric and Marine Science
- University of North Carolina Wilmington Center for Marine Science
- University of Cincinnati Biostatistics Department
- University of Miami Pulmonary Medicine Department

Question 3

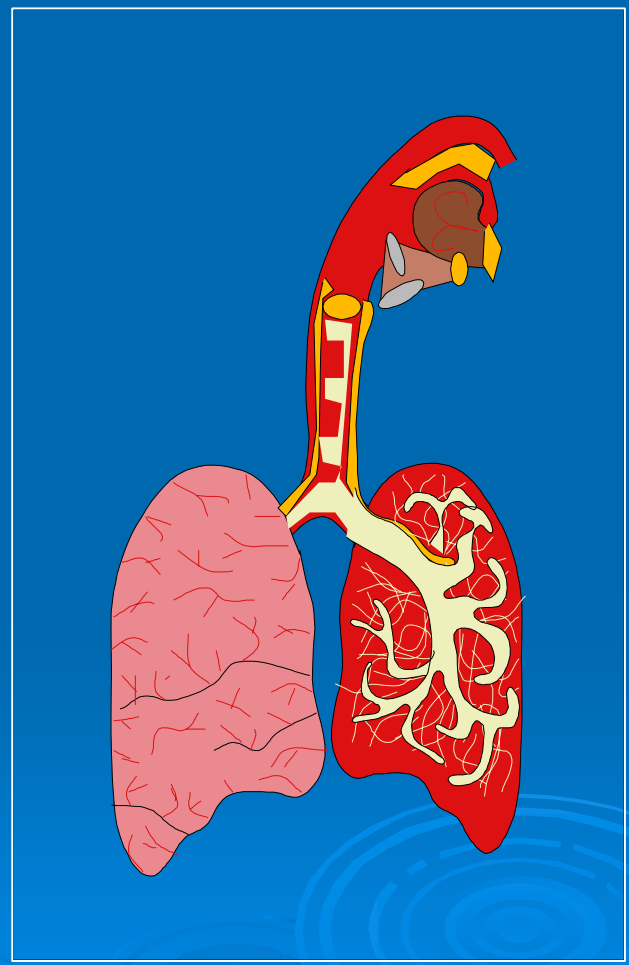
My husband and I are both healthy people, but when we go to the beach during red tides, we cough a lot. Is the red tide affecting our lungs?

Studies of Sarasota County lifeguards (2001-2002)

- 5 days pre/post shift
- Symptoms
- Lung Capacity
- During a red tide and with no red tide

Results

- No significant change in lung function (spirometry) during red tide.
- Significant for increased upper airway symptoms during red tide (cough, throat irritation, eye tearing).



Question 2

My neighbor jogs every day on the beach, even during red tide. Is it safe?

- ✓ Lifeguard study, 2003.
- ✓ Measured symptoms and lung capacity before and after exercise on stationary bike.
- ✓ During red tide and with no red tide.

Results

Data significant for upper airway symptoms but no significant change in lung function (spirometry).

Question #1!

My sister has asthma, should she go to the beach during red tide?

Current study with ~120 participants with diagnosis of asthma or chronic lung disease.

Assessed:

✓ Symptoms pre/post 1 hour walk on the beach

✓Lung capacity pre/post 1 hour walk on the beach

✓ Air monitoring for toxins during sampling

✓Participants did NOT change their medication regime for study.

How much red tide toxin was in the air?

Date	Temp (°C)	Humidity (%)	Average Wind Speed (KPH)	Wind Direction	Amt. in Water (um/L)	Amt. in Air (ng/m^3)
Unexposed Period						
1/17/03	12.2 ± 1.6	68 ± 5	25.6 ± 3.4	off shore	0.07±0.06	0.09±0.17
1/18/03	8.3 ± 1.6	47 ± 5	10.9 ± 3.7	off shore	0.09±0.07	0.01±0.02
1/19/03	13.3 ± 1.1	53 ± 7	12.4 ± 4.0	off shore	0.07±0.03	0.00±0.00
Exposed Period						
3/29/03	24.4 ± 0.5	83 ± 4	10.5 ± 5.4	partly on shore	3.52±1.96	36.57±17.51
3/30/03	18.9 ± 2.2	84 ± 6	24.9 ± 6.0	partly on shore	14.01±8.06	3.71±2.63
3/31/03	12.8 ± 1.1	32 ± 12	22.7 ± 2.6	off shore	0.23±0.31	0.02±0.04

Pierce, Henry, Blum and Hamel
Mote Marine Laboratory

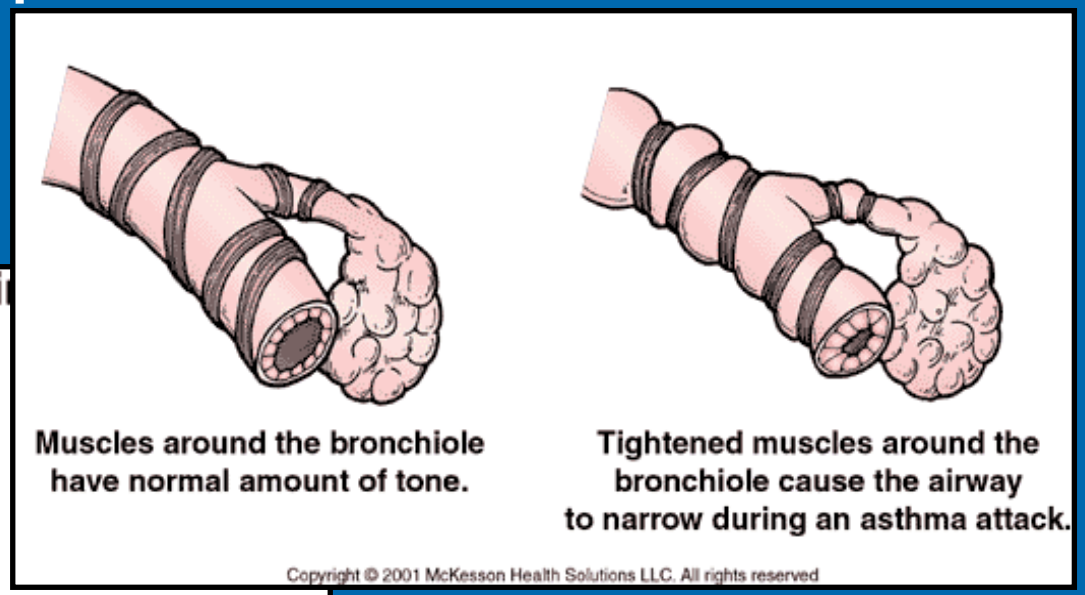
Was there a measurable respiratory effect from the airborne toxins?

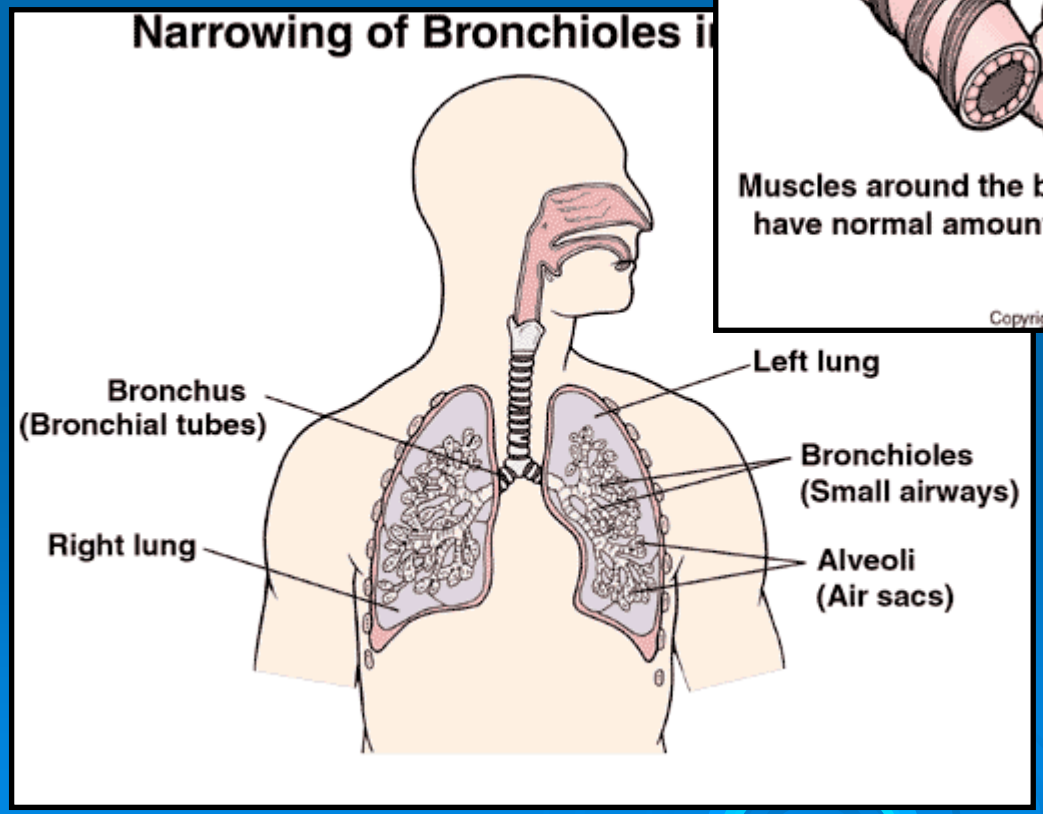
In the symptoms people reported?

*McNemar's test	Unexposed Period		Exposed Period	
Reported Symptom	**Pre=no Post=yes (N)**	**Pre vs Post difference significance***	**Pre=no Post=yes (N)**	**Pre vs Post difference significance***
Cough	9	0.44	15	**0.01**
Wheezing	4	0.74	7	**0.03**
Shortness of Breath	7	0.56	8	0.06
Chest tightness	8	0.25	17	**0.002**
Throat irritation	5	0.56	12	**0.02**
Nasal congestion	6	0.76	12	0.25
Eye irritation	3	1.00	9	**0.01**
Headache	5	0.26	6	0.06
Itchy skin	1	0.32	1	0.56
Diarrhea	0	0	1	1.00

Was there a measured difference:

In the spirometry?





	Unexposed (no red tide)		
Spirometry Value	**Pre Beach Mean ± SD**	**Mean Difference± SD**	**Significance (p value)****
FEV_1	3.01±0.88 L	21.0±139.0 ml	0.24
FVC	4.02±1.07 L	2.0±179.0 ml	0.93
FEV_1/FVC%	75%±9%	0.6%±3%	0.09
FEF_{25-75}	2.48±1.19 L/sec	39.0±332.0 ml/sec	0.36
PEF	7.56±2.02 L/sec	42.0±693.0 ml/sec	0.64

** paired t-test

	Exposed (red tide)		
Spirometry Value	**Pre Beach Mean ± SD**	**Mean difference ± SD**	**Significance (p value)****
FEV_1	3.03 ± .87 L	38.0 ± 118.0 ml	**0.02**
FVC	4.04 ± 1.03 L	35.0 ± 176.0 ml	0.13
FEV_1/FVC%	75 ± 9%	0.3 ± 3%	0.48
FEF_{25-75}	2.53 ± 1.26 L/sec	95.0 ± 296.0 ml/sec	**0.02**
PEF	7.79 ± 2.02 L/sec	81.0 ± 458.0 ml/sec	0.18

** paired t-test

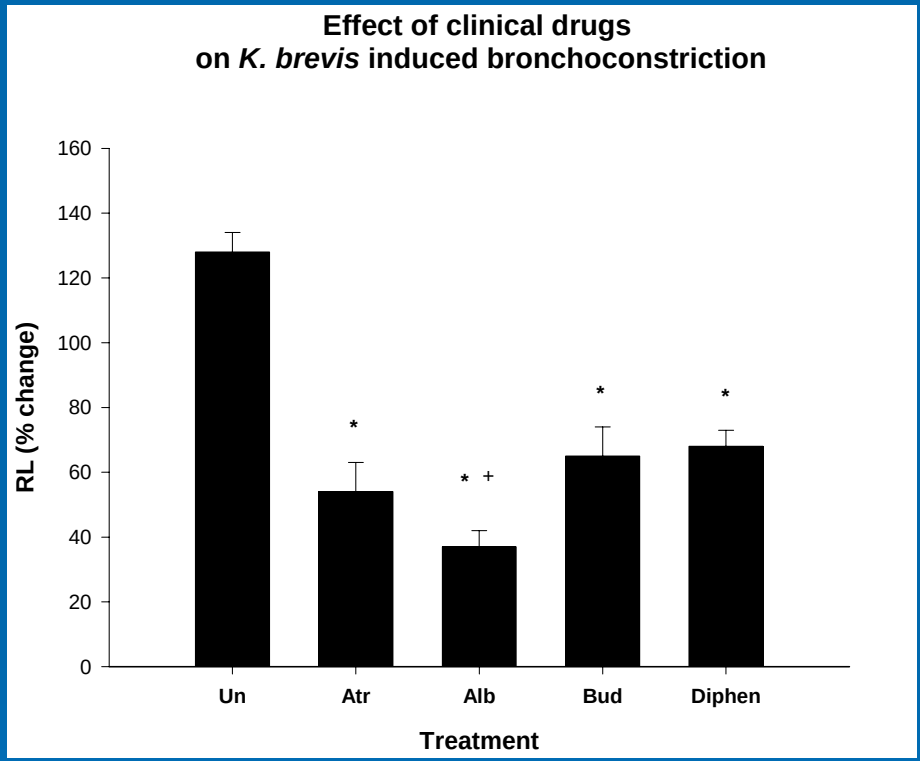
Results from Year 1

Increase in cough, wheezing, chest tightness, throat irritation, eye irritation after 1 hour walk on the beach.

Decrease in lung function parameters for asthma (FeV_1 and FEF_{25-75}). No asthma attacks! Just a small decrease.

What can we learn from the animal models?

Which clinically available drugs affect toxin –induced airway effects?

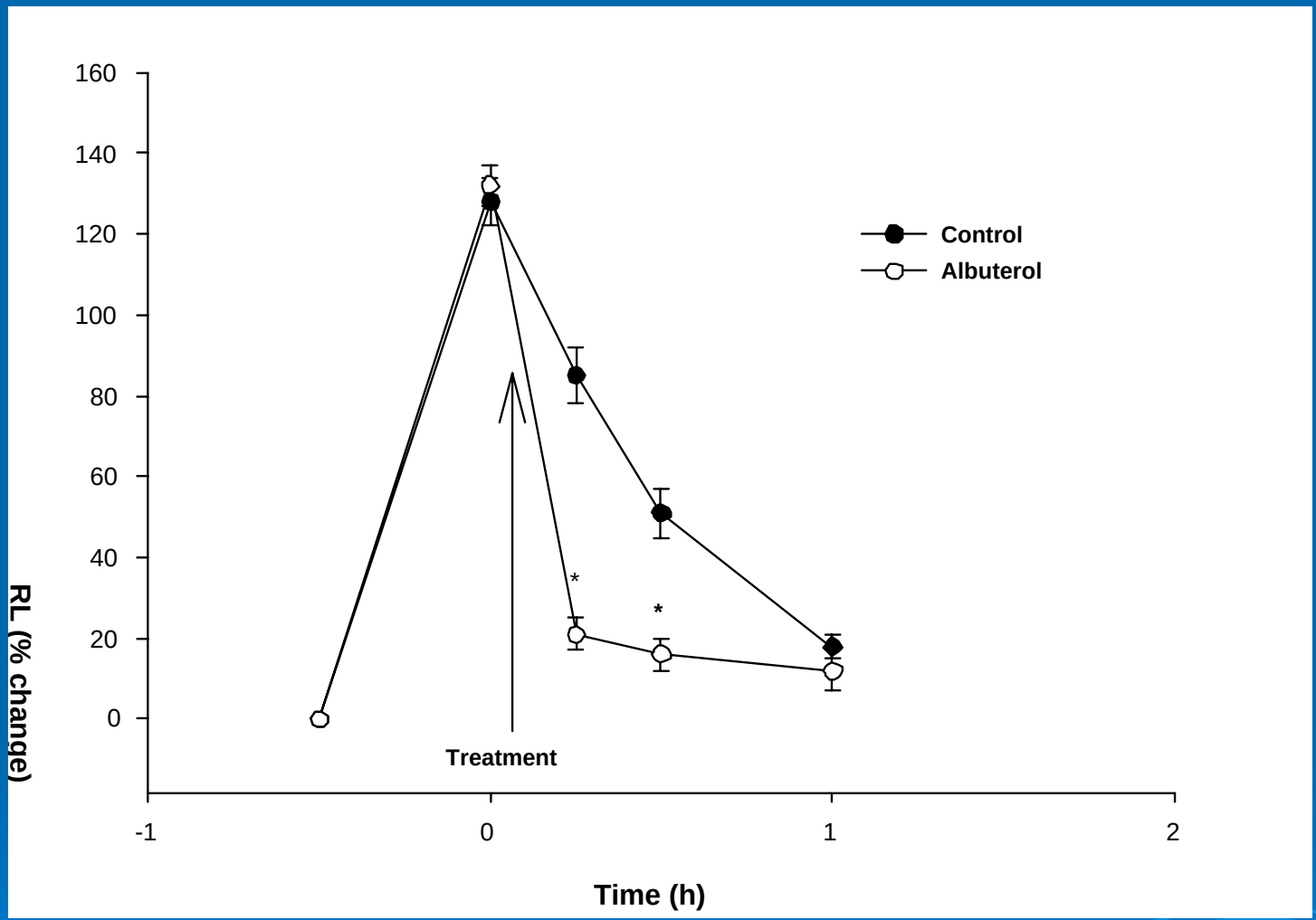


Abraham and Zaias
Mount Sinai Medical
Center, Miami, FL

values are mean ± se for 4 – 6 sheep * P < 0.05 vs. untreated; + P < 0.05 vs. diphenhydramine;

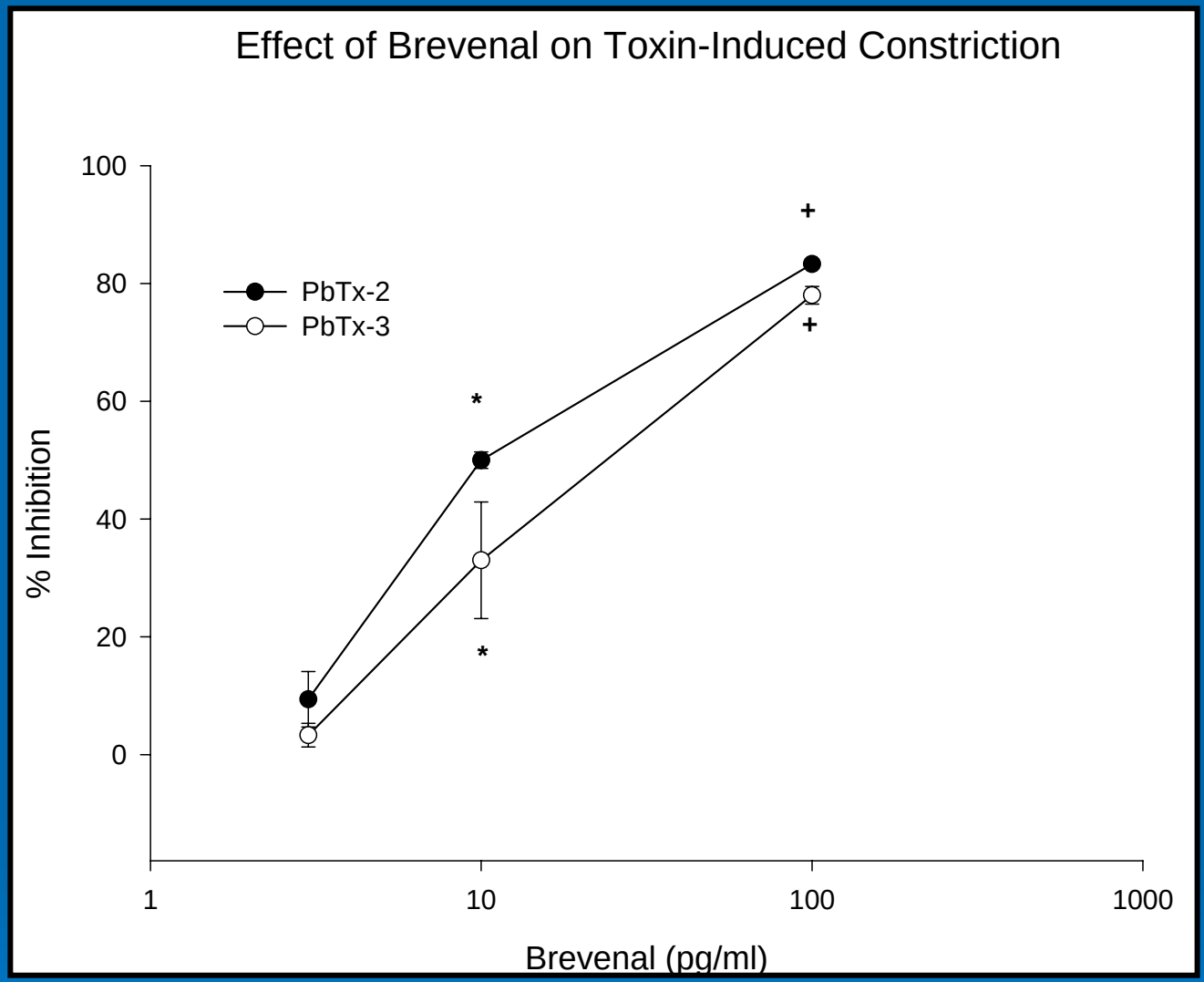
***K. brevis* 100 pg/ml**

Albuterol reverses *K. brevis* induced bronchoconstriction



Abraham and Zaias Mount Sinai Medical Center, Miami, FL

values are mean ± se for 5 sheep * P < 0.05 vs. control



Abraham and Zaias Mount Sinai Medical Center, Miami, FL

values are mean ± se for 4 – 7 sheep at each concentration

*** P < 0.05 vs. 3 pg/ml; + P < 0.05 vs. 3 and 10 pg/ml**

Conclusion from the animal model- not tested in people at this time

- Pre treatment with common medicines such as antihistamines, inhaled steroids, bronchodilators, and anticholinergics will decrease the response to inhaled brevetoxins.
- Post treatment with bronchodilators will reverse most of the affects from inhaled toxins.

The Top Ten Again!

10. Is it safe to eat fish during a red tide? YES!

9. Can I order/eat seafood in a restaurant when there is a red tide? YES!

8. Can I go out shell fishing during a red tide? NO!

7. If I cook the seafood will heat deactivate the toxin? NO!

6. How far inland do the red tide toxins travel?

To be studied soon!

5. Is it OK to swim during a red tide?

A qualified yes.

4. Is there a time of day when there is less red tide in the air?

Check the marine forecast for offshore winds.

3. My husband and I are both healthy people, but when we go to the beach during red tides, we cough a lot. Is the red tide affecting our lungs?

No, just upper airway symptoms.

2. My neighbor jogs every day on the beach, even during red tide. Is it OK?

Yes, recent studies indicate its only an upper airway issue- not lung.

1. My sister has asthma, should she go to the beach during red tide?

A careful yes- considering:

✓ the severity of her asthma

✓ her current health (head cold, allergies, etc)

✓the marine forecast (offshore vs. onshore winds, wind speed),

✓ and the severity of the red tide bloom.

More research ahead……

- Follow participants for 10 days after beach exposure for late onset of symptoms
- Follow participants for 2 more years (at least)
- Transport of aerosols inland and human impacts
- Investigate prevention/mitigation of effects in people- such as filter masks, antihistamines
- Further investigate allergy component of response

Support for this research was provided by grants from the

National Institute of Environmental Health Sciences,

National Institutes of Health

PO1 ES10594

and the

Centers for Disease Control and Prevention
Grant #U50-CCU423360-01

Aquatic Toxins Program
Division of Environmental Health
Bureau of Community Environmental Health
4052 Bald Cypress Way
Tallahassee, Florida 32399-1712

To report illnesses related to Red Tide, call the toll free Aquatic Toxins Hotline at 1.888.232.8635