

Florida Red Tide: Health Studies and Current Activities

Barbara Kirkpatrick
Senior Scientist



Routes of Exposure

- Ingestion
- Inhalation
- Topical



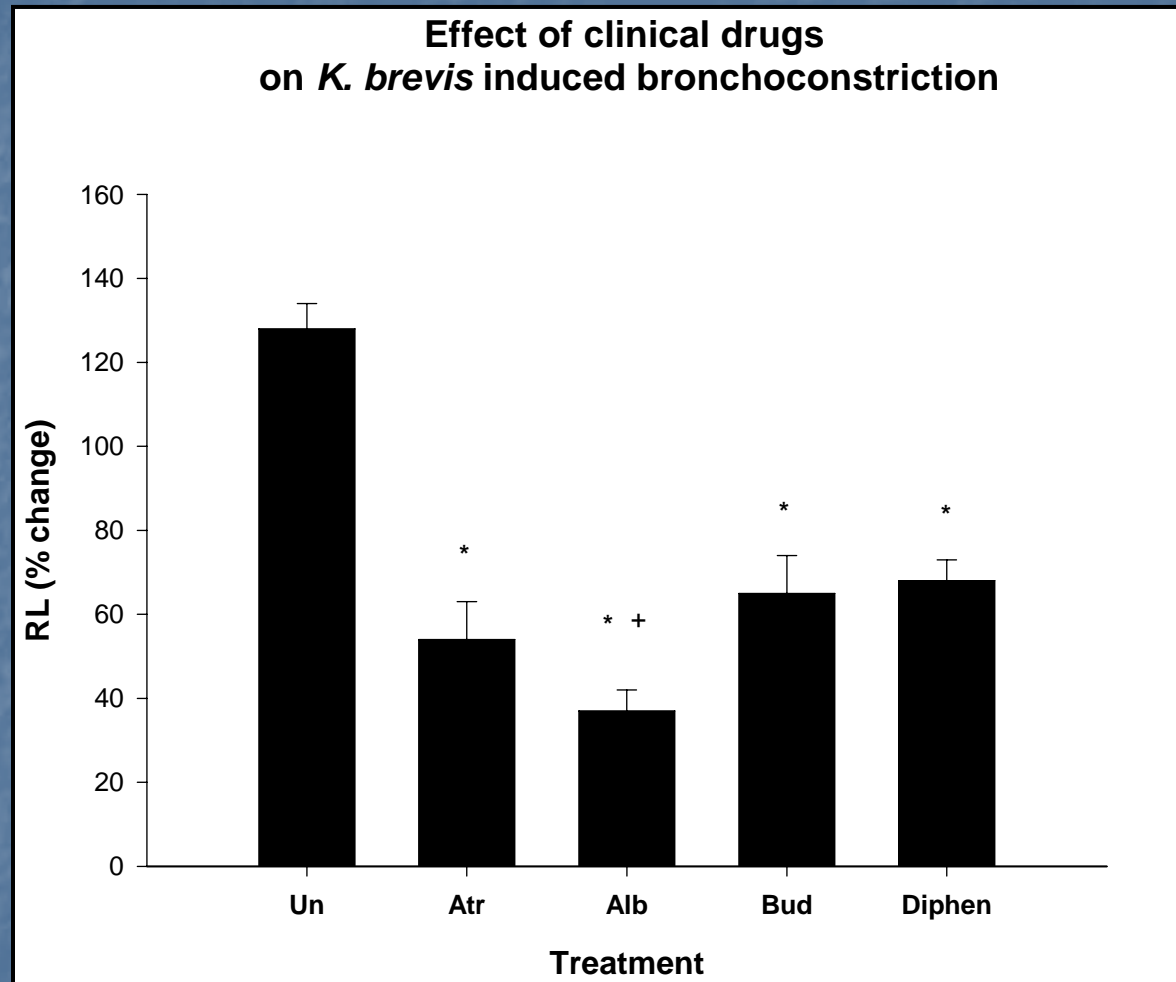
Inhalation Studies

- Animal
- Occupational
- Asthma
- Emergency room
- Inland
- Follow up

Animal Studies

- Wells et al. (1984) increased airway resistance in guinea pigs with inhaled brevetoxins
- Singer et al. (1998) and Abraham et al. (2001) asthmatic sheep, picogram doses of PbTx-3 causes increased airway resistance
- Benson et al. (1999) – rats- intratracheal instillation of PbTx-3- 80% rapidly cleared through lung, 20% retained in lung, liver and blood for up to 7 days

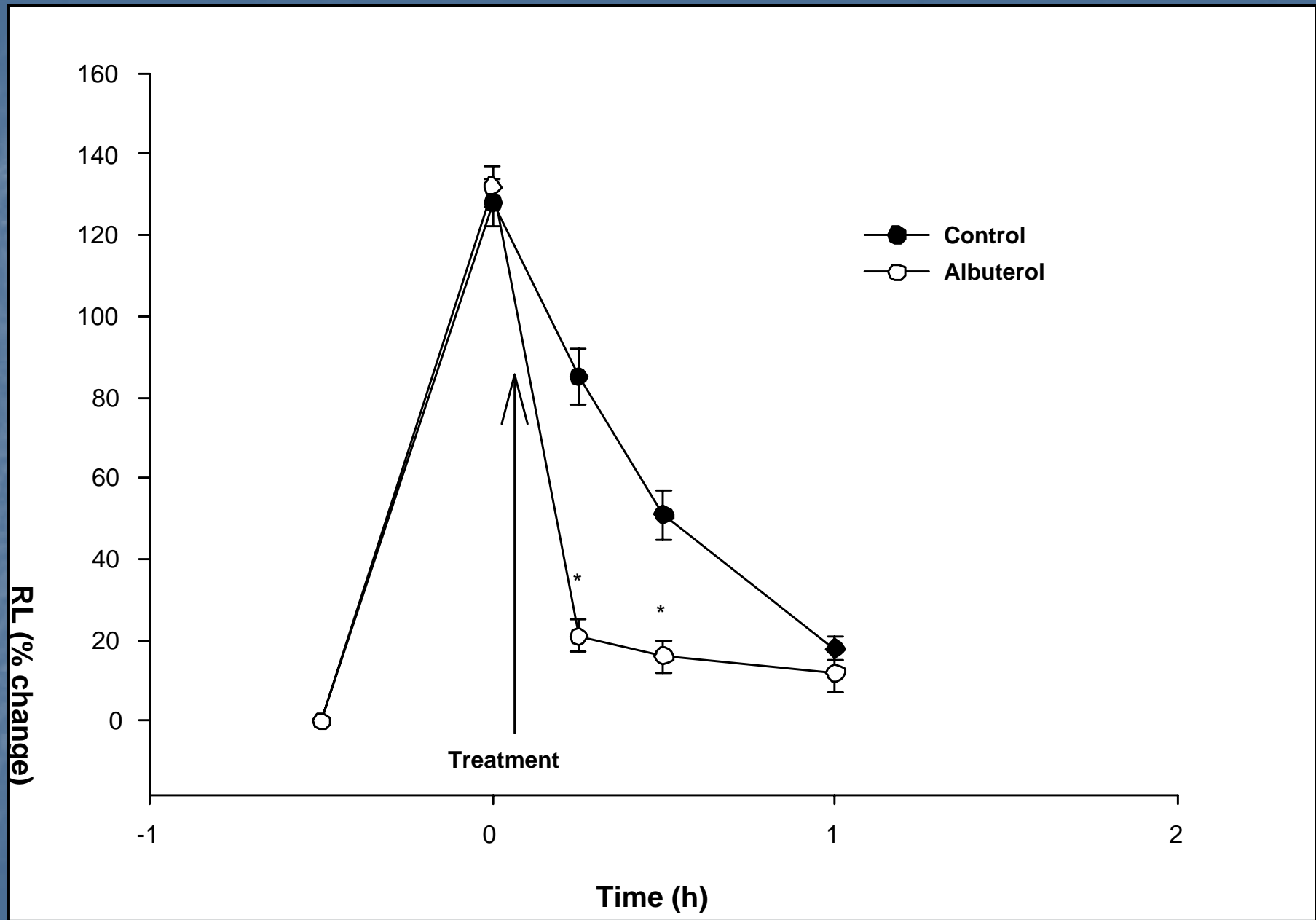
Which clinically available drugs affect toxin –induced airway effects?



values are mean \pm 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



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

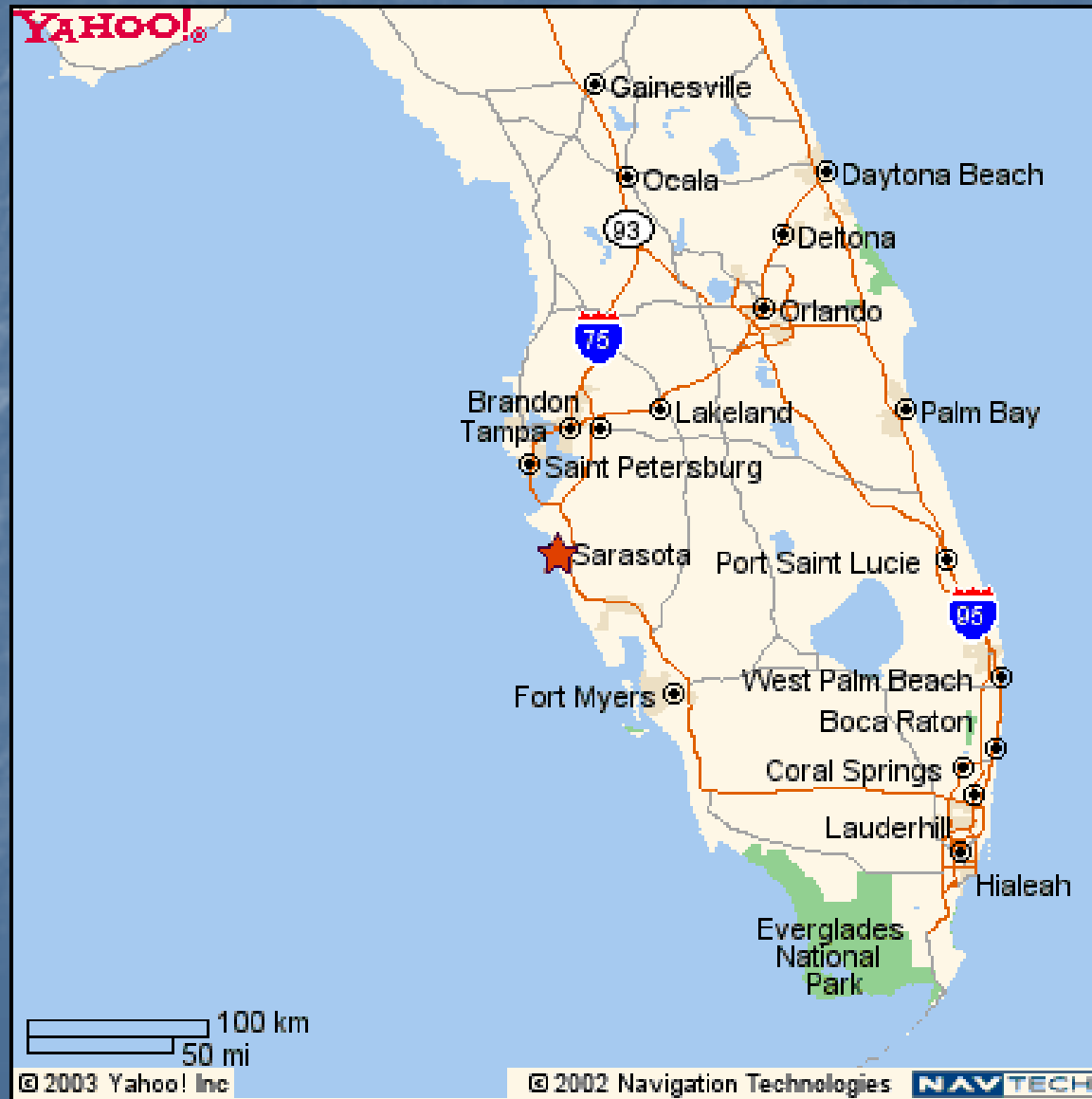
Conclusion from the animal model-
not tested in people at this time

- 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.

Inhalation Studies

- Animal
- Occupational
- Asthma
- Emergency room
- Inland
- Follow up

Study Site



Collaborators

- Centers for Disease Control and Prevention
- Florida Department of Health
- Harbor Branch Oceanographic Institution
- Lovelace Respiratory Research Institute
- Mote Marine Laboratory
- Mount Sinai Medical Center
- Twin Cities Hospital
- University of Miami Epidemiology
- UNCW Center for Marine Science
- University of Cincinnati Biostatistics
- University of Miami Pulmonary Medicine



Occupational

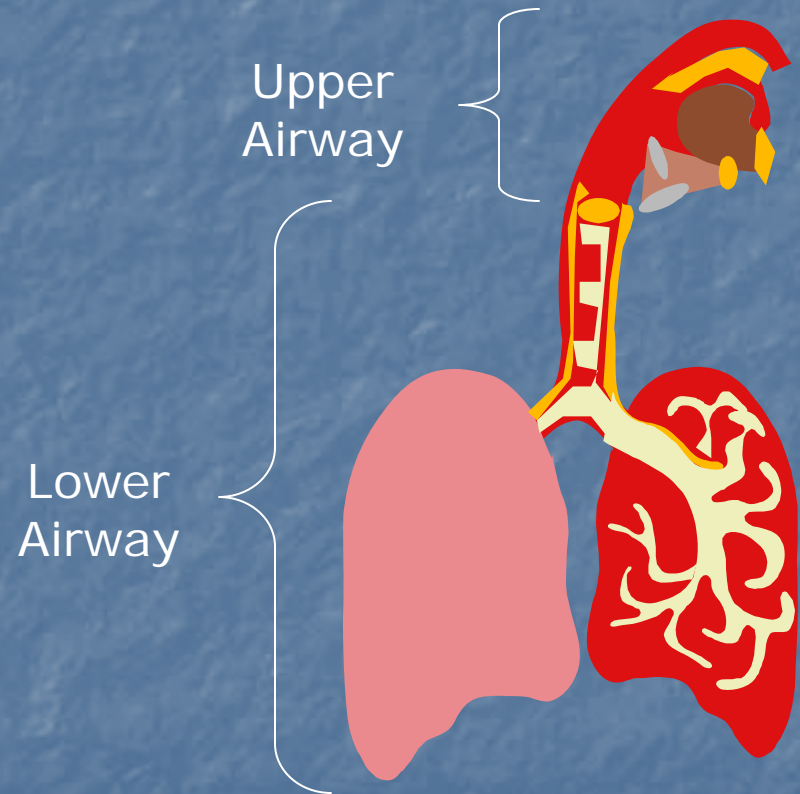
Studies of Sarasota County lifeguards (2001-2002)

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



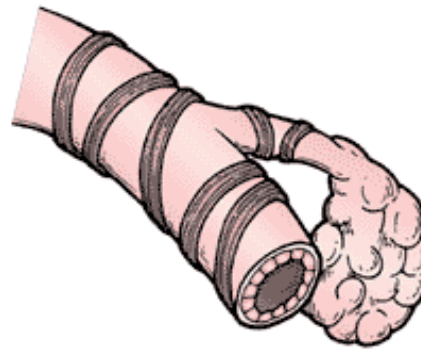
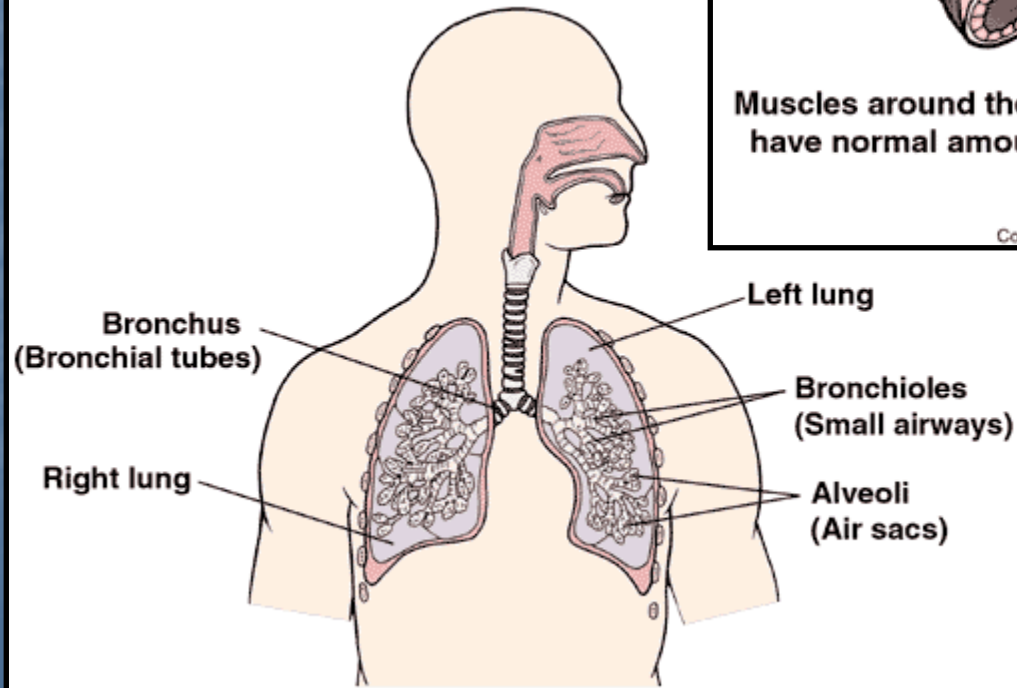
Symptoms

- ✓ **Throat irritation**
 - ✓ **Nasal congestion**
 - ✓ **Eye irritation**
 - ✓ **Cough**
 - ✓ **Wheezing**
 - ✓ **Shortness of Breath**
 - ✓ **Chest tightness**
 - ✓ **Headache**
 - ✓ **Itchy skin**
 - ✓ **Diarrhea**
- Upper Airway
- Lower Airway

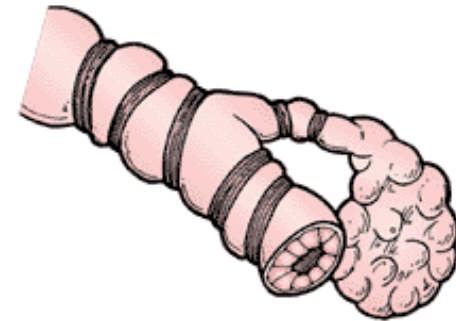


Was there a measured difference:
In the spirometry?

Narrowing of Bronchioles in



Muscles around the bronchiole have normal amount of tone.

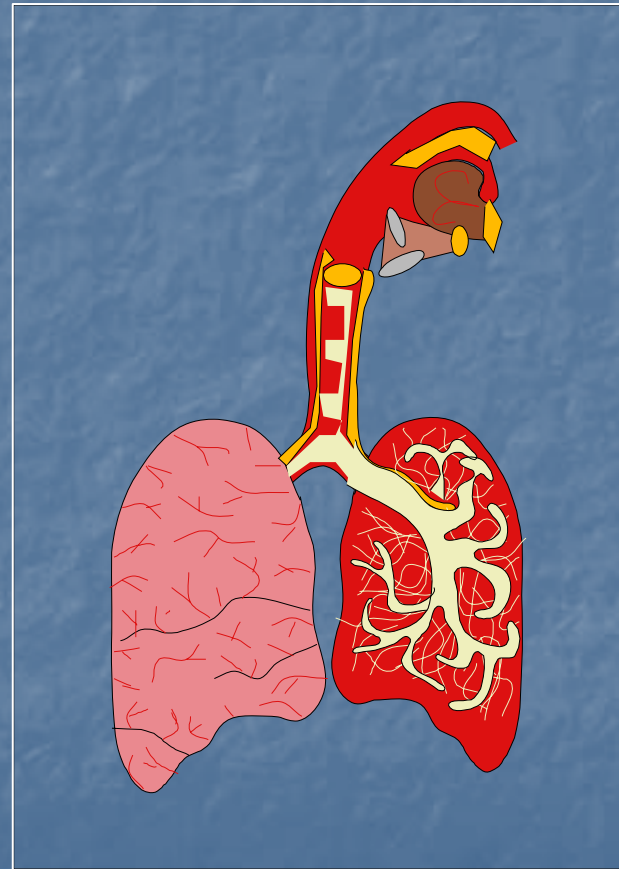


Tightened muscles around the bronchiole cause the airway to narrow during an asthma attack.

Copyright © 2001 McKesson Health Solutions LLC. All rights reserved.

Results

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



Inhalation Studies

- Animal
- Occupational
- **Asthma**
- Emergency room
- Inland
- Follow up

Methods

- Participants were evaluated before and after going to the beach for 1 hour:
 - Pulmonary health history and exposure symptom questionnaires
 - Swab nose and throat for brevetoxin ELISA and inflammation
 - NIOSH approved spirometry
 - Personal air sampler monitor for brevetoxins
- During a red tide and with no red tide

Environmental Sampling

- Solar powered weather station for wind speed/direction
- High volume air samplers on beach for toxins
- Particulate air samplers for particle size distribution
- Personal samplers for individual dose



Karenia brevis (Water), PbTx (Water, Air) & Environmental Conditions

6 Sampling Periods

Exposed

- *Karenia brevis* (cells/L)
 - 96,000-3,900,000
- Brevetoxin Water (uM/L)
 - 0.23 ± 0.3 - 14.0 ± 8.1
- Brevetoxin Air (ng/m³)
 - 0.02 ± 0.0 - 38.6 ± 17.5
- Wind Direction
 - Partly/Onshore

Mar 2003, Mar 2005,
(? Feb 2005)

Unexposed

- *Karenia brevis* (cells/L)
 - < 1,000
- Brevetoxin Water (uM/L)
 - 0.07 ± 0.0 - 0.09 ± 0.1
- Brevetoxin Air (ng/m³)
 - 0.00 ± 0.0 - 0.09 ± 0.2
- Wind Direction
 - Off Shore

Jan 2003, May 2004, Oct 2004

Results/Conclusions

- Documented Environmental Exposures to airborne red tide toxins
 - Cells & Toxins in water
 - Toxins in the air (picogram doses)
 - Wind speed and direction Important
 - Particulate Size (20% respirable)

Results

- Symptoms
- Spirometry



Results/Conclusions

- Non-exposure
 - No significant changes for symptoms & spirometry
- **1 Hour Exposure**
 - Significant changes for upper & lower airway symptoms
 - Significant changes in air flow as measured by spirometry in Asthmatics
 - Medications > No Medications
 - Coastal >> Inland

Inhalation Studies

- Animal
- Occupational
- Asthma
- Emergency room
- Inland
- Follow up

Is there an Increased Burden to the Medical Community during Red Tide?

- Local pulmonary physicians report increased office visits prior to and during reporting of a red tide bloom by the media
- Issues with Office Medical Records



Study Site

- Sarasota Memorial Hospital (Sarasota, FL)
 - Emergency room data all electronic database
 - Facility serves 63.3% of Sarasota County's Population



Methods

- Retrospective Cohort study
- Exposure Data
 - **Exposure** Oct 1 – Dec 31, 2001
 - **Non-Exposure** Oct 1- Dec 31, 2002
 - Based on Mote Marine Laboratory's *K. brevis* cell count database
 - Same months to account for seasonal allergies and seasonal population

Methods

Health Endpoint and Other Data

- Patient age, residence zip code, Date of admission
 - Repeated admissions from same person possible
- Zip codes separated
 - Coastal
 - On water: Barrier island or Mainland
 - Inland

Methods

Health Endpoint and Other Data

- ICD 9 codes for respiratory diseases
- Evaluation by physician collaborators selected ICD 9 codes (92% Respiratory)
 - Pneumonia
 - Bronchitis
 - Asthma
 - Upper airway disease
- All Other Diseases

Statistical analysis

- Age-Standardized ER Admission rates calculated
 - Florida 2000 population
- Rate Ratios
 - 2001 Rate/2002 Rate
 - > 1 means ELEVATED RISK
 - < 1 means DECREASED RISK
 - 95% confidence intervals

Results- Environmental Data

Cell Count Averages by Month in Cells/L

	EXPOSED (2001)	UnEXPOSED (2002)
September	1,419,435	50,329
October	302,895	207
November	399,020	2,333
December	53,070	173

Results

- No overall sig. change in admissions for the 2 periods
- 19% increase in pneumonia during red tide
- When separated by zip code
 - Coastal residents had a 54% increase in admissions compared to non red tide
 - Pneumonia 31%, bronchitis 56%, asthma 44%, and 64% upper airway disease

(manuscript in press)

Discussion

- Increased rates consistent with acute response
 - Animal models & Human Studies
- May be chronic health effects from Florida red tide toxins
 - Pneumonia
 - Bronchitis
- Location of residence important

Limitations

- No individual exposure or underlying health information
- No assessment of daily toxin levels in air
- Only one venue of health care: emergency rooms

Further research

- Further work needed to examine other venues of health care to validate these results with individual data

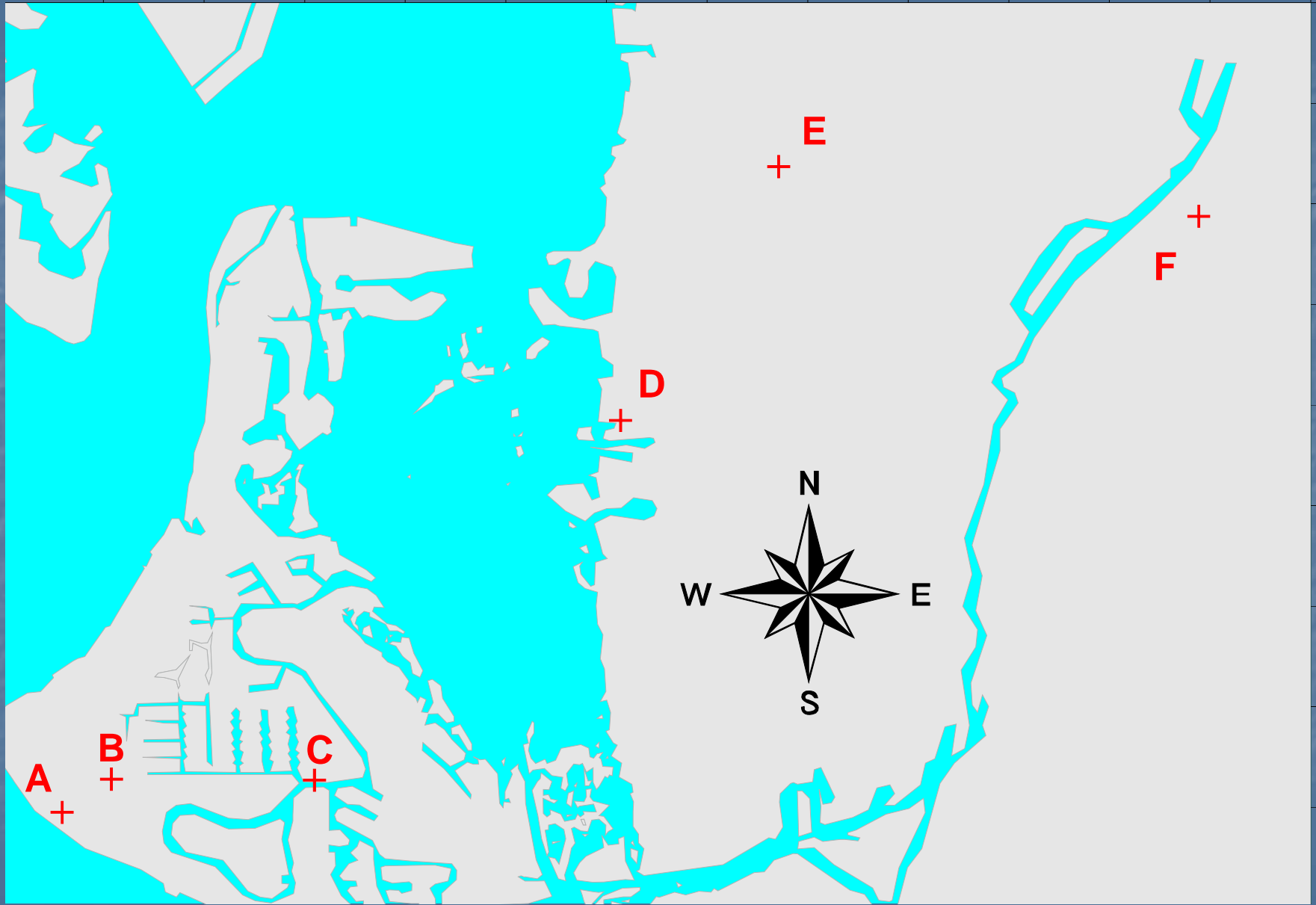
Inhalation Studies

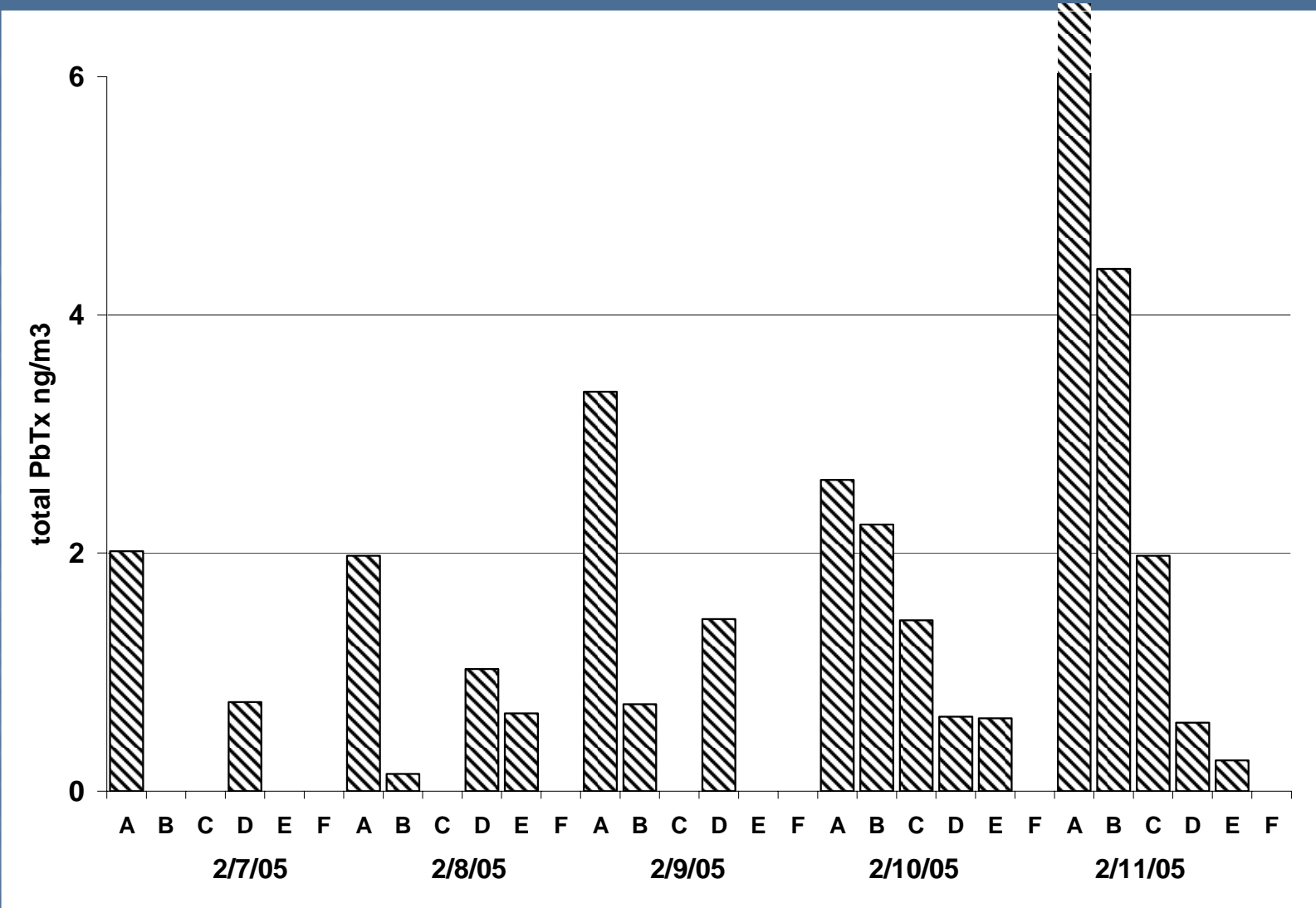
- Animal
- Occupational
- Asthma
- Emergency room
- **Inland**
- Follow up

Inland study

- Distance airborne toxins travel inland from beach/bay?
- 6 high volume air samples placed on west-east line starting at Siesta Key Beach and spanning ~ 3 miles







Inland Transect, 2/7 - 2/11, 2005: Total Aerosol Brevetoxins (ng/m³) at each sampling location (A through F).

Inhalation Studies

- Animal
- Occupational
- Asthma
- Emergency room
- Inland
- Follow up

Follow up study

- Are all symptoms and spirometry changes captured at beach study?
- Do symptoms and air flow changes persist for some period after exposure?
- Method
 - Symptom diary for 10 days
 - Peak flowmeter for home monitoring

Follow up study

- Analysis to be completed soon (sorry!)

Routes of Exposure

- Ingestion
- Inhalation
- **Topical**

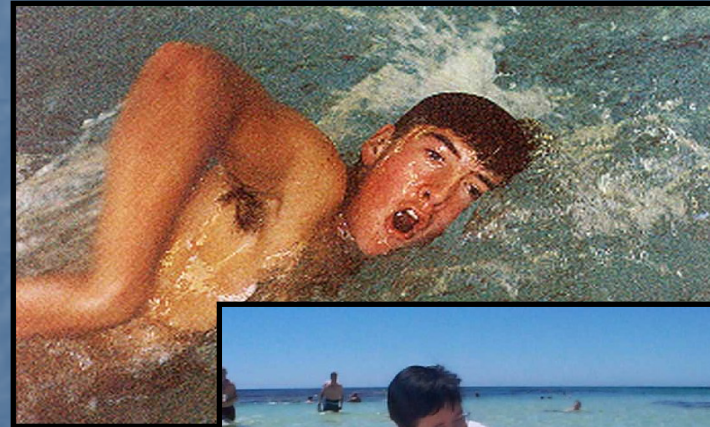


Topical

Anecdotal reports of skin rashes, swelling of eyes and lips

? Bacterial load in water

Research needed!



Acknowledgements

- CDC/FL DOH
Cooperative
Agreement
U50/CCU423360-02
- NIH/NIEHS PO1 ES
10594



Visit our website at:
www.mote.org/niehsredtidestudy