

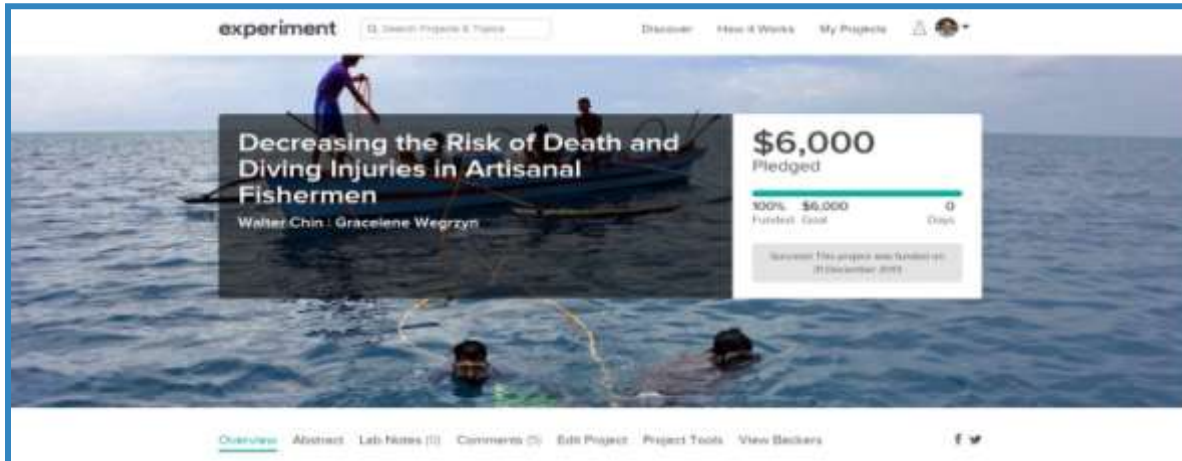
# CO and CO<sub>2</sub> Analysis in the Diving Gas of the Fishermen of the Yucatan Peninsula

June 2014

# Funding and IRB

UCLA

- UCLA Medical IRB-approved
  - IRB Number: 13-00532
- Microryza Crowd funding
  - \$6,000
- Oxyheal Health Group
  - \$1,600
- UCLA Health Care System
  - \$2,000



## Budget



5 Dive Recorders, ULTRA SENSUS	\$1,180
Model Hookah Air Power Plant	\$725
Model Compressor	\$745
Model Volume Tank, 15 gallons	\$460
Model Filter System	\$350
Dive Umbilical	\$295
Carbon Monoxide test tubes	\$480
Carbon Dioxide test tubes	\$420
Carbon Monoxide Analyzer	\$345
Travel, Lodging, Facility, and Administration	\$1,000



San Felipe

parque naturel  
rio lagartos

Rio Lagartos














5-6.5 HP  
Gas  
Engine

Single-  
Stage Air  
Compressor

2 ft<sup>3</sup>  
Volume  
Tank





# Depths and Dive Profiles

Max D (FSW)	Avg D (FSW)	TBT/day (min)	Dives/Day
68.93	49.37	96.47	2.53

Source: Huchim et. al. "Diving behavior and fishing performance: the case of lobster artisanal fishermen of the Yucatan coast, Mexico" (2014)

# Annual Incidence of DCS

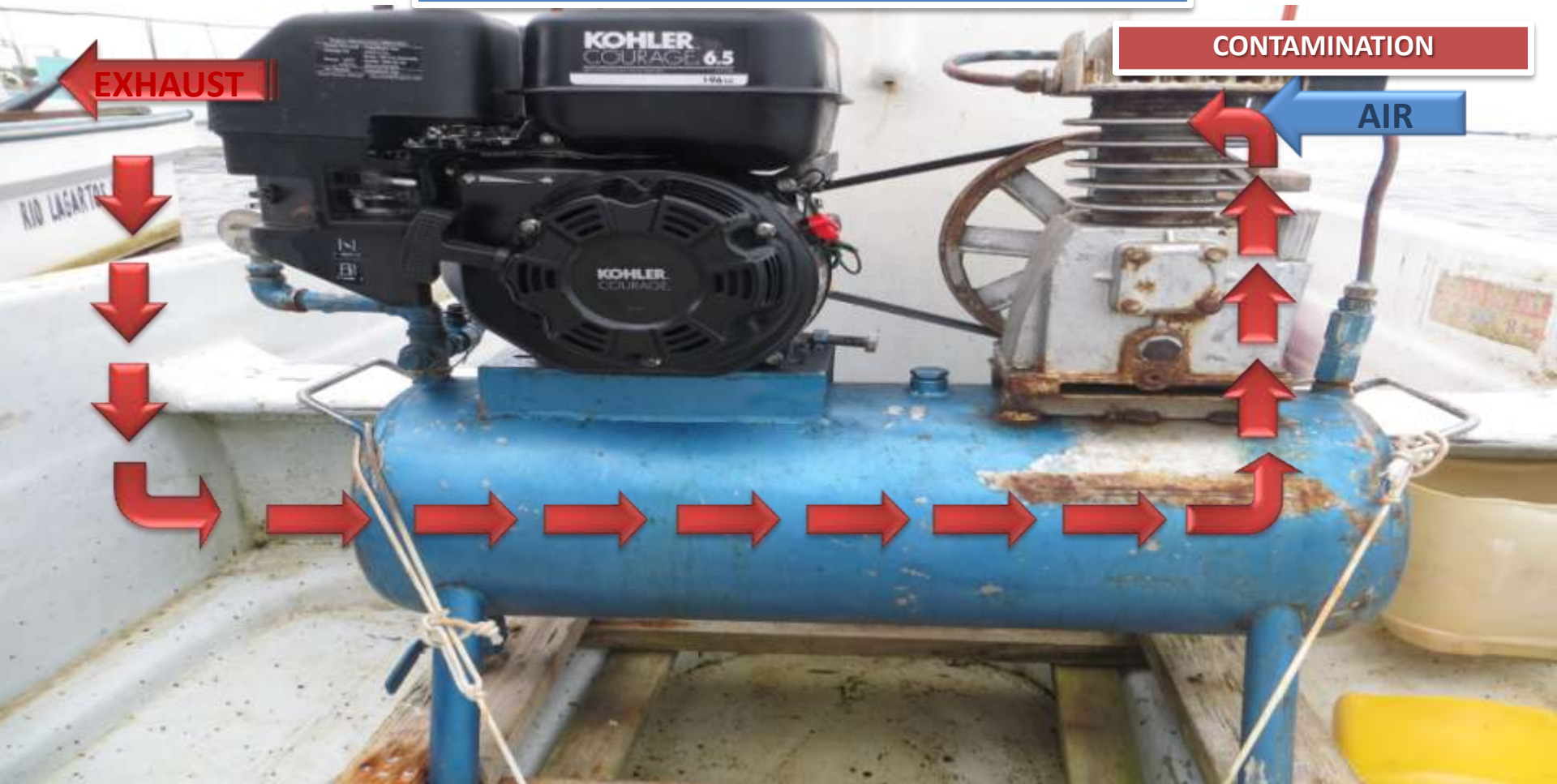
# Fishermen in Yucatan	# Fishermen in Rio Lagartos and San Felipe	# DCS Cases/Year	# Deaths/Year
1,300	200-250	200	10-15

Source: Huchim et. al. "Diving behavior and fishing performance: the case of lobster artisanal fishermen of the Yucatan coast, Mexico" (2014)

# Problem Statement

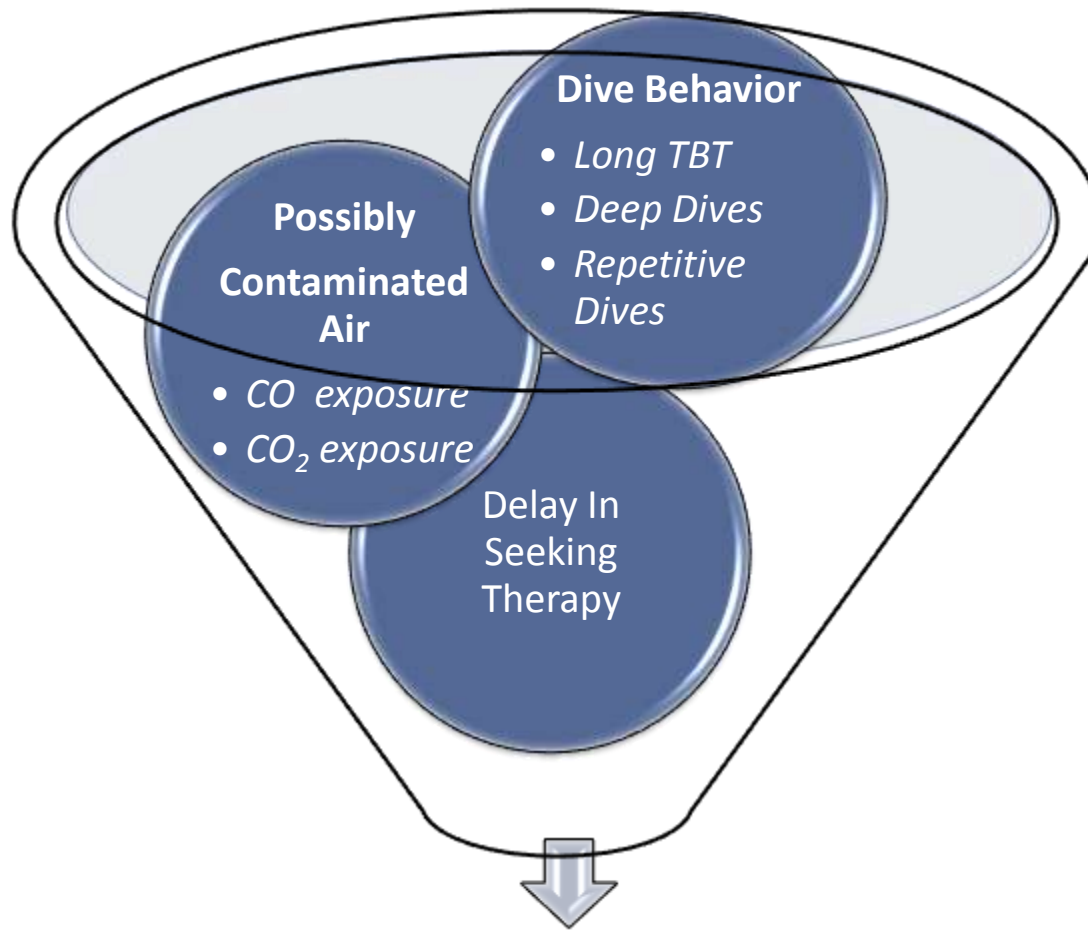
- Over 75% of 200-250 fishermen in the Yucatan experience DCS annually
  - Other diseases mimic signs and symptoms of DCS

# AIR SOURCE CONTAMINATION?









**Symptomatic Patient**

# Questions

1. Are artisanal fishermen being exposed to CO and CO<sub>2</sub> in their diving gas?
2. Could CO and CO<sub>2</sub> be contributing factors or sources of injury?
3. Are their current filtration systems effective?

# Theories

1. Hookah systems compress CO and CO<sub>2</sub> into air supply
2. CO and CO<sub>2</sub> poisoning can produce signs and symptoms that may be misdiagnosed as DCS
3. Filtration systems are ineffective.

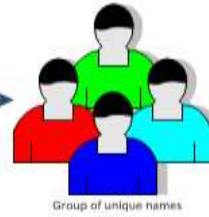


# Study Design

18 Invited



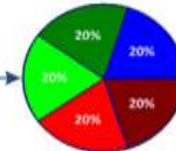
14 said yes



4 Excluded  
No

Group  
instructed  
not to drain  
volume tank

Analysis on 10  
Boats





Volume Tank

Flowmeter  
 $\pm 5\%$

Dräger Tube  
 $\pm 10\%$

(0.2 L/min)



(5 min)



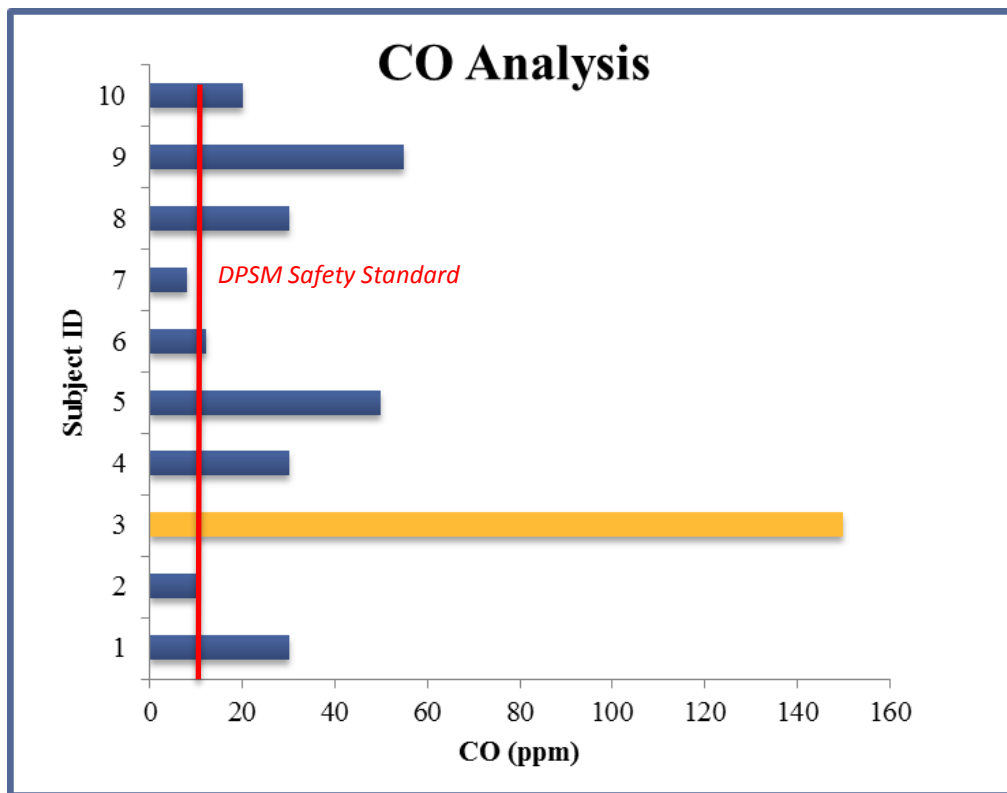
# Diving Air Quality Standards

Safety Organization	CO (ppm)	CO <sub>2</sub> (ppm)
HSE	3	500
DPSM	10	1,000
U.S. NAVY	20	1,000
OSHA	35*	10,000*

\*These are acceptable CO and CO<sub>2</sub> levels permitted in diving gas over an 8-hour period of time



# Results



# Results: Diving Air Quality

Sample	Mean (ppm)	Range (ppm)
CO		
Total (n = 10)	42	8-150
Filter (n = 4)	72	10-150
No Filter (n = 6)	27	8-50

# Results: Diving Air Quality

Sample	Mean (ppm)	Range (ppm)
<b>CO<sub>2</sub></b>		
<b>Total (n = 10)</b>	<b>663</b>	600-800
<b>Filter (n = 4)</b>	<b>700</b>	600-800
<b>No Filter (n = 6)</b>	<b>650</b>	600-700

# Results: Filter Effect

Sample	N	Mean Rank
<b>CO</b>		
<b>Filter</b>	4	<b>6.33</b>
<b>No Filter</b>	6	<b>4.33</b>
<b>CO<sub>2</sub></b>		
<b>Filter</b>	4	<b>5.25</b>
<b>No Filter</b>	6	<b>4.25</b>



# Conclusion

- **Problem:** 75% of 300 fishermen experience DCS annually
- **Theory:** Signs/symptoms of CO/CO<sub>2</sub> poisoning could be mistaken as DCS
- **Suspicion:** Diving gas could be contaminated
- **Results:** Diving gas is contaminated and filters add contamination
- **New Theories:**
  1. Improving air purity will reduce disease
  2. Improving air purity will improve accuracy of diagnosis of DCS



**Thanks for Listening**

CO and CO<sub>2</sub> Analysis in the Diving Gas of  
the Fishermen of the Yucatan Peninsula

June 2014