

# Carbon Monoxide Exposure from Recreational Watercraft

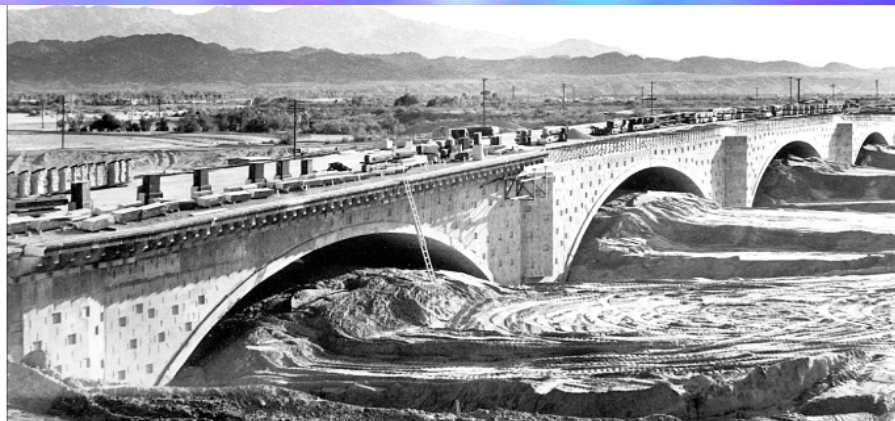
## The Tale of Two Arizona Lakes

The London Bridge at Lake Havasu  
&  
Lake Pleasant Regional Park



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# Lake Havasu



In the last 2 years at Lake Havasu

10 people have either died or required emergency medical care due to CO poisoning.

*A 31 year-old California man drowned the weekend the study was conducted.*

*Carbon Monoxide Poisoning was listed as the Secondary cause of death.*

# Study Objective

- The objective of our investigation was to determine whether a public health hazard from CO exposure exists during a busy holiday weekend at Lake Havasu City.
- The investigation measured carbon monoxide exposure in boaters near the London Bridge during the 2003 Memorial Day Holiday.

# Carbon Monoxide

- Carbon monoxide is an odorless, colorless gas that interferes with oxygen distribution in the blood.
- For years, CO poisonings were thought to occur only in enclosed, poorly ventilated areas.
- Open-air cases of carbon monoxide poisoning have been reported from houseboats, cabin cruisers and ski boats.
- 1990- 2000: 493 CO Poisonings (USCG)
- 214 occurred on boats other than houseboats (USCG)

# Carbon Monoxide Sources



# Human Exposure to CO



# Health Effects of CO Exposure

<b>% COHb</b>	<b>Symptoms</b>
<b>&lt;5%</b>	<b>None</b>
<b>5 – 10%</b>	<b>Headache, Decreased exercise tolerance</b>
<b>10-20%</b>	<b>Mild dyspnea on exertion, Headache</b>
<b>20-30%</b>	<b>Throbbing headache, Nausea &amp; Vomiting, Impaired judgment</b>
<b>30-40%</b>	<b>Severe Headache, Nausea &amp; Vomiting, Impaired judgment</b>
<b>40-50%</b>	<b>Confusion &amp; Syncope</b>
<b>50-60%</b>	<b>Syncope, Coma, Seizures</b>
<b>60-70%</b>	<b>Coma, Seizures, Cardio-respiratory depression, Death</b>
<b>&gt;70%</b>	<b>Failing hemodynamic status, Death</b>



# High Risk Activities





# Methods

- Exhaled CO was used as a measure of the amount of carboxyhemoglobin (COHb) in the participant's blood.
- Ethanol does not interfere with the analytical results.
- We administered a short questionnaire to determine smoking status and activity questions.



# Results

- Significant carbon monoxide exposure occurred during the investigation.
- The average % COHb in nonsmokers increased from an average of 1% at noon to 11% after 6 pm.
- The average % COHb in smokers increased from an average of 3% at noon to 13% after 6 pm.

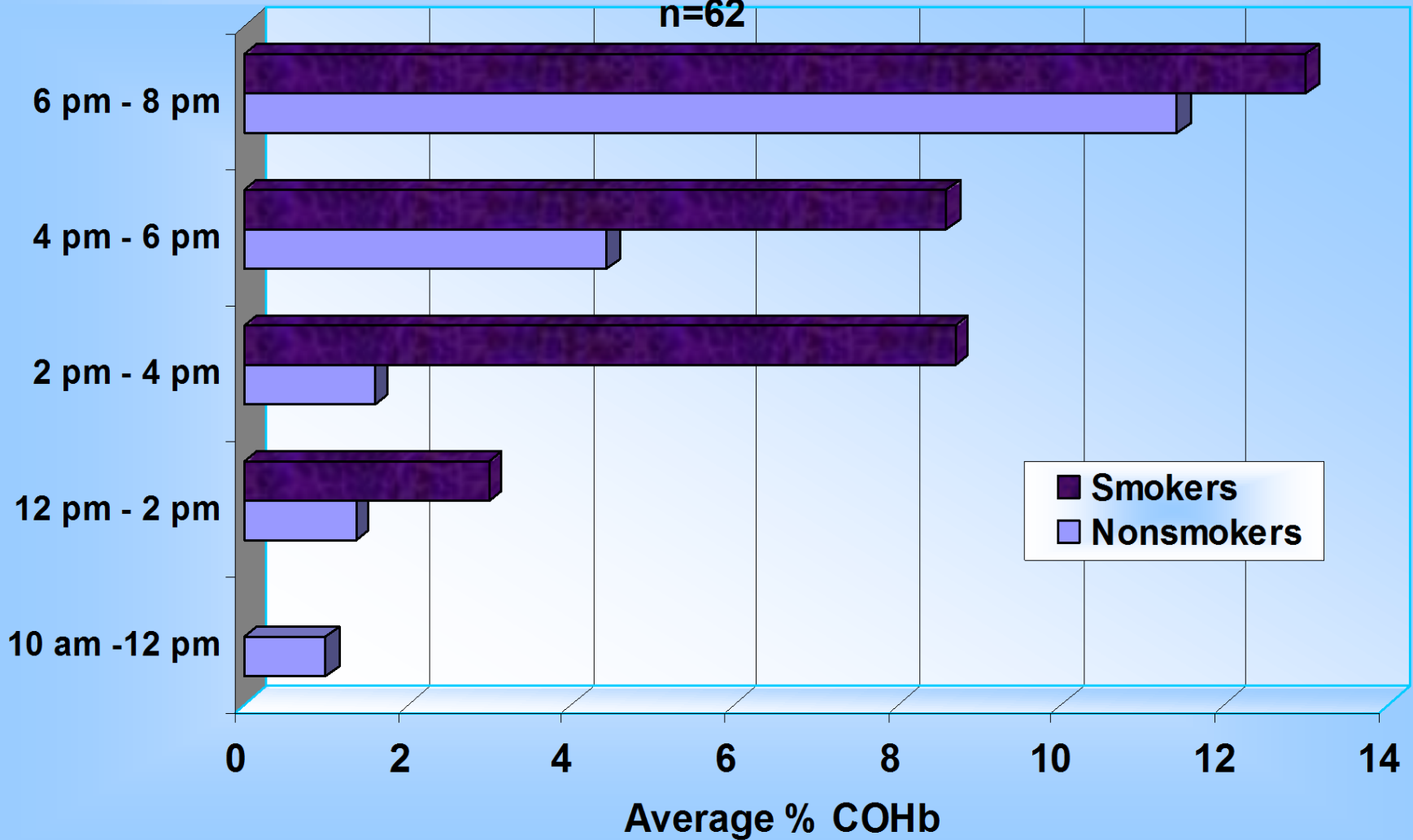
# Results

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- Maximum COHb observed for non-smokers was 23%.
- Maximum COHB observed for smokers was 26%.
- The man who drowned during the weekend had a COHb concentration of 47%.

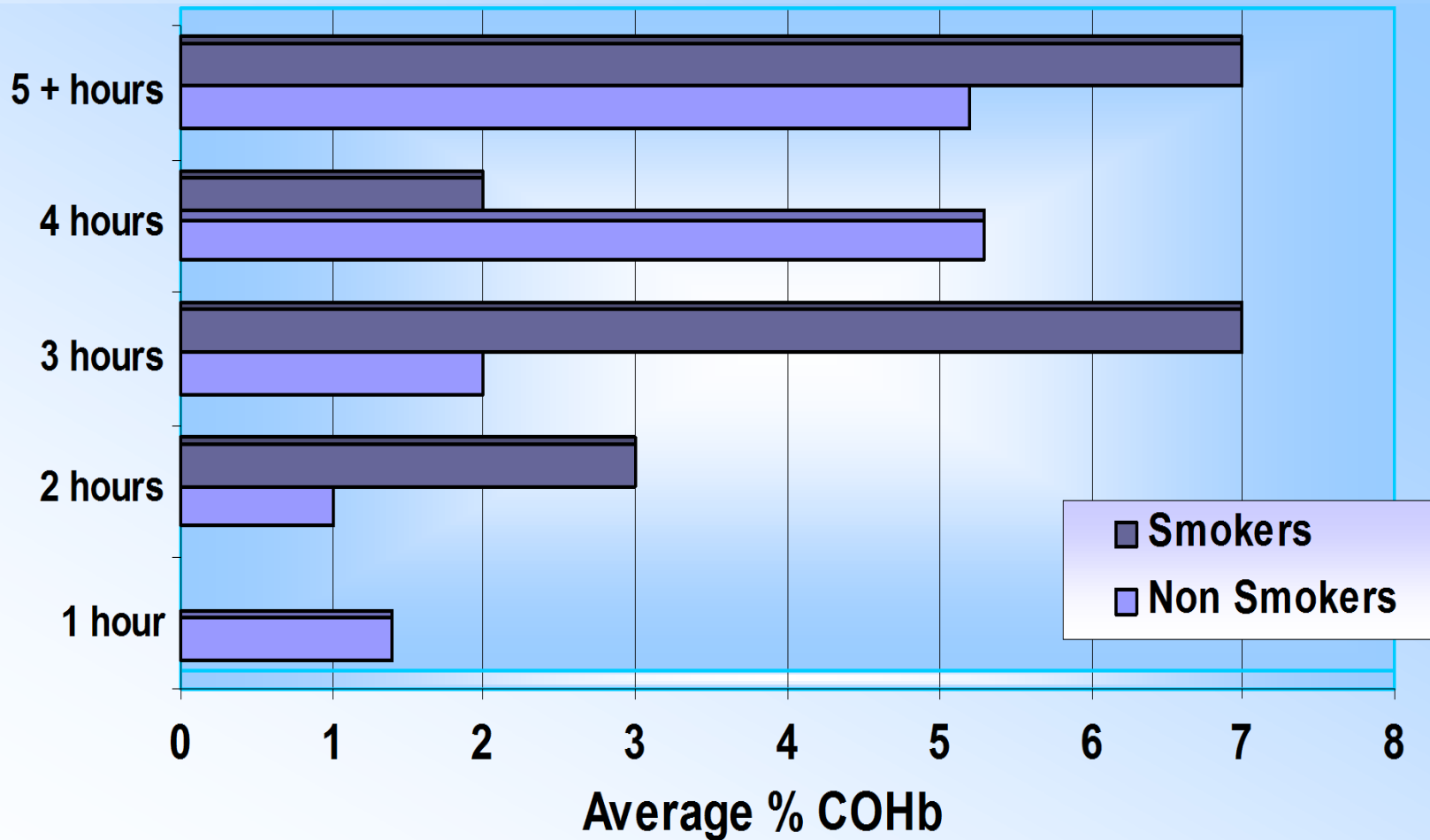
# Average % COHb in Smokers and Non Smokers by Time of Day

n=62



# Average % COHb by Number of Hours

n=62



# Discussion

- Alcohol consumption was common among the participants.
- Alcohol consumption causes similar symptoms including headache, impaired judgment, nausea and vomiting.
- The combination of alcohol consumption and carbon monoxide exposure likely creates a more significant health hazard (drowning & trauma).





# Conclusions

- Significant carbon monoxide exposure occurred among participants during the investigation.
- The cumulative carbon monoxide exposure increased as the day progressed.
- The COHb levels observed late in the day posed a public health hazard.

# Conclusions

- The combination of alcohol consumption and carbon monoxide exposure creates a more significant public health hazard.
- The recreational activities conducted during the investigation were predominately in or near water, creating a drowning hazard for those with impaired judgment or more severe symptoms of carbon monoxide exposure and alcohol consumption.



- Lake Havasu handed out 15,000 flyers during the summer of 2003.
- Multi-million dollar lawsuit filed against Lake Havasu City in connection with the Memorial Day Weekend drowning.
- Another drowning occurred on the Labor Day weekend.



# Lake Pleasant Carbon Monoxide Exposure Study



# Lake Pleasant

## Carbon Monoxide Exposure Study

- **Labor Day Weekend, 2003.**
- **Measured exposure to carbon monoxide from a variety of watercraft**
- **90 participants - adults & children**
- **Ambient air - carbon monoxide levels**
- **No apparent public health hazard**

# Lake Pleasant Results

- Average % in the 67 non-smoking participants was below the threshold for adverse symptoms. (<2%)
- Average % in 23 participants who smoked was 3.5%.
  - 7 / 23 of these participants exceeded thresholds for mild adverse health effects (5.1 to 6.6%)

# Ambient Air Measurements

- Measurements were non-detect except when the SeaArk was idling nearby.
- Monitor had to be turned off while on the SeaArk & the sheriff's patrol boats





# Lake Pleasant vs. Lake Havasu

- Lake Pleasant had a much lower density of boats except at Humbug Bay
- Low water levels and  $>105$  degree temperatures limited the number of boaters and the length of time spent at the lake
- Boaters at Lake Pleasant frequently exit the water to seek shade & swim





# The Problems at Humbug Bay

- It's the Party Place
- Accessible by water
- No beaches or roads
- Did not enter cove on advice of park police
- Tried to persuade boaters to participate as they exited the cove – Most declined
- Boaters in the cove were more likely to have higher COHb levels



