Eric P. Kindwall Memorial Lecture

UHMS Annual Scientific Meeting

St. Louis, Missouri

June 20, 2014

Eric P. Kindwall, MD
1934-2012

Helped shape specialty of hyperbaric medicine and UHMS
US Navy during Vietnam War
    Associate Director of School of Submarine Medicine
    Senior Officer in charge of diving medicine program
Chief of Hyperbaric Medicine, St. Lukes, Milwaukee 1969
Founded what became the UHMS Education Committee
Convinced AMA to allow UMS to grant CME credit
Started newsletter, "Pressure" 1972
Chaired first HBO_2 Therapy Committee and edited first 3 Reports 1972
Initial Editor of *Hyperbaric Oxygen Review*
UHMS President 1981-82
Created *Hyperbaric Medicine Practice* 1994, edited 2 more editions

“My Career in Carbon Monoxide Poisoning”

Neil B. Hampson, MD

Emeritus Physician, Section of Hyperbaric Medicine

Virginia Mason Medical Center

Clinical Professor of Medicine, University of Washington

Raising Public Awareness

- Pick-up trucks
  - *JAMA* 1992
- Charcoal
  - *JAMA* 1994
- Storms
  - *J Emerg Med* 1997
  - *MMWR* 2005
  - *UHM* 2006
  - *Am J Public Health* 2008
  - *Pediatrics* 2009
- Generators
  - *Am J Prev Med* 1995
- Motor vehicles in garages
  - *Am J Emerg Med* 2011
- CO Alarms
  - *J Environ Health* 2011
  - *J Emerg Med 2012*

Epidemiology of CO Poisoning

- Pediatric
  - *UHM* 2005
- Influence of race
  - *Pub Health Rep* 2000
- Intentional CO poisoning and weather
  - *UHM* 2000
- Intentional CO poisoning and co-ingestions
  - *J Emerg Med* 2013
- Online reporting system of CO patients
  - *UHM* 2012

Diagnosis of CO Poisoning

- Pulse oximetry
  - *Chest* 1998
- Symptoms
  - *Headache* 2002
  - *Am J Emerg Med* 2008
  - *UHM* 2012
- Pulse CO-oximetry
  - *UHM* 2005
  - *UHM* 2006
  - *Respir Care* 2007
  - *Emerg Med J* 2008
  - *Am J Emerg Med* 2012

Selection Criteria and Hyperbaric Treatment of CO Poisoning

- Selection criteria
  - *J Emerg Med* 1995
  - *UHM* 2001
  - *Ann Emerg Med* 2001
  - *UHM* 2006
- Treatment protocols
  - *J Hyperbaric Med* 1992
  - *UHM* 1996
  - *UHM* 2001
  - *UHM* 2005
  - *UHM* 2006

”Myth Busting in Carbon Monoxide Poisoning”

Neil B. Hampson, MD

Emeritus Physician, Section of Hyperbaric Medicine

Virginia Mason Medical Center

Clinical Professor of Medicine, University of Washington

Topics for Today

Dispelling 9 myths about CO poisoning, plus 1 about water

Topics for Today

Dispelling 9 myths about CO poisoning, plus 1 about water

OR

Why you should be skeptical about "common knowledge," followed by a crash course in how to take down an industry with simple science

Myth Busting 101 – 1.0 CME

Dispelling Myths About CO

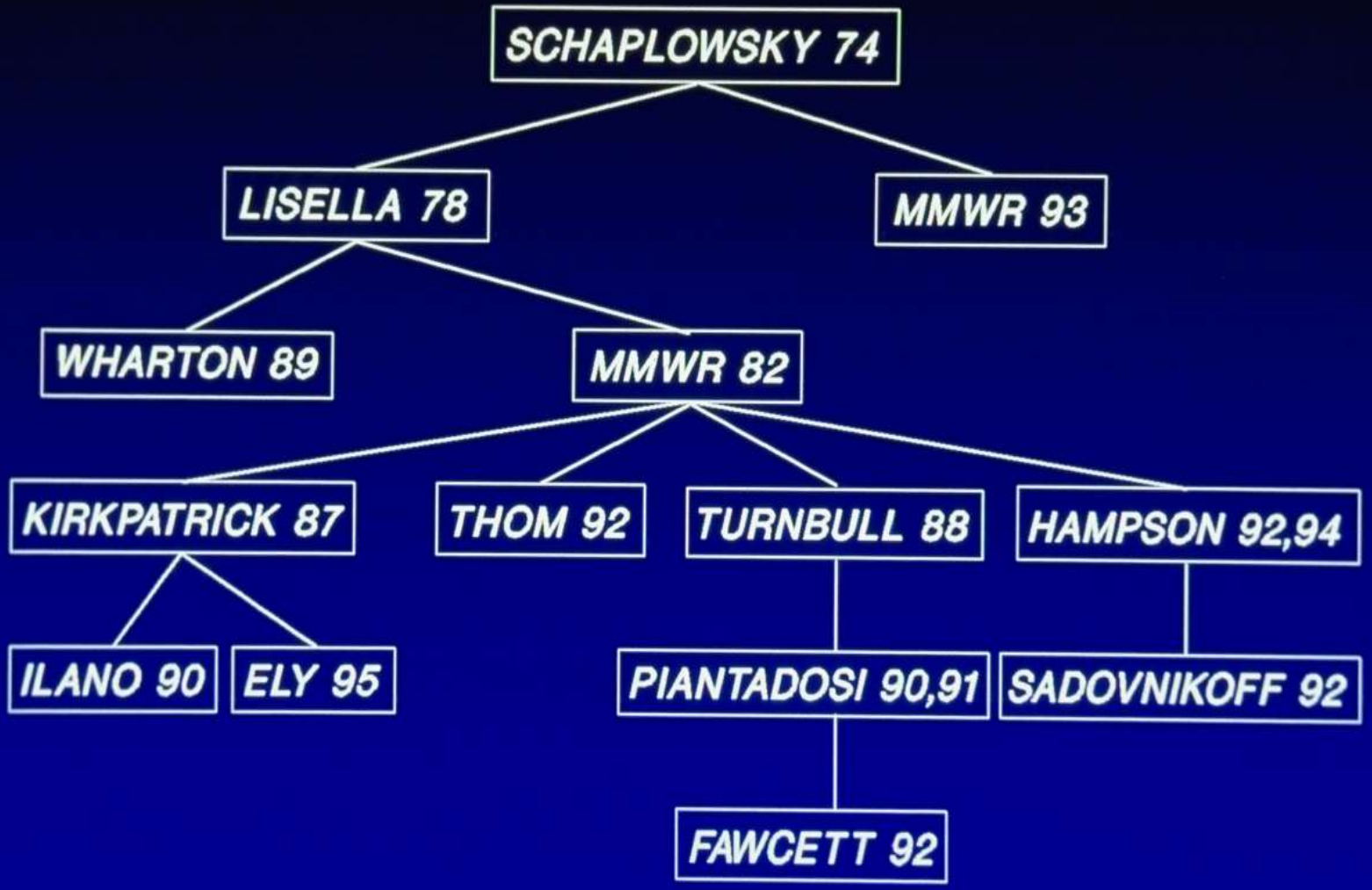
1. “10,000 cases in US per year”

Incidence of CO Poisoning in the US Commonly Quoted Figure 1990's

"10,000 poisonings in the US annually sufficiently severe to cause individuals to seek medical attention or lose one or more days of normal activity"

“10,000 Cases in US Annually” Papers Referencing this Number

Bozeman 1997
Ely 1995
Hampson 1992,94
Ilano 1990
Lisella 1978
Kirkpatrick 1987
Meredith 1988
MMWR 1982,84,93
Mofenson 1984
Sadovnikoff 1992
Schaplowsky 1974
Silvers 1995
Turnbull 1988


SCHAPLOWSKY 74
LISELLA 78
MMWR 93
WHARTON 89
MMWR 82
KIRKPATRICK 87
THOM 92
TURNBULL 88
HAMPSON 92,94
ILANO 90
ELY 95
PIANTADOSI 90,91
SADOVNIKOFF 92
FAWCETT 92

Carbon Monoxide Contamination of the Living Environment
A National Survey of Home Air and Children's Blood

By A. F. Schaplowsky
F. B. Oglesbay
J. H. Morrison
R. E. Gallagher
William Berman, Jr., M.D.
U.S. Dept. of Health, Education, and Welfare

The current heating fuel shortages may continue for several years, and we predict that many people will use auxiliary fuels and heating devices in their homes. The use of plastic film and other methods to cut air circulation between the inside and outside is also increasing. These trends have an ominous potential for increasing exposure to carbon monoxide and its hazard to health.

Presently, nearly 10,000 people seek medical attention or lose one or more days of normal activity annually because of carbon monoxide intoxication.

ficates as such). Other sources of the CO in these fatal poisonings were stoves, refrigerators, and charcoal.[1]

Radford[2] reported on a survey of 302 old houses in East Baltimore, Md., of which 20 percent showed elevated levels (10 ppm or more) of carbon monoxide. In about 4 percent of the houses, the concentrations were 20 parts per million or more, and in 1 percent, they exceeded 50 parts per million. Of the entire sample, 83 percent of the homes were rented, while of those homes with high concentrations of carbon monoxide, 93 percent were rented. In houses where the higher concentrations of CO were found, the problem was traced to unvented space heaters or stoves used for heating. Some vented heaters also were associated with high concentrations of carbon monoxide including both space heaters and oil or gas fired furnaces used with central heating.

Incidence of Carbon Monoxide Poisoning in the United States

To the Editor:

It is commonly written in the medical literature that carbon monoxide (CO) poisoning results in 3,700 deaths annually in the United States, and causes 10,000 less severely poisoned individuals to seek medical attention or to miss at least a day of normal activity. A 1991 study from the Centers for Disease Control supported the mortality figure, reporting an average of 3,744 deaths annually during the decade of the 1980s (1).

The estimate of 10,000 nonfatal cases annually came into question when it was found that 2,355 individuals with acute CO poisoning were treated in U.S. hyperbaric chambers in 1992 (2). If 10,000 cases were indeed the denominator for this population, it would suggest that nearly one-quarter of symptomatic patients with CO poisoning were treated with hyperbaric oxygen (HBO_2).

Oglesbay. Personal communication revealed that the estimate of 10,000 cases annually in the United States originated from data collected by the Injury Control Program of the Public Health Service in the late 1960s. In the "Carbon Monoxide Program Action Kit" developed by the Public Health Service in 1969, the estimate of 10,000 cases per year was noted to be "based on the scant evidence available" and representative of "only a portion of the true number".

This demonstrates clearly the importance of quoting original sources when referencing earlier work, especially when referring to an epidemiologic estimate of the prevalence of disease incidence. Because several authors, including myself, have failed to go back to the original source, an outdated estimate of disease incidence has been

“Carbon Monoxide Program Action Kit” (USPHS 1969)

98-671

carbon monoxide

fact sheet

Each year, more than 10,000 persons require medical attention as a result of being exposed to carbon monoxide gas. About 1,500 Americans die from poisoning by this gas. The toll is expected to mount because of shortages of home heating fuel and extraordinary measures people might take to conserve fuel. Protect yourself—find out what carbon monoxide is and how to avoid it.

Carbon Monoxide poisoning: A new incidence for an old disease.

N. B. HAMPSON[1], L.K. WEAVER[2]

Submitted - 2-15-07; accepted - 3-22-07

[1]Center for Hyperbaric Medicine, Section of Pulmonary and Critical Care Medicine Virginia Mason Medical Center; Seattle, Washington; [2]Pulmonary and Critical Care Division, Department of Internal Medicine, LDS Hospital Center; Salt Lake City, Utah

Hampson NB, Weaver LK. Carbon Monoxide Poisoning: A new incidence for an old disease. Undersea Hyperb Med 2007; 34(3):163-168. Purpose: While carbon monoxide (CO) poisoning is common in the USA, its incidence is uncertain. Fatal poisonings are counted with relative accuracy from death certificate data, but estimates of the more common nonfatal poisonings are either old or limited. This study was performed to estimate the number of emergency department (ED) visits annually in the USA for carbon monoxide poisoning. Basic Procedures: ED visit rates in five states (Idaho, Maine, Montana, Utah, and Washington) from three prior studies, each using different methodology, were used to extrapolate independent estimates of national ED visits. Main Findings: After correcting for regional differences in CO poisoning incidence, estimates of national ED visits per year ranging from 32,413 to 56,037 were obtained. Excluding the estimate derived from the Maine rate because it did not include intentional and fire-related poisonings, the national average is 50,558 $\pm$ 4,843 visits per year. Conclusions: There are approximately 50,000 ED visits for CO poisoning in the USA annually, 3-5 times the numbers previously estimated. As this disease can result in significant long-term morbidity even when treated, enhanced prevention efforts are warranted.

Dispelling Myths About CO

1. ~~10,000 cases in US per year~~

   UHM 1999

   Am J Emerg Med 2005

   UHM 2007

2. "Most CO-poisoned patients are cherry red, possibly precluding the need for [COHb] measurement"

Dispelling Myths About CO

1. ~~10,000 cases in US per year~~

   UHM 1999

   Am J Emerg Med 2005

   UHM 2007

2. "Most CO-poisoned patients are cherry red, possibly precluding need for [COHb] measurement"

Do we need to measure COHb or can we rely on cherry-red coloration to diagnose CO poisoning?

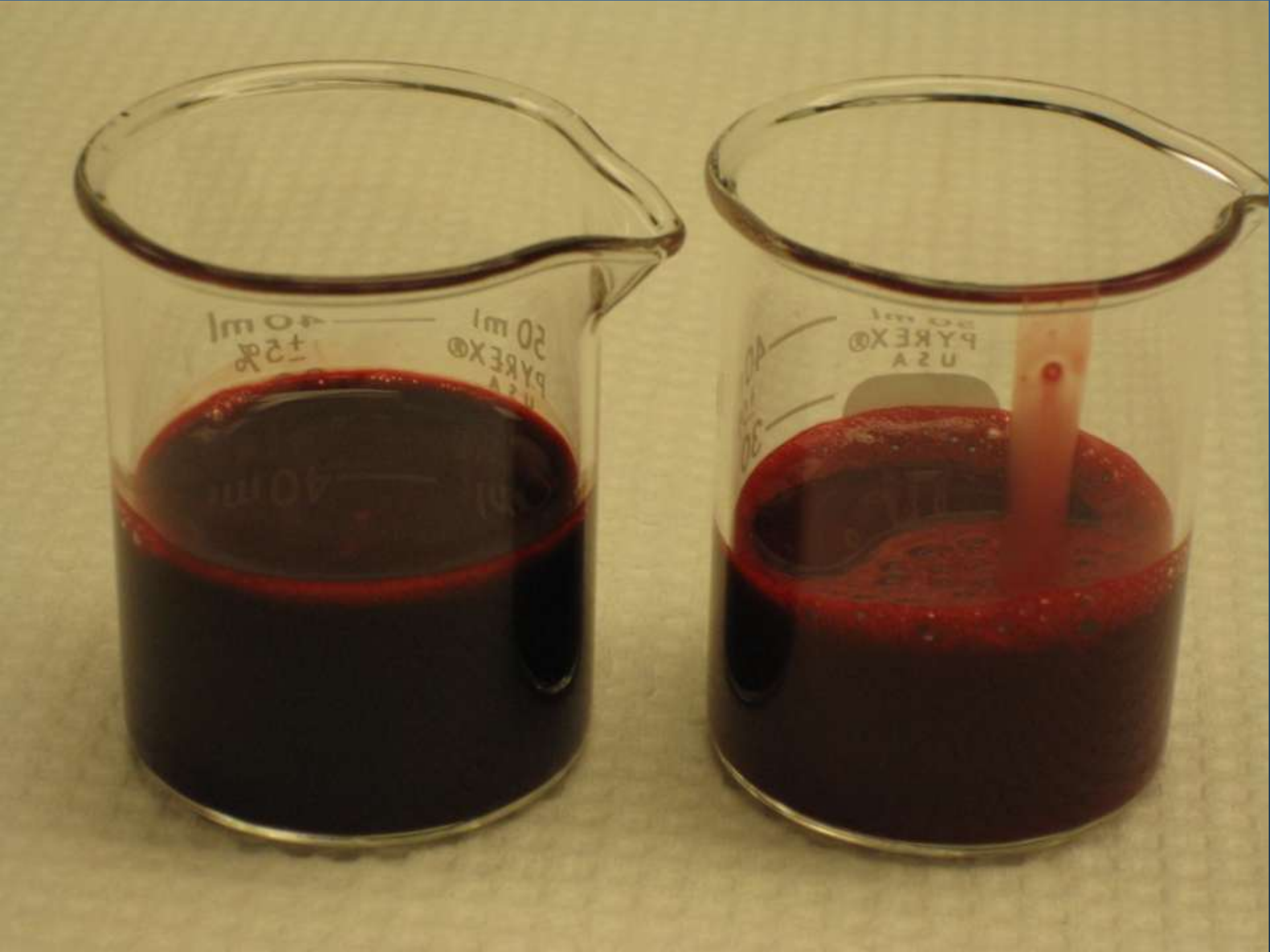
S: Was reportedly in closed garage c motor running x 45 minutes. Unresponsive when EMTs arrived; somnolent and intermittently combative since

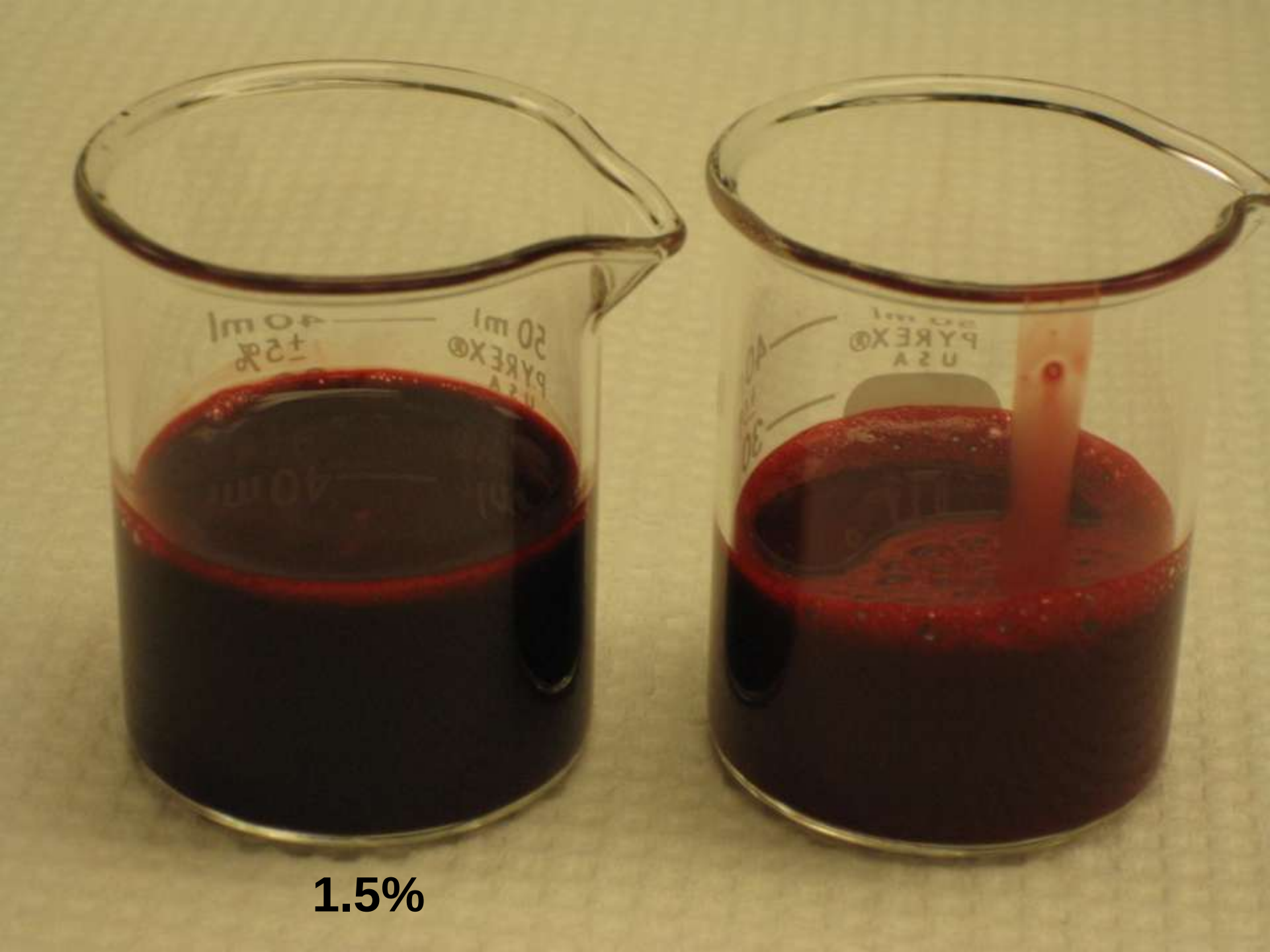
O: Cherry red skin - somnolent, rouses to voice & can mumble his first name only.
HbCO = 21% (@ 1 hour after removal from CO), mostly on 100% O,

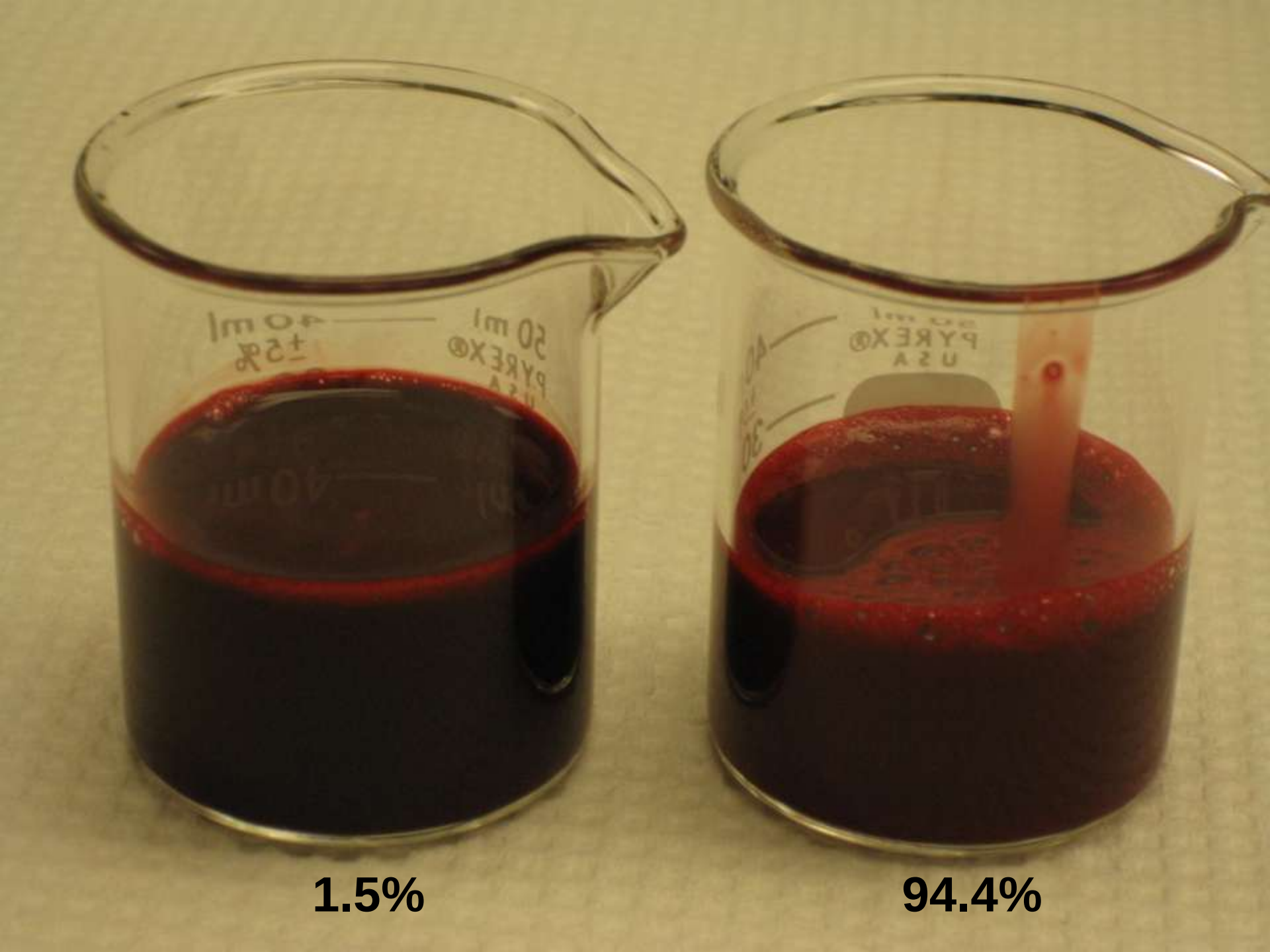
A: Carbon monoxide poisoning, peak levels of HbCO probably > 40%

P: Transfer, Virginia Mason for hyperbaric | 90506

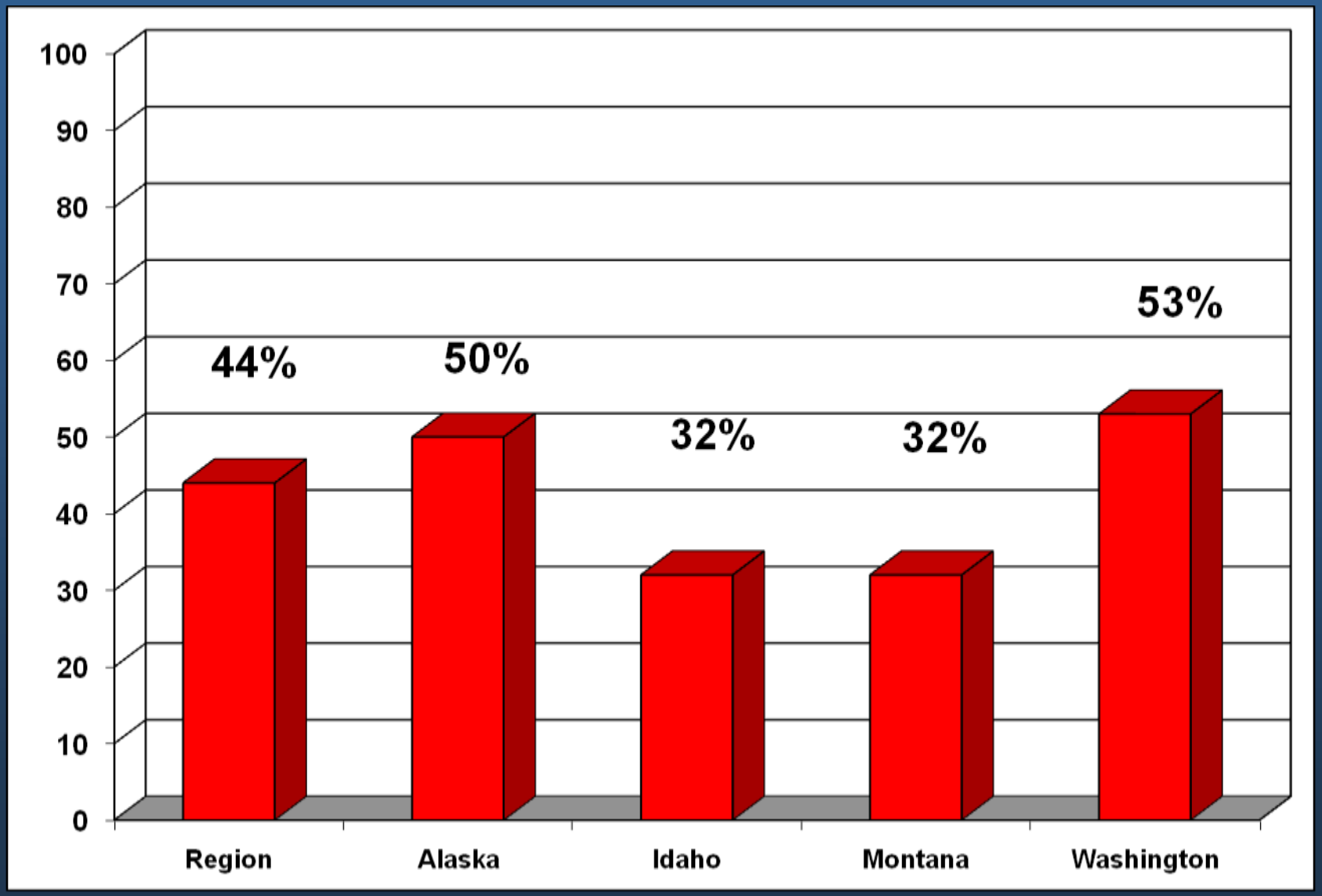
Photo courtesy Dr. Jim Caruso


50 ml
±5%
PYREX®
USA
PYREX®
USA


1.5%

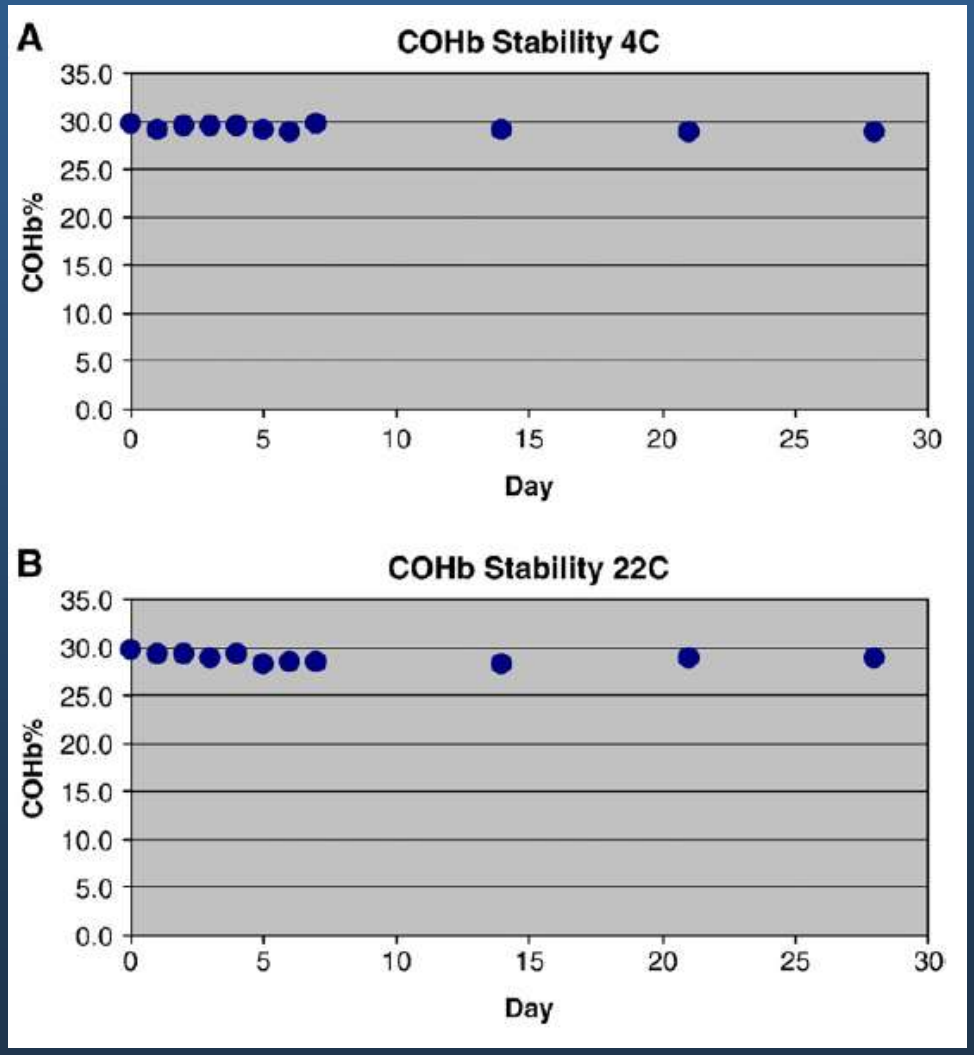

1.5%
94.4%

Hospitals able to Measure COHb



Hampson N. *J Emerg Med* 2006

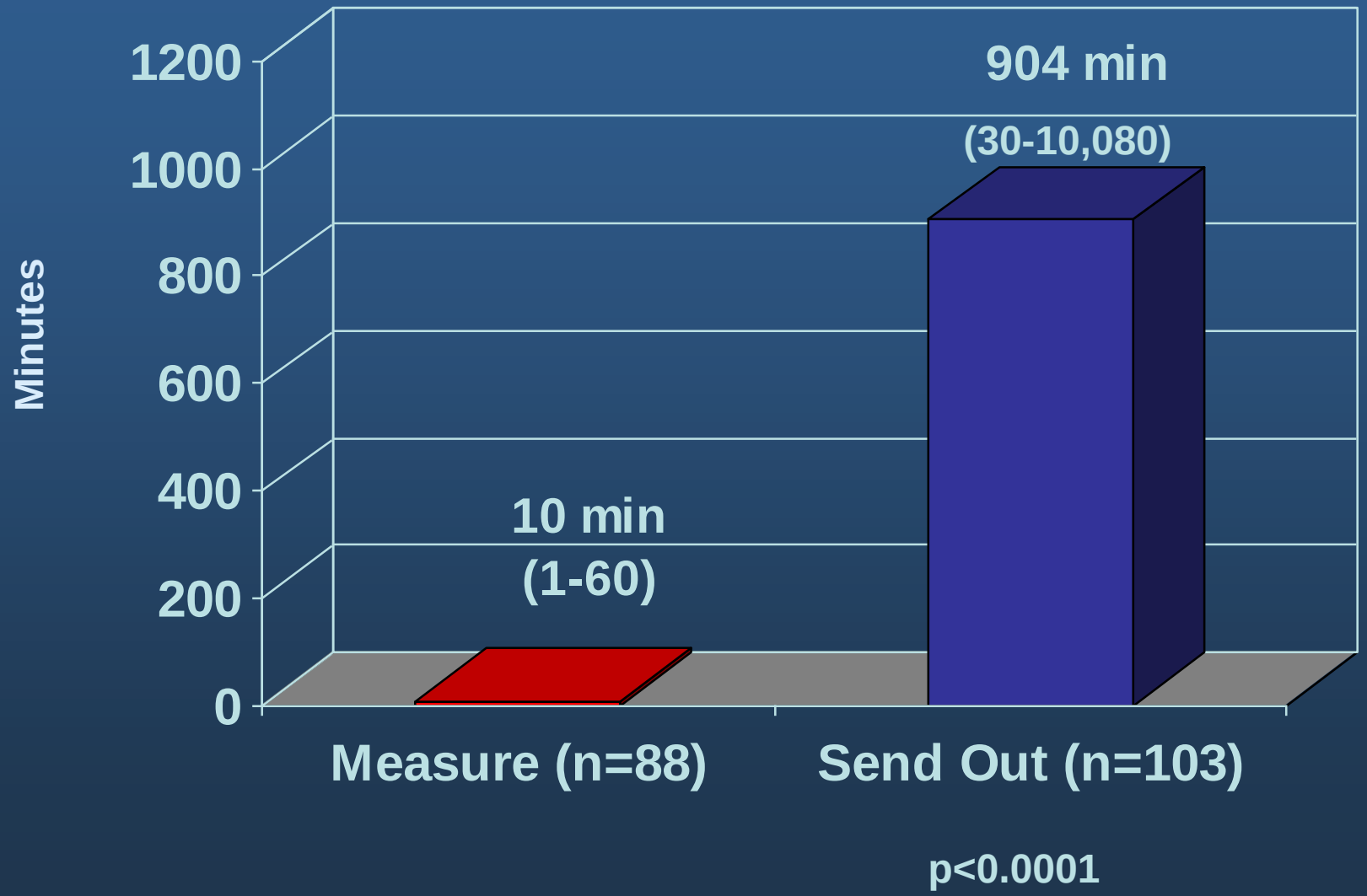
Stability of COHb Heparinized Blood Samples



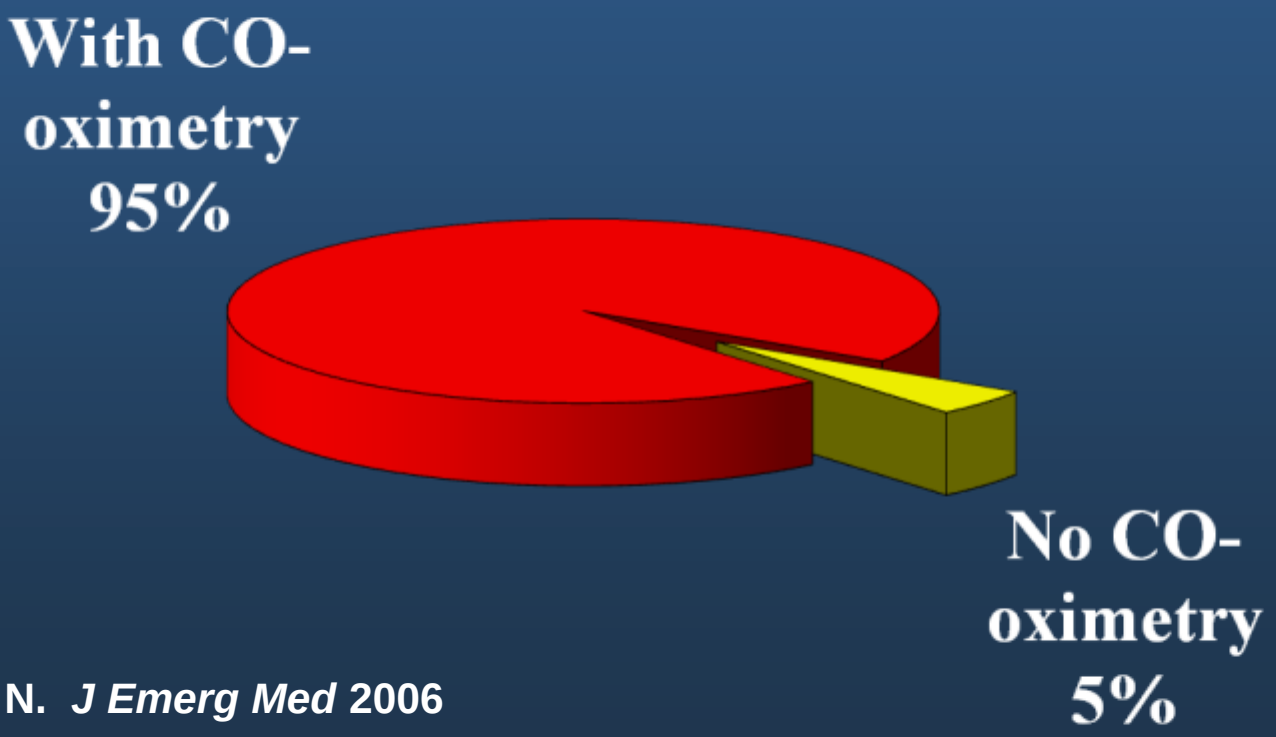
Hampson NB.

Am J Emerg Med 2007.

Time Required for COHb Result



Hospitals Referring CO-Poisoned Patients to VMMC for HBO_2 (2003-2004, n=85)



Hampson N. *J Emerg Med* 2006

Dispelling Myths About CO

1. ~~10,000 cases in US per year~~
2. ~~Most CO-poisoned patients are cherry red, precluding need for [COHb]~~

J Emerg Med 2006

Am J Emerg Med 2007

Dispelling Myths About CO

1. ~~10,000 cases in US per year~~
2. ~~Most CO-poisoned patients are cherry red, precluding need for [COHb]~~

   J Emerg Med 2006

   Am J Emerg Med 2007
3. "COHb level predicts clinical presentation"

Dispelling Myths About CO

1. ~~10,000 cases in US per year~~
2. ~~Most CO-poisoned patients are cherry red, precluding need for [COHb]~~

   J Emerg Med 2006

   Am J Emerg Med 2007

3. "COHb level predicts clinical presentation"

American Journal of Emergency Medicine (2008) **26**, 665–669

ELSEVIER

The American Journal of Emergency Medicine

www.elsevier.com/locate/ajem

Original Contribution

Carboxyhemoglobin levels in carbon monoxide poisoning: do they correlate with the clinical picture?☆

Neil B. Hampson MD[a,*], Niels M. Hauff BE[b]

[a]*Center for Hyperbaric Medicine, Section of Pulmonary and Critical Care Medicine, Virginia Mason Medical Center, Seattle, WA 98101, USA*
[b]*School of Medicine, University of Michigan, Ann Arbor, MI*

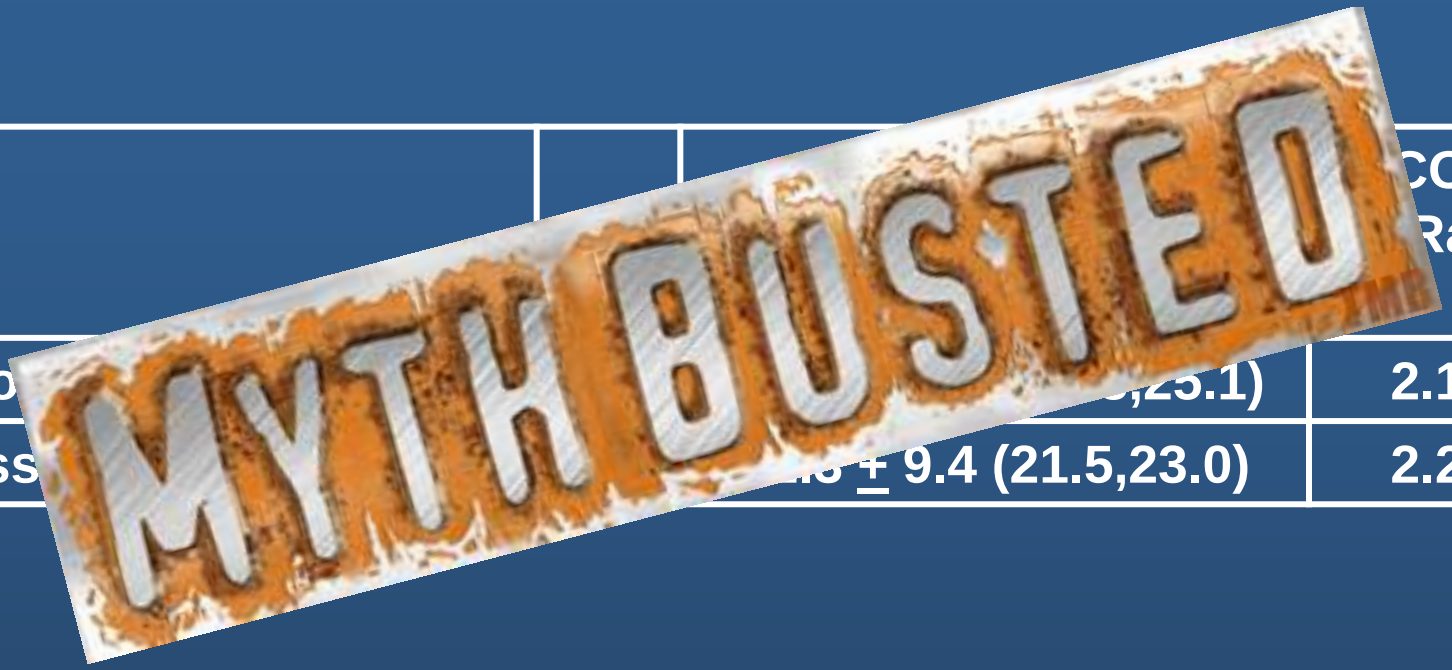
	No.	COHb% Mean ± SD (95% CI of the mean)	COHb% Range
All patients	1,407	22.3 ± 11.0 (22.7,23.9)	2.1-72.3
Male	922	24.2 ± 11.2 (23.5,24.9)	2.1-72.3
Female	485	21.5 ± 11.6 (20.6,22.5)	2.1-60.0
< 18 years old	228	19.5 ± 10.3 (18.2,20.8)	2.2-57.6
≥ 18 years old	1,179	24.0 ± 11.0 (23.4,24.7)	2.1-72.3
Accidental poisoning	972	22.8 ± 10.3 (22.2,23.4)	2.2-64.0
Intentional poisoning	427	23.4 + 12.4 (23.2,26.6)	2.1-72.3
Unknown intent	8		
Loss of consciousness	745	24.3 ± 12.2 (23.3,25.1)	2.1-72.3
No loss of consciousness	661	22.3 ± 9.4 (21.5,23.0)	2.2-61.0
Unknown	1		
Endotracheal intubation	247	24.8 ± 13.2 (23.0,26.3)	2.1-60.8
Not intubated	1,160	23.0 ± 10.5 (22.4,23.6)	2.2-72.3
Died (< 30 days)	37	32.1 ± 12.8 (27.9,36.4)	3.0-60.0
Survived (> 30 days)	1,370	23.1 + 10.9 (22.5,23.6)	2.1-72.3

	No.	COHb% Mean ± SD (95% CI of the mean)	COHb% Range
All patients	1,407	22.3 ± 11.0 (22.7,23.9)	2.1-72.3
Male	922	24.2 ± 11.2 (23.5,24.9)	2.1-72.3
Female	485	21.5 ± 11.6 (20.6,22.5)	2.1-60.0
< 18 years old	228	19.5 ± 10.3 (18.2,20.8)	2.2-57.6
≥ 18 years old	1,179	24.0 ± 11.0 (23.4,24.7)	2.1-72.3
Accidental poisoning	972	22.8 ± 10.3 (22.2,23.4)	2.2-64.0
Intentional poisoning	427	23.4 + 12.4 (23.2,26.6)	2.1-72.3
Unknown intent	8		
Loss of consciousness	745	24.3 ± 12.2 (23.3,25.1)	2.1-72.3
No loss of consciousness	661	22.3 ± 9.4 (21.5,23.0)	2.2-61.0
Unknown	1		
Endotracheal intubation	247	24.8 ± 13.2 (23.0,26.3)	2.1-60.8
Not intubated	1,160	23.0 ± 10.5 (22.4,23.6)	2.2-72.3
Died (< 30 days)	37	32.1 ± 12.8 (27.9,36.4)	3.0-60.0
Survived (> 30 days)	1,370	23.1 + 10.9 (22.5,23.6)	2.1-72.3

	No.	COHb% Mean ± SD (95% CI of the mean)	COHb% Range
Loss of consciousness	745	24.3 ± 12.2 (23.3,25.1)	2.1-72.3
No loss of consciousness	661	22.3 ± 9.4 (21.5,23.0)	2.2-61.0

Presenting COHb levels do NOT predict the clinical presentation.

			COHb% Range
Loss o		,23.1)	2.1-72.3
No loss		.3 ± 9.4 (21.5,23.0)	2.2-61.0



Presenting COHb levels do NOT predict the clinical presentation.

	No.	COHb% Mean ± SD (95% CI of the mean)	COHb% Range
All patients	1,407	22.3 ± 11.0 (22.7,23.9)	2.1-72.3
Male	922	24.2 ± 11.2 (23.5,24.9)	2.1-72.3
Female	485	21.5 ± 11.6 (20.6,22.5)	2.1-60.0
< 18 years old	228	19.5 ± 10.3 (18.2,20.8)	2.2-57.6
≥ 18 years old	1,179	24.0 ± 11.0 (23.4,24.7)	2.1-72.3
Accidental poisoning	972	22.8 ± 10.3 (22.2,23.4)	2.2-64.0
Intentional poisoning	427	23.4 + 12.4 (23.2,26.6)	2.1-72.3
Unknown intent	8		
Loss of consciousness	745	24.3 ± 12.2 (23.3,25.1)	2.1-72.3
No loss of consciousness	661	22.3 ± 9.4 (21.5,23.0)	2.2-61.0
Unknown	1		
Endotracheal intubation	247	24.8 ± 13.2 (23.0,26.3)	2.1-60.8
Not intubated	1,160	23.0 ± 10.5 (22.4,23.6)	2.2-72.3
Died (< 30 days)	37	32.1 ± 12.8 (27.9,36.4)	3.0-60.0
Survived (> 30 days)	1,370	23.1 + 10.9 (22.5,23.6)	2.1-72.3

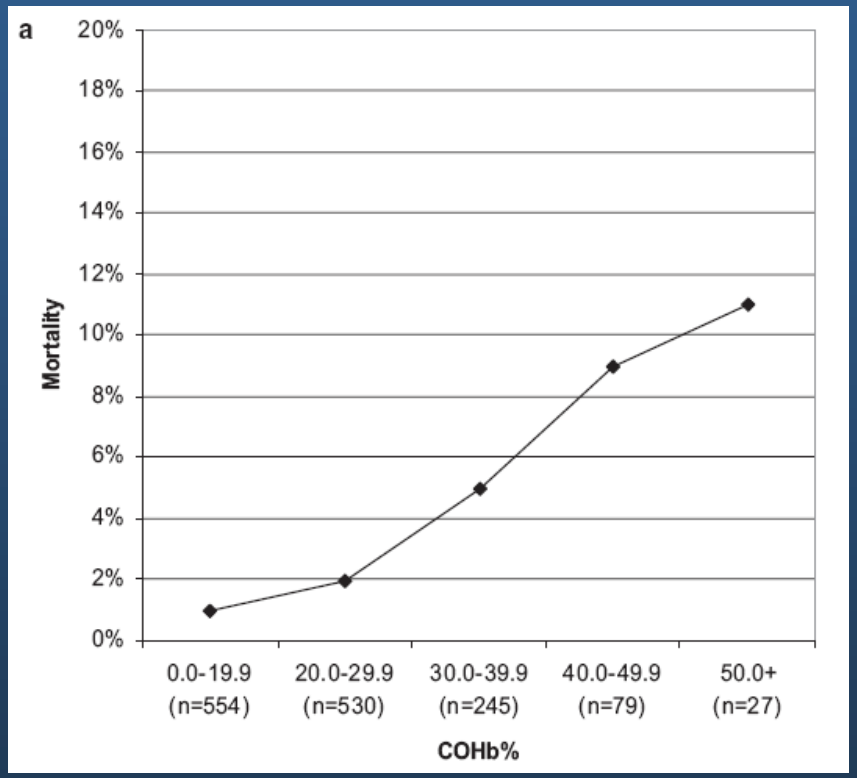
Dispelling Myths About CO

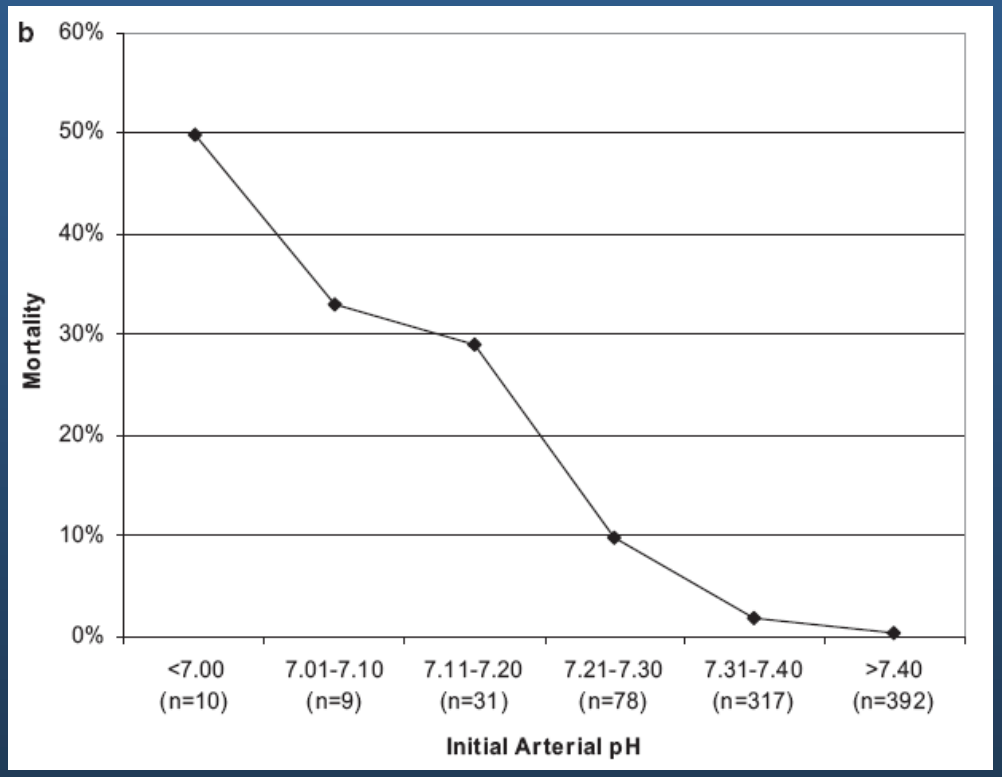
1. ~~10,000 cases in US per year~~
2. ~~Most CO-poisoned patients are cherry red~~
3. ~~COHb level predicts clinical presentation~~

   Am J Emerg Med 2008
4. "COHb level is the best predictor of short-term mortality"

Risk factors for short-term mortality from carbon monoxide poisoning treated with hyperbaric oxygen*

Neil B. Hampson, MD; Niels M. Hauff, BE





Crit Care Med 2008.

Dispelling Myths About CO

1. ~~10,000 cases in US per year~~
2. ~~Most CO-poisoned patients are cherry red~~
3. ~~COHb level predicts clinical presentation~~
4. ~~COHb level is the best predictor of short-term mortality~~

Crit Care Med 2008

5. "COHb level correlates with symptoms"

130 /	/	/	/	/	/
37.					

WEIGHT: ___
WOUND PREP: ___
ICE / ELEV: ___
HI BP ADV: ___
S.R. UP: ___

G: ___ P: ___

ORDERS	PHY	A #
O_2 pl per FM @ 10/L	m	
CO Level 24.4		

NURSING NOTES, COURSE IN E.D.

S: Ate spoiled chicken & beef from defrosted refrigerator. Also used BBQ inside for heat. Spanish speaking only

O: C/o stomach pain & HA on side of head. Emesis x 8.

A: Alt comfort & gas exchange

P: O_2, OBS

PHYSICIAN NOTES

H/A, nau, vom x 8 ↑ diarrhea, dizziness, dec ... ↓

PRIMARY CARE PHYSICIAN / NOTIFIED / TIME NO PHD	BROUGHT BY LW: /

	NUMBER	PHYSICIAN NAME	ACCIDENT	ACCIDENT DATE	ACC TIME
ADMITTING	10227	FINE, D			:00
ATTENDING	10227	FINE, D	ADMIT CODE / DIAGNOSIS		

COMPLAINT	ALLERGIES	
POSS FOOD POISONING	NKA	DC

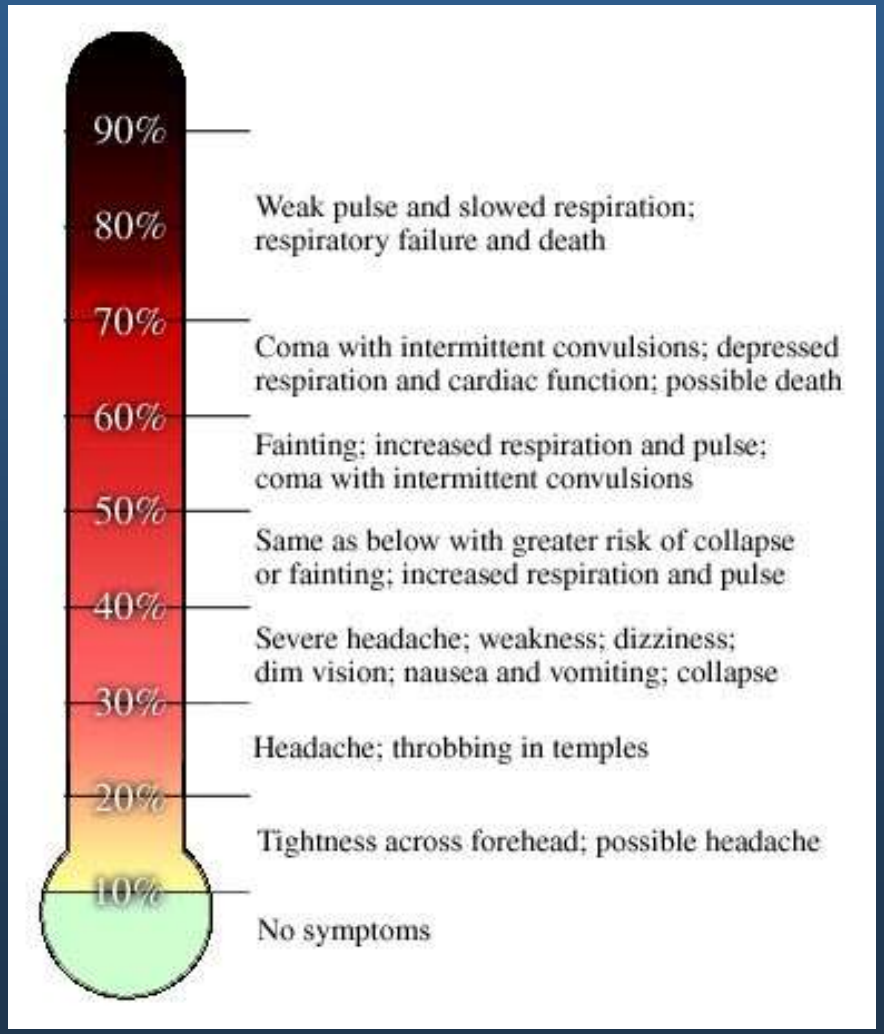
ED 300 1/93 96-0201-3

MEDICAL RECORDS

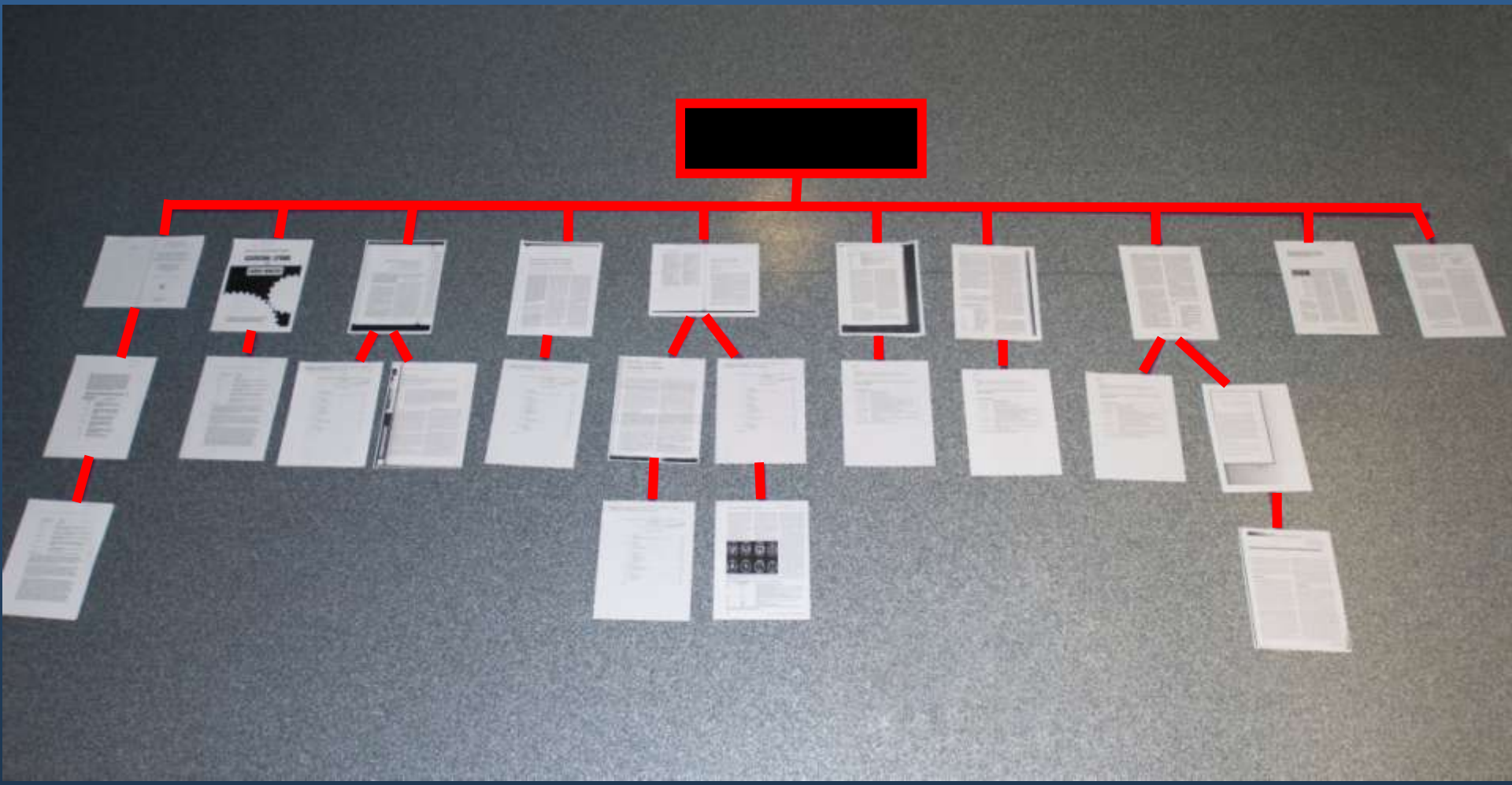
Common Table Correlating COHb with Symptoms

Table 1—*Symptoms Commonly Found with Different CO Levels*

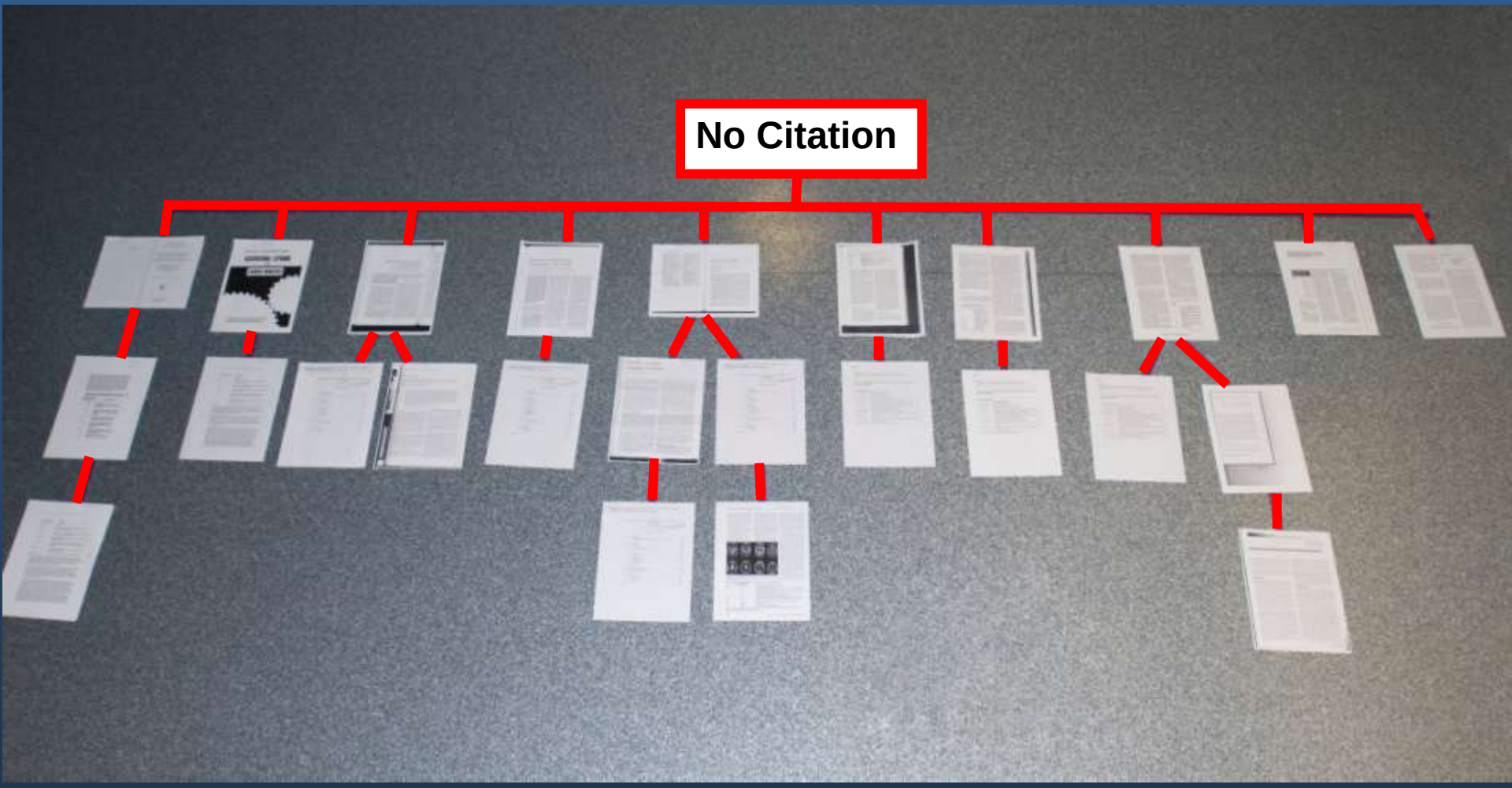
Blood Level of COHb, percent	Symptoms
0-10	Usually none in healthy individuals; reduced exercise tolerance in patients with pulmonary disease; decreased threshold for angina in patients with coronary heart disease
10-20	Headache; dyspnea on mild exertion; angina in patients with coronary heart disease; dilation of cutaneous vessels
20-30	Throbbing headache; nausea or vomiting (or both); easy fatigability and irritability; difficulty with concentration
30-40	Severe headache; dizziness; fatigue and weakness; syncope on exertion; impaired thought processes
40-50	Tachypnea; tachycardia; syncope; confusion
50-60	Respiratory failure; collapse; intermittent convulsions or seizures; coma
60-70	Respiratory failure; severe hypotension; coma, frequently fatal
>70	Coma, rapidly fatal



Origin of COHb vs Symptoms Table



Origin of COHb vs Symptoms Table



Technical Paper 373

DEPARTMENT OF COMMERCE
HERBERT HOOVER, SECRETARY
BUREAU OF MINES
D. A. LYON, ACTING DIRECTOR

THE PYROTANNIC ACID METHOD FOR THE QUANTITATIVE DETERMINATION OF CARBON MONOXIDE IN BLOOD AND IN AIR

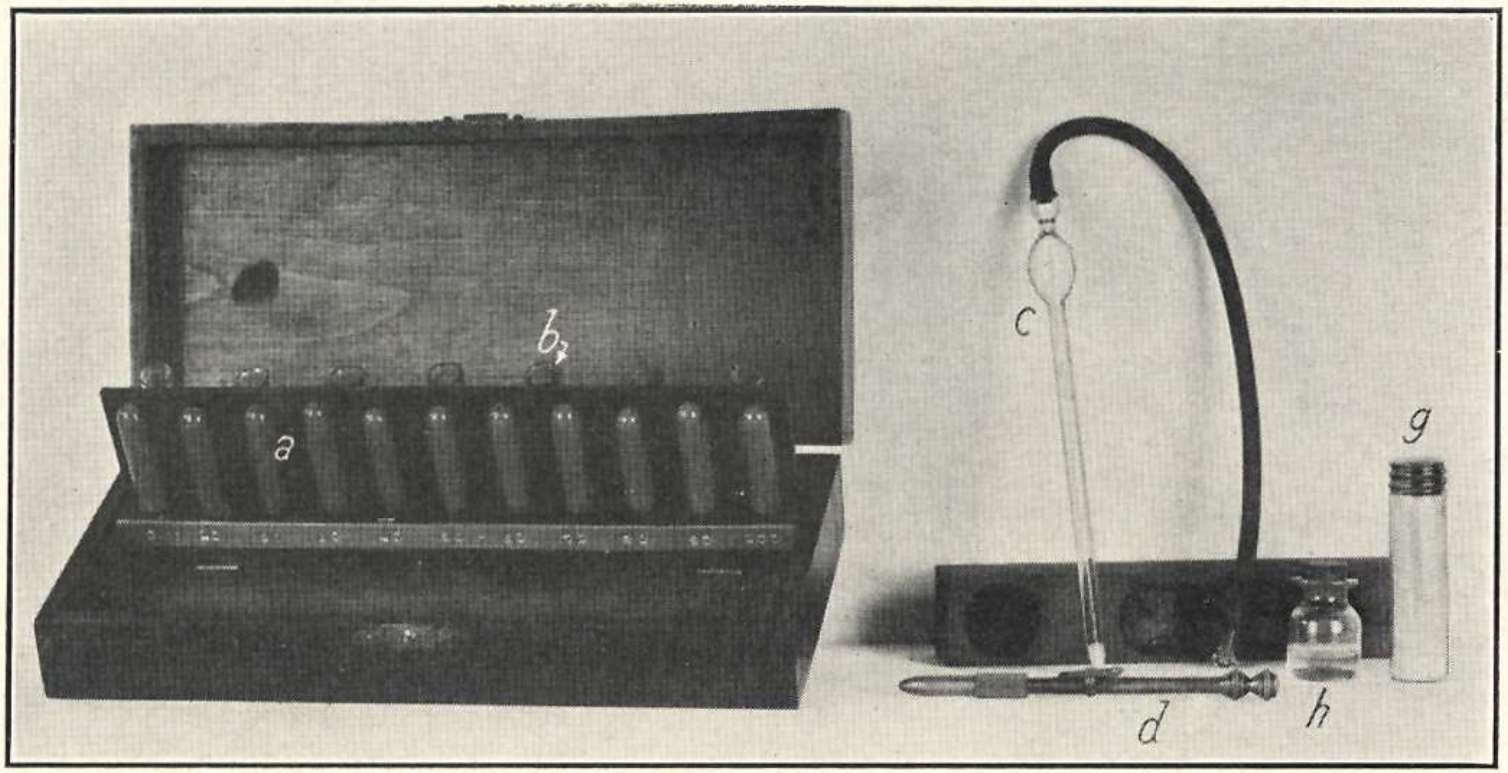
ITS USE IN THE DIAGNOSIS AND INVESTIGATION OF CASES OF CARBON MONOXIDE POISONING

BY

R. R. SAYERS and W. P. YANT

PRICE 5 CENTS
Sold by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1925



A. APPARATUS FOR DETERMINATION OF CO IN BLOOD SEE TEXT FOR EXPLANATION OF LETTERS


2
24
48
72
96

Symptoms caused by various percentages of carbon monoxide in the blood

Blood saturation *Per cent*	Symptoms
0—10	None.
10—20	Tightness across forehead; possibly slight headache.
20—30	Headache; throbbing in temples.
30—40	Severe headache, weakness, dizziness, dimness of vision, nausea and vomiting, collapse.
40—50	Same as previous item with more possibility of collapse and syncope, increased respiration and pulse.
50—60	Syncope; increased respiration and pulse, coma with intermittent convulsions; Cheyne-Stokes' respiration.
60—70	Coma with intermittent convulsions, depressed heart action and respiration, possibly death.
70—80	Weak pulse and slowed respiration; respiratory failure and death.

32126°—25——2

May, 1923.

REPORTS OF INVESTIGATIONS

DEPARTMENT OF THE INTERIOR - - BUREAU OF MINES

0 - 10	No symptoms.
0 - 20	Tightness across forehead; possibly slight headache, dilatation of cutaneous blood vessels.
20 - 30	Headache; throbbing in temples.
30 - 40	Severe headache, weakness, dizziness, dimness of vision, nausea and vomiting, collapse.
40 - 50	Same as previous item with more possibility of collapse and syncope, increased respiration and pulse.
50 - 60	Syncope, increased respiration and pulse; coma with intermittent convulsions; Cheyne-Stokes' respiration.
60 - 70	Coma with intermittent convulsions, depressed heart action and respiration, possibly death.
70 - 80	Weak pulse and slowed respiration; respiratory failure and death.

Table 1—*Symptoms Commonly Found with Different CO Levels*

Blood Level of COHb, percent	Symptoms
0-10	Usually none in healthy individuals; reduced exercise tolerance in patients with pulmonary disease; decreased threshold for angina in patients with coronary heart disease
10-20	Headache; dyspnea on mild exertion; angina in patients with coronary heart disease; dilation of cutaneous vessels
20-30	Throbbing headache; nausea or vomiting (or both); easy fatigability and irritability; difficulty with concentration
30-40	Severe headache; dizziness; fatigue and weakness; syncope on exertion; impaired thought processes
40-50	Tachypnea; tachycardia; syncope; confusion
50-60	Respiratory failure; collapse; intermittent convulsions or seizures; coma
60-70	Respiratory failure; severe hypotension; coma, frequently fatal
>70	Coma, rapidly fatal

PUBLIC HEALTH REPORTS

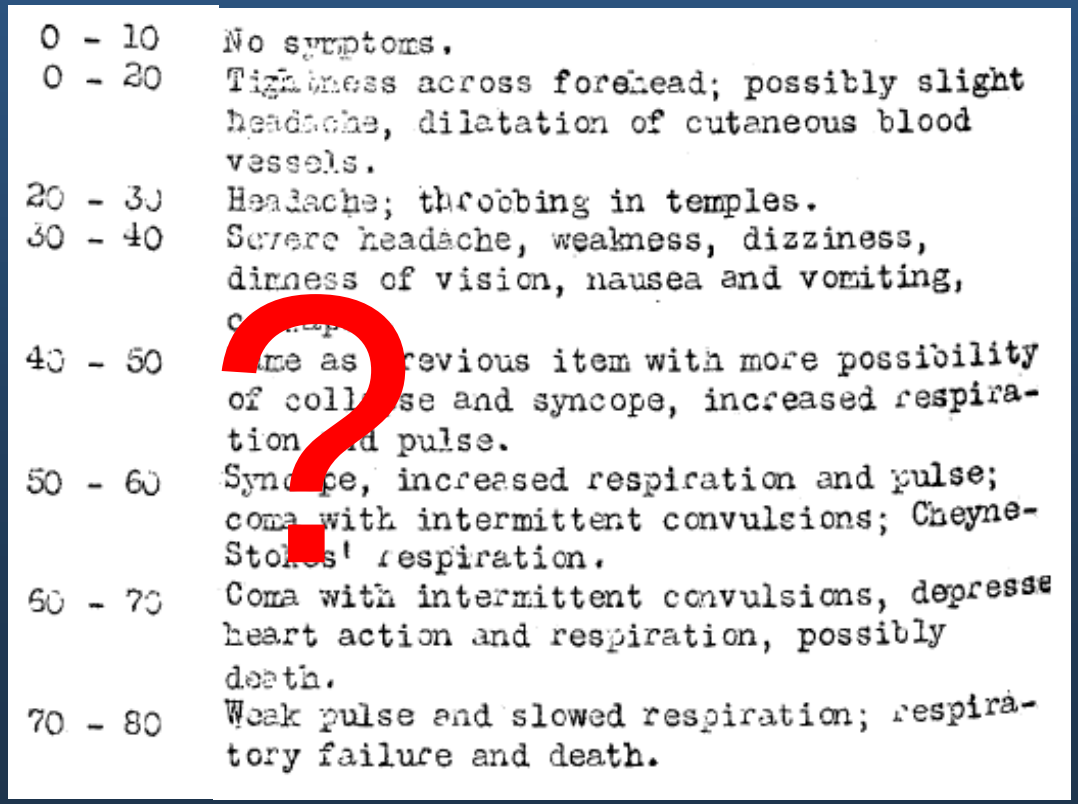
VOL. 37 MAY 12, 1922 No. 19

PHYSIOLOGICAL EFFECTS OF EXPOSURE TO LOW CONCENTRATIONS OF CARBON MONOXIDE.[1]

By R. R. SAYERS, Passed Assistant Surgeon, United States Public Health Service, Chief Surgeon, United States Bureau of Mines; F. V. MERIWETHER, Acting Assistant Surgeon, United States Public Health Service, Car Surgeon, United States Bureau of Mines; and W. P. YANT, Assistant Chemist, United States Bureau of Mines.

CO Exposures 1922

- 16 total exposures on 3 authors (Sayers 8)
- COHb 14-28%



0 - 10	No symptoms.
0 - 20	Tightness across forehead; possibly slight headache, dilatation of cutaneous blood vessels.
20 - 30	Headache; throbbing in temples.
30 - 40	Severe headache, weakness, dizziness, dimness of vision, nausea and vomiting, c[illegible]
40 - 50	[illegible]me as previous item with more possibility of coll[illegible]se and syncope, increased respiration [illegible]d pulse.
50 - 60	Syn[illegible]pe, increased respiration and pulse; coma with intermittent convulsions; Cheyne-Stok[illegible]s' respiration.
60 - 70	Coma with intermittent convulsions, depressed heart action and respiration, possibly death.
70 - 80	Weak pulse and slowed respiration; respiratory failure and death.

COHb	N	Headache	Dizziness	N/V	Confusion	Chest Pain	LOC
0.0-10.0%	98	65 (66%)	34 (35%)	49 (50%)	32 (33%)	9 (9%)	36 (37%)
10.1-20.0%	313	181 (58%)	131 (42%)	130 (42%)	88 (28%)	26 (8%)	142 (45%)
20.1-30.0%	368	243 (66%)	195 (53%)	158 (43%)	114 (31%)	36 (10%)	163 (44%)
30.1-40.0%	183	85 (46%)	61 (33%)	60 (33%)	51 (28%)	17 (5%)	130 (71%)
40.1-50.0%	63	17 (27%)	19 (30%)	15 (24%)	20 (32%)	6 (10%)	52 (82%)
>50.0%	10						10 (100%)
	1025	526	406	363	273	85	533

Hampson et al. *UHM*, 2012.


29 . 2. 64

Dispelling Myths About CO

6. “CO-induced headache is throbbing and temporal in location”

Dispelling Myths About CO

6. “CO-induced headache is throbbing and temporal in location”

Prospective Evaluation of Headache

- Standardized HA questionnaire administered to 100 consecutive patients with CO poisoning and headache
- Location - frontal 66%, temporal 52%, occipital 47%, bitemporal alone 13%
- Constant 74%, throbbing 41%

Characteristics of Headache Associated With Acute Carbon Monoxide Poisoning

Neil B. Hampson, MD; Lindsay A. Hampson

Objective.—To evaluate systematically the characteristics of headache due to acute exposure to carbon monoxide.

Background.—Headache is the most commonly reported symptom in acute carbon monoxide poisoning. While it is often described as throbbing and diffuse, a systematic characterization of carbon monoxide-associated headache has never been published.

Methods.—Patients referred for hyperbaric oxygen treatment of acute carbon monoxide poisoning were asked whether headache was part of their symptom complex. When present, specific details about the nature of the headache were collected from 100 consecutive patients through use of a standardized questionnaire.

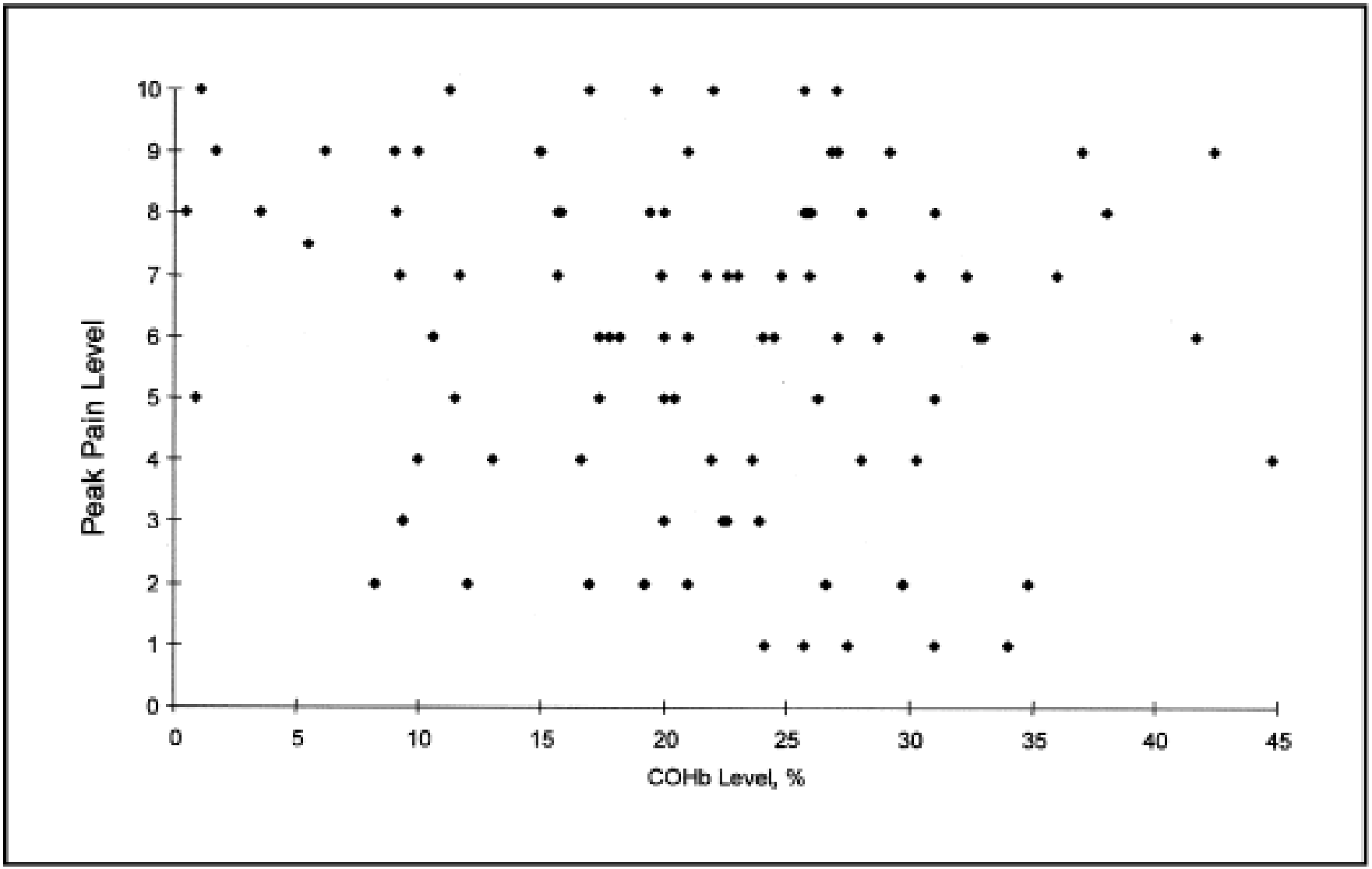
Results.—Information on carbon monoxide-associated headache was collected from 34 female and 66 male patients with a mean carboxyhemoglobin level of 21.3% ± 9.3%. The most common location for pain was frontal (66%), although more than one location was involved in 58% of patients. Nature of the pain at any time during its course was dull in 72% of patients and sharp in 36%. Headache was throbbing in 41%, continuous in 74%, and intermittent in 16% of those evaluated. Peak intensity of pain did not correlate with the carboxyhemoglobin level. Headache improved prior to hyperbaric oxygen treatment in 72%, resolving entirely in 21%. Of those with residual headache, pain improved with hyperbaric oxygen in 97%, resolving entirely in 44%.

Conclusions.—The headache accompanying acute carbon monoxide poisoning is extremely variable in nature. "Classic" throbbing, diffuse headaches were rarely described by patients. There are no patterns which can be considered characteristic to aid in the diagnosis of carbon monoxide-induced headache. Similarly, no trait was identified which might allow elimination of carbon monoxide poisoning from the differential diagnosis of headache.

Key words: headache, carbon monoxide, poisoning

Abbreviations: CO carbon monoxide, HBO_2 hyperbaric oxygen, COHb carboxyhemoglobin

(*Headache.* 2002;42:220-223)



Relationship of blood carboxyhemoglobin level to peak head pain intensity.

Dispelling Myths About CO

~~6. CO-induced headache is throbbing~~

Headache 2002

7. “CO-poisoning predisposes to increased risk of cardiac death”

Dispelling Myths About CO

6. ~~CO-induced headache is throbbing~~

   Headache 2002

7. "CO-poisoning predisposes to increased risk of cardiac death"

Myocardial Injury and Long-term Mortality Following Moderate to Severe Carbon Monoxide Poisoning

Christopher R. Henry, BS
Daniel Satran, MD
Bruce Lindgren, MS
Cheryl Adkinson, MD
Caren I. Nicholson, RN
Timothy D. Henry, MD

Context Carbon monoxide (CO) poisoning is a common cause of toxicological morbidity and mortality. Myocardial injury is a frequent consequence of moderate to severe CO poisoning. While the in-hospital mortality for these patients is low, the long-term outcome of myocardial injury in this setting is unknown.

Objective To determine the association between myocardial injury and long-term mortality in patients following moderate to severe CO poisoning.

Design, Setting, and Participants Prospective cohort study of 230 consecutive adult patients treated for moderate to severe CO poisoning with hyperbaric oxygen and admitted to the Hennepin County Medical Center, a regional center for treatment of CO poisoning, between January 1, 1994, and January 1, 2002. Follow-up was through November 11, 2005.

Main Outcome Measure All-cause mortality.

Results Myocardial injury (cardiac troponin I level ≥0.7 ng/mL or creatine kinase-MB level ≥5.0 ng/mL and/or diagnostic electrocardiogram changes) occurred in 85 (37%) of 230 patients. At a median follow-up of 7.6 years (range: in-hospital only to 11.8 years), there were 54 deaths (24%). Twelve of those deaths (5%) occurred in the hospital as a result of a combination of burn injury and anoxic brain injury (n=8) or cardiac arrest and anoxic brain injury (n=4). Among the 85 patients who sustained myocardial injury from CO poisoning, 32 (38%) eventually died compared with 22 (15%) of 145 patients who did not sustain myocardial injury (adjusted hazard ratio, 2.1; 95% confidence interval, 1.2-3.7; $P=.009$).

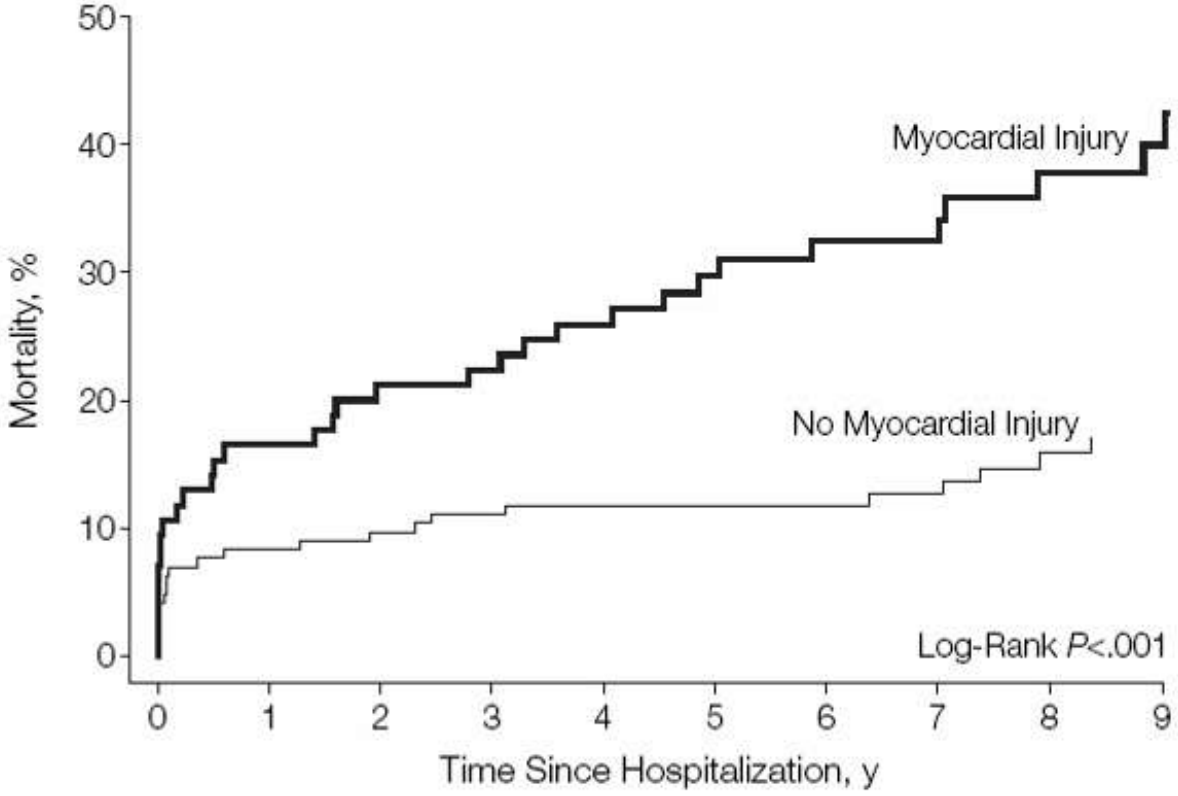
Conclusion Myocardial injury occurs frequently in patients hospitalized for moderate to severe CO poisoning and is a significant predictor of mortality.

JAMA. 2006;295:398-402 www.jama.com

CARBON MONOXIDE (CO) POISONING is a common cause of toxicological morbidity and mortality. From 1968 through 1998, the Centers for Disease Control and Prevention reported that CO poisoning contributed to an average of 1091 unintentional deaths and 2385 suicidal deaths per year in the United States.[1,2] Although the annual death rate from CO poisoning has declined over time, CO remains the most common type of accidental poisoning in the Unites States, contributing to 40 000 emergency department visits annually.[3] Carbon monoxide poisoning can occur with expo-

Henry 2006 “Long-term” Mortality

Figure. Mortality of Patients With and Without Myocardial Injury



No. at Risk					
Myocardial Injury	85	67	61	45	31
No Myocardial Injury	145	131	126	102	71

Henry's Analysis of "Long-term" Mortality

	Total Deaths (n=54)	Known Cause (n=41)		Unknown cause (n=13)
		Cardiac	Noncardiac	
Myocardial injury (n=85)	32/85 (38%)	14	12	6
No myocardial injury (n=145)	22/145 (15%)	4	11	7

Henry's Analysis of "Long-term" Mortality

	Total Deaths (n=54)	Known Cause (n=41)		Unknown cause (n=13)
		Cardiac	Noncardiac	
Myocardial injury (n=85)	32/85 (38%)	14	12	6
No myocardial injury (n=145)	22/145 (15%)	4	11	7

Henry's Analysis of "Long-term" Mortality

	Total Deaths (n=54)	Known Cause (n=41)		Unknown cause (n=13)
		Cardiac	Noncardiac	
Myocardial injury (n=85)	32/85 (38%)	14	12	6
No myocardial injury (n=145)	22/145 (15%)	4	11	7

My Analysis of Henry's Data

	Total Deaths (n=54)	In Hospital Deaths (n=12)		
		Total	Cardiac	Noncardiac
Myocardial injury (n=85)	32/85 (38%)	6	4	2
No myocardial injury (n=145)	22/145 (15%)	6	0	6

	Long-term deaths (n=42)			
	Total	Cardiac	Noncardiac	Unknown
Myocardial injury (n=85)	26	10	10	6
No myocardial injury (n=145)	16	4	5	7

Myocardial Injury and Long-term Mortality Following Moderate to Severe Carbon Monoxide Poisoning

Christopher R. Henry, BS
Daniel Satran, MD
Bruce Lindgren, MS
Cheryl Adkinson, MD
Caren I. Nicholson, RN
Timothy D. Henry, MD

Context Carbon monoxide (CO) poisoning is a common cause of toxicological morbidity and mortality. Myocardial injury is a frequent consequence of moderate to severe CO poisoning. While the in-hospital mortality for these patients is low, the long-term outcome of myocardial injury in this setting is unknown.

Objective To determine the association between myocardial injury and long-term mortality in patients following moderate to severe CO poisoning.

Design, Setting, and Participants Prospective cohort study of 230 consecutive adult patients treated for moderate to severe CO poisoning with hyperbaric oxygen

CARBON MONOXIDE (CO) POI-
soning is a common cau
toxicological morbidity
mortality. From 1968 thru
1998, the Centers for Disease Co
and Prevention reported that CO
soning contributed to an average of
unintentional deaths and 2385 sui
deaths per year in the United Stat
Although the annual death rate from
poisoning has declined over time,
remains the most common type o
cidental poisoning in the Unites St
contributing to 40 000 emergency
partment visits annually.[3] Carbon
oxide poisoning can occur with e

Increased long-term mortality among survivors of acute carbon monoxide poisoning*

Neil B. Hampson, MD; Rose Anne Rudd, MSPH; Niels M. Hauff, BE

Objective: Recent data suggest that patients surviving acute carbon monoxide (CO) poisoning (COP) may have increased risk for long-term mortality. The objective of this study was to analyze long-term mortality of a large population of CO-poisoned patients treated at one medical center over three decades.

Design: Retrospective cohort study of patients treated with hyperbaric oxygen and surviving the acute poisoning episode. Long-term mortality was compared to a standard population. Comparison of mortality within the cohort by clinical indicators of poisoning severity was assessed using Cox proportional hazards regression analysis.

Setting: Regional referral center for hyperbaric treatment of COP.

Patients: One thousand seventy-three patients aged ≥18 years treated from 1978 to 2005.

Interventions: All patients received hyperbaric oxygen treatment.

Measurements and Main Results: During 11,741 person-years of follow-up, 162 subjects died. The expected number of deaths was 87 (standardized mortality ratio [SMR]), 1.9; 95% confidence interval [CI], 1.6–2.2). Most of the excess mortality was in the group treated initially for intentional COP (58 excess deaths; SMR, 3.7; 95% CI, 2.9–4.6) vs. those treated for accidental COP (17 excess deaths; SMR, 1.3; 95% CI, 1.01–1.6). For the entire cohort, the major causes of death with significantly raised mortality were mental and psychiatric disorders, injuries, and violence. More specific causes of death with significantly raised mortality were alcoholism, motor vehicle accidents with pedestrians, motor vehicle accidents of unspecified type, accidental poisonings, and intentional self-harm. Within cohort comparisons showed that no difference in survival was observed by measure of CO poisoning severity, after controlling for age at poisoning, sex, race, and intent of CO poisoning.

Conclusions: Adult survivors of acute CO poisoning treated with hyperbaric oxygen were at increased risk for long-term mortality. Such patients should be followed closely after discharge with consideration given to psychiatric and/or neurocognitive evaluation, as appropriate. (Crit Care Med 2009; 37:1941–1947)

KEY WORDS: carbon monoxide; poisoning; mortality; cause of death

Long Term Mortality in CO Poisoning

- Analyzed 1,073 patients 1978-2005 *(vs. 230)*
- 11,742 person-years at risk *(vs. 1,748)*
- 162 deaths with 87 expected (SMR 1.9)
- Intentional SMR 3.7, accidental 1.3
- Causes of death: completed suicide, MVA, falls, accidental poisoning
- No increase in cardiac mortality

Hampson NB. *Crit Care Med* 2009

Dispelling Myths About CO

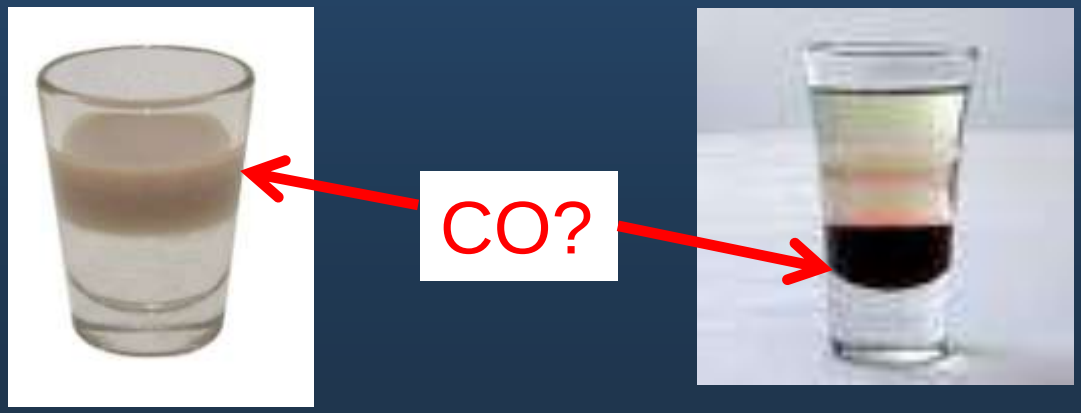
6. ~~CO-induced headache is throbbing~~
7. ~~CO-poisoning predisposes to increased risk of cardiac death~~

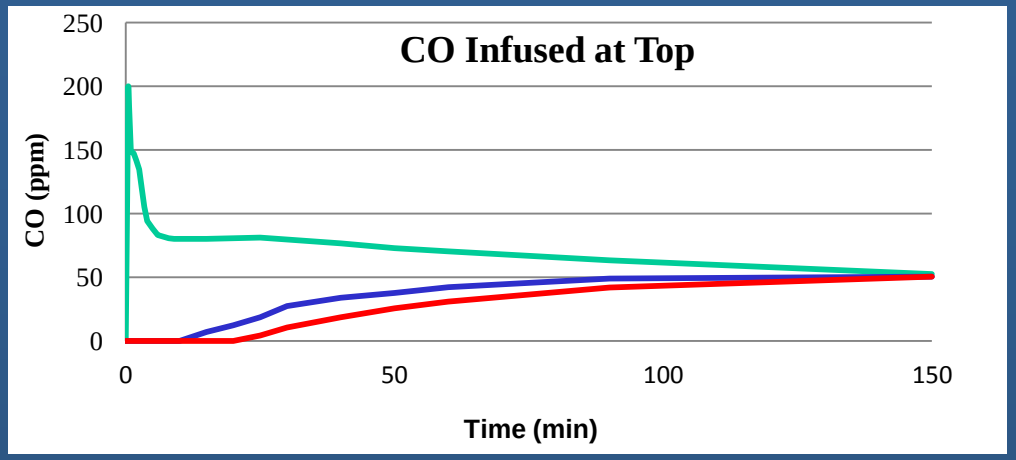
Crit Care Med 2009

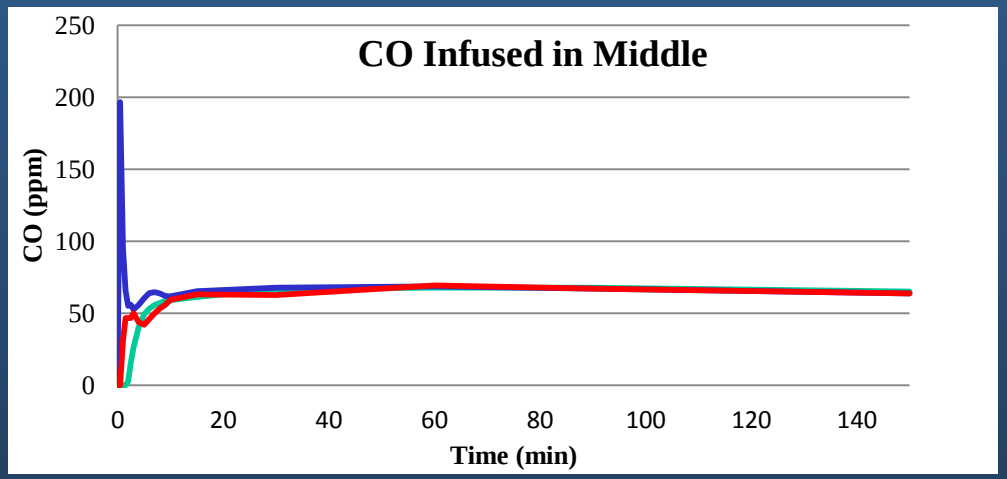
8. “CO is lighter than air so it accumulates near the ceiling”

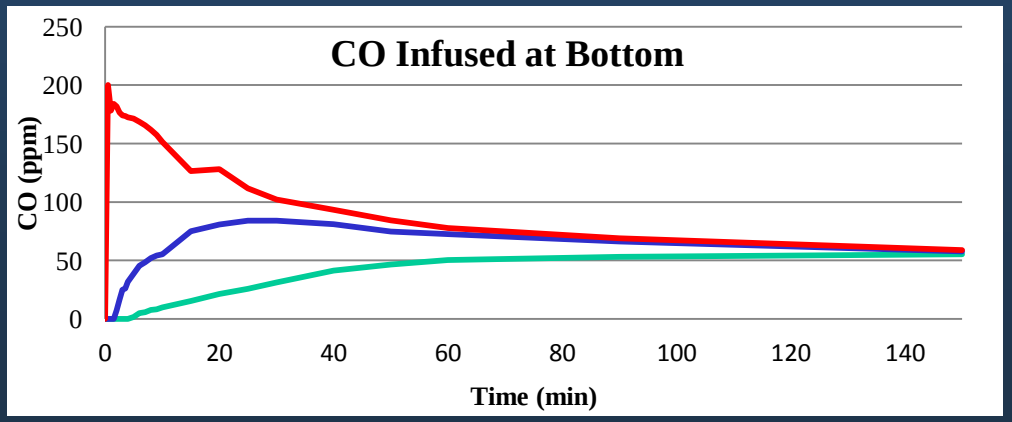
The Internet tells you whatever you want to find

- “Plugging CO alarms into sockets near the floor is less effective because CO rises.” (shopwiki.com)
- “Carbon monoxide is heavier than air and will pool in lower areas.” (askville.amazon.com)




CO Infused at Top
CO (ppm)
250
200
150
100
50
0
0
50
100
150
Time (min)


CO Infused in Middle
CO (ppm)
250
200
150
100
50
0
0
20
40
60
80
100
120
140
Time (min)


CO Infused at Bottom
CO (ppm)
250
200
150
100
50
0
0
20
40
60
80
100
120
140
Time (min)

Dispelling Myths About CO

~~6. CO-induced headache is throbbing~~

~~7. CO-poisoning predisposes to increased risk of cardiac death~~

~~8. CO is lighter than air so it concentrates near the ceiling~~

J Emerg Med 2012

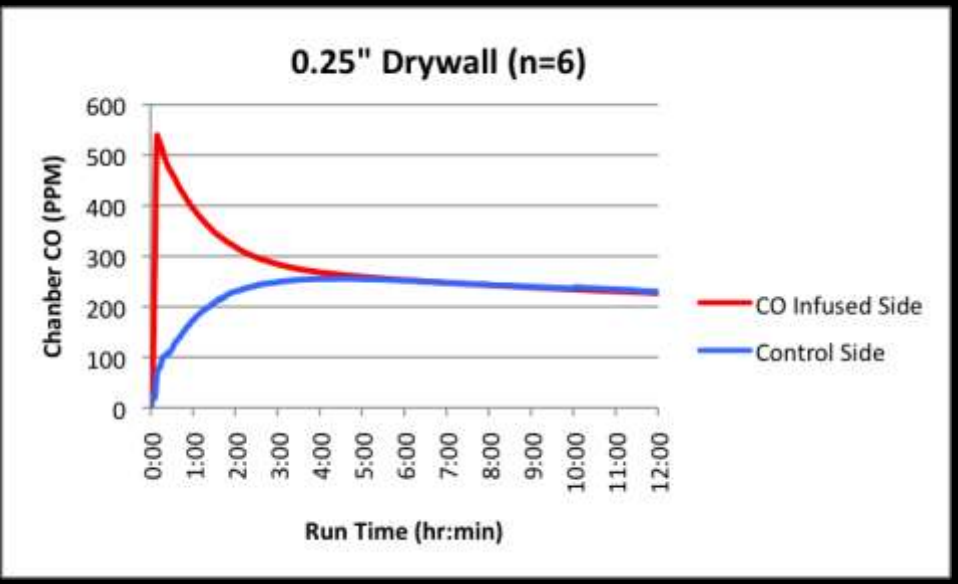
9. “Without fuel-burning appliances in the home, there is no risk for CO exposure”

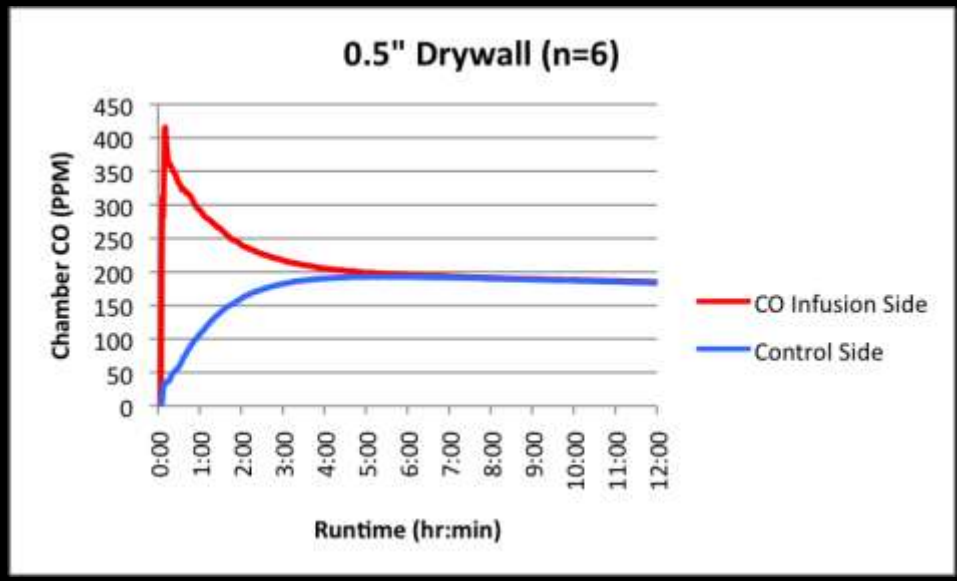
Of 46 states mandating residential CO alarms, 33 (73%) exclude residences without fuel burning appliances, fireplaces and/or the presence of an attached garage

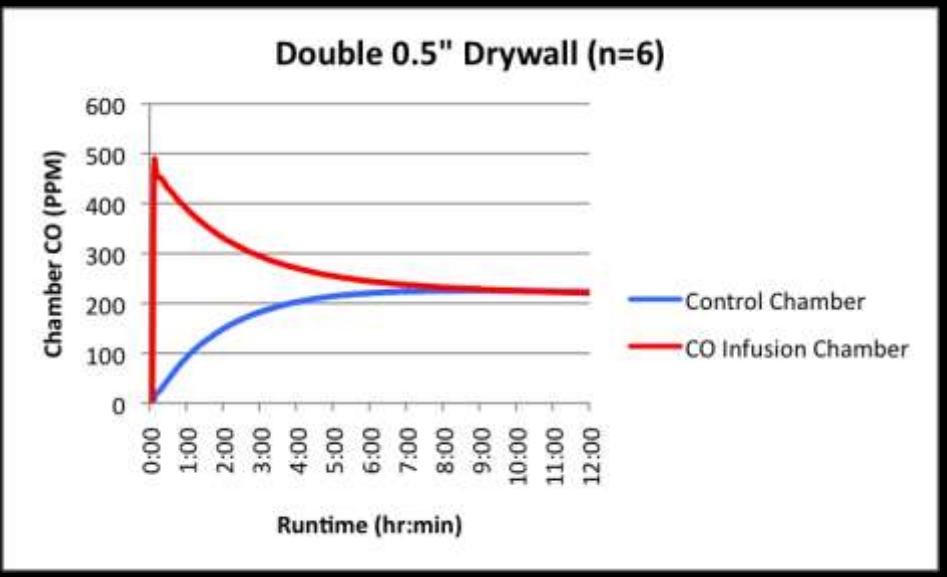
CO Poisonings in More than One Unit of a Multifamily Dwelling

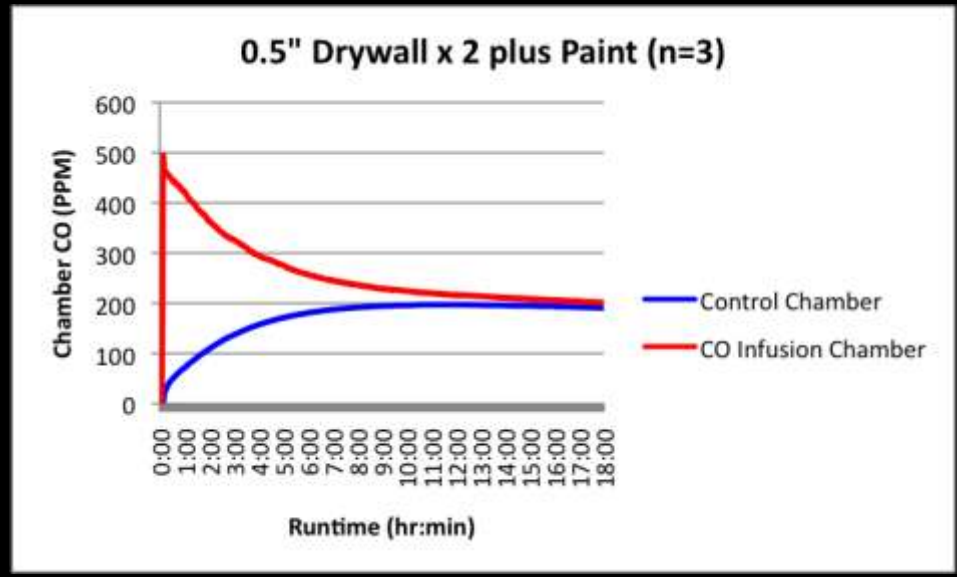
- Typically explained by CO diffusion through public spaces or ductwork
- But sometimes CO appears to pass through walls
- Can CO diffuse through gypsum wallboard?

CO Diffusion Chamber


0.25" Drywall (n=6)
Chanber CO (PPM)
600
500
400
300
200
100
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
Run Time (hr:min)
CO Infused Side
Control Side


0.5" Drywall (n=6)
Chamber CO (PPM)
450
400
350
300
250
200
150
100
50
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
Runtime (hr:min)
CO Infusion Side
Control Side


Double 0.5" Drywall (n=6)
Chamber CO (PPM)
600
500
400
300
200
100
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
Runtime (hr:min)
Control Chamber
CO Infusion Chamber


0.5" Drywall x 2 plus Paint (n=3)
Chamber CO (PPM)
600
500
400
300
200
100
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
Runtime (hr:min)
Control Chamber
CO Infusion Chamber


BUSTED

Dispelling Myths About CO

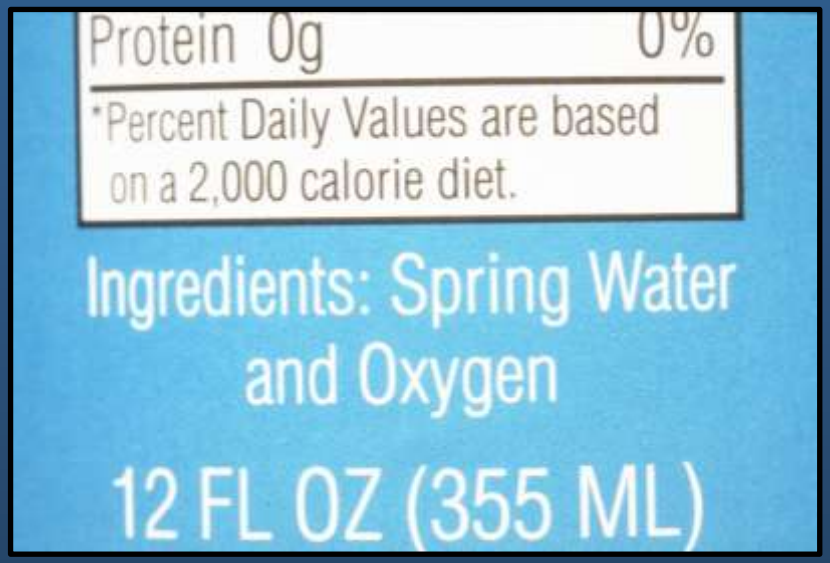
6. ~~CO-induced headache is throbbing~~
7. ~~CO-poisoning predisposes to increased risk of cardiac death~~
8. ~~CO is lighter than air so it concentrates near the ceiling~~
9. ~~Without fuel-burning appliances in the home, there is no risk for CO exposure~~

JAMA 2013

Let's Take Down an Industry

!Oxygenated Waters 2003

Bold Claims about Athletic Performance



"Enhanced sports performance"
"Improves cardiovascular and sports endurance"

Table 1. Results of Water P_{O_2} Measurements*

Sample	P_{O_2}, mm Hg	Calculated o_2 Content, mL o_2 per 100 mL Water
Oxygenated water		
Brand 1	133	2.5
Brand 2	505	9.5
Brand 3	555	10.5
Brand 4	637	12.0
Brand 5	1184	22.6
Tap water	127	2.5

*Maximum value of triplicate measurements corrected to 37°C.

Hampson NB, Pollock NW, Piantadosi CA. *JAMA* 2003

Human Exercise Data

Table 2. Summed Data for Maximal Exercise Performance Variables in Participants (N = 11) Following Consumption of Oxygenated or Tap Water

Performance Variable	Oxygenated Water, Mean (SD)	Nonoxygenated Water, Mean (SD)	Mean (95% CI) Difference	*P* Value (2-Tailed)
Vo_{2max}, L/min	3.13 (0.67)	3.14 (0.72)	–0.01 (–0.12 to 0.10)	.90
Vo_{2max}, mL/min per kg	40.2 (6.1)	40.1 (6.3)	0.1 (–1.20 to 1.40)	.87
Metabolic equivalents*	11.5 (1.8)	11.5 (1.8)	0 (–0.40 to 0.40)	.92
VCo_2, L/min	3.88 (0.77)	3.88 (0.96)	0 (–0.20 to 0.20)	.96
Peak heart rate, bpm	179 (11)	181 (14)	–2 (–7.00 to 3.00)	.38
Ratio of Co_2 output to o_2 uptake	1.26 (0.07)	1.25 (0.10)	0.01 (–0.03 to 0.05)	.62
V_E, L/min	123.6 (33.2)	123.1 (37.1)	0.5 (–9.60 to 10.60)	.93
Ventilatory equivalent for o_2 (V_E/Vo_2)	39.553 (6.246)	39.150 (7.140)	0.404 (–1.84 to 2.64)	.73
o_2 pulse, mL/beat†	17.563 (4.186)	17.424 (4.604)	0.139 (–0.52 to 0.80)	.69

Abbreviations: VCo_2, carbon dioxide production; V_E, minute ventilation at peak exercise; Vo_{2max}, maximal oxygen uptake.
*o_2 uptake divided by standard assumed resting oxygen uptake (3.5 mL/kg per min).
†o_2 uptake divided by heart rate.

THE DR. OZ SHOW

Oxygenated Water: Great stuff? Or Just Water?

The bottom line? This is an easy one. Don't get ripped off by oxygenated water.

Does Oxygenated Water Provide Health Benefits?

Science does not support the claims that oxygenated water manufacturers promise.

Oxygenated water nonsense

Junk science in the marketplace

Unless you have gills, it's just an expensive burp!

Oxygenated Waters 2014

Myth Busting

Myth Busting

Vitamin Waters 2014

PHARMA & HEALTHCARE 12/17/2013 @ 9:38AM | 53,116 views

Vitamins Lack Clear Health Benefits, May Pose Risks

+ Comment Now + Follow Comments

Vitamin fans, take note: An editorial in the journal *Annals of Internal Medicine* suggests that multivitamins provide no health benefit in the long-run, and in fact, "should be avoided." The authors of the piece, "Enough is Enough: Stop Wasting Money on Vitamin and Mineral Supplements," summarize the work of three review studies in the same journal, which together find no effect for vitamins on cardiovascular health, cancer risk, cognitive health, or mortality. The bottom line, at least to the authors, is clear: We should stop wasting our money on multivitamins, since there's little evidence to their benefit, and some evidence to their detriment. But as always, others say they jury is still out on this one.

Centrum Vitamins (Photo credit: Wikipedia)

Serial Chase

A true story of the lives and deaths of a doctor and a deputy

Neil Bradley Hampson, MD


New Look!
Same Great Taste!
fruitO2
natural
strawberry
flavored
with other natural flavor
PURIFIED WATER BEVERAGE
0
CALORIES
PER BOTTLE
6-16 FL OZ (1 PT) 473mL BOTTLES
NET 96 FL OZ (3 QUARTS [2.83L])
Less is more
No Calories
No Artificial Flavors
No Artificial Colors


New Look!
Same Great Taste!
fruit2O
Less is more
No Calories
No Artificial Flavors
No Artificial Colors
Less is more
No Calories
No Artificial Flavors
No Artificial Colors

CONTAINS 0% JUICE

INGREDIENTS: PURIFIED WATER, CONTAINS LESS THAN 2% OF NATURAL FLAVOR, CITRIC ACID, SODIUM CITRATE, SUCRALOSE, SODIUM HEXAMETAPHOSPHATE, POTASSIUM SORBATE AND SODIUM BENZOATE TO PROTECT FLAVOR.

PURIFIED WATER BEVERAGE