
Congratulations
With your
20th Anniversary

Carbon Monoxide Intoxication
&
Smoke Inhalation

Ignace Demeyer, MD, PhD

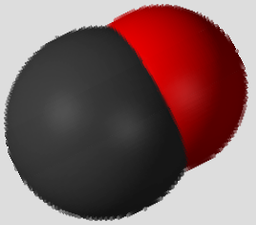
Emergency Medicine, Onze-Lieve-Vrouw Hospital, AALST

Definitions

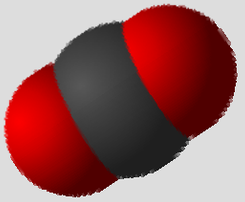
What is in a word ?

definitions

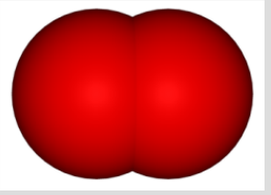
- Carbon Monoxide = CO



- Carbon Dioxide = CO_2



- Oxygen (di-oxide) = O_2



Overview

- Introduction
- CO and our world
- CO in the human being
  - Endogenous CO
  - Toxicity CO
  - Symptoms CO intox
  - Pregnancy and CO
  - Treatment CO intox

Properties of CO

Gas:

- colorless
- odorless
- tasteless
- nonirritating

Properties CO

colorless
odorless

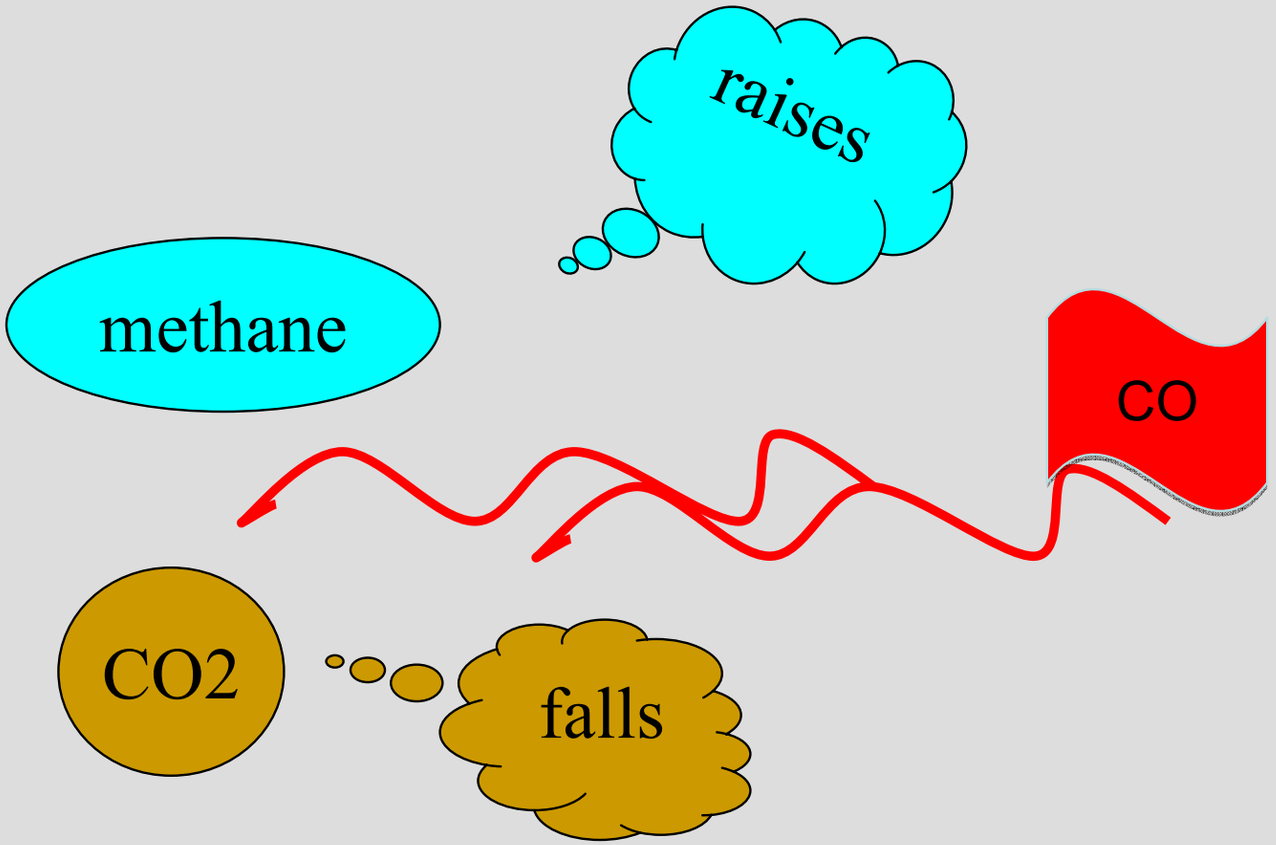
tasteless
nonirritating

not detectable
by
human beings

Properties CO

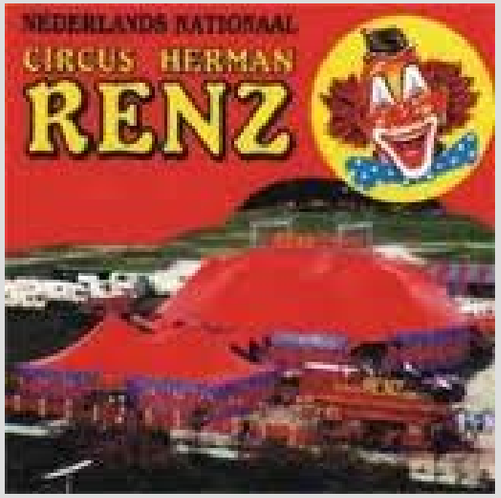
Density air: 1.25 kg/m^3

Gas Specific CO: 0.967 times airdensity



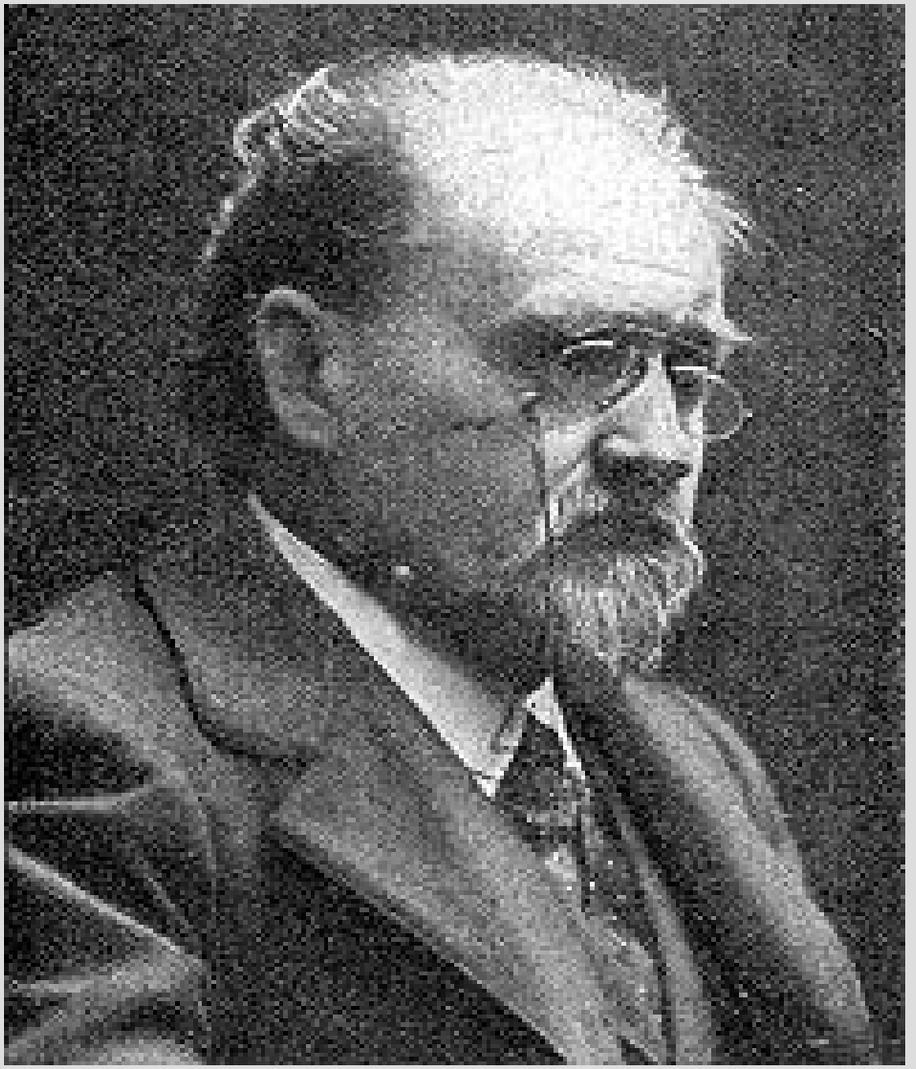
CO victims

- Herman en Diana RENZ
- 1996



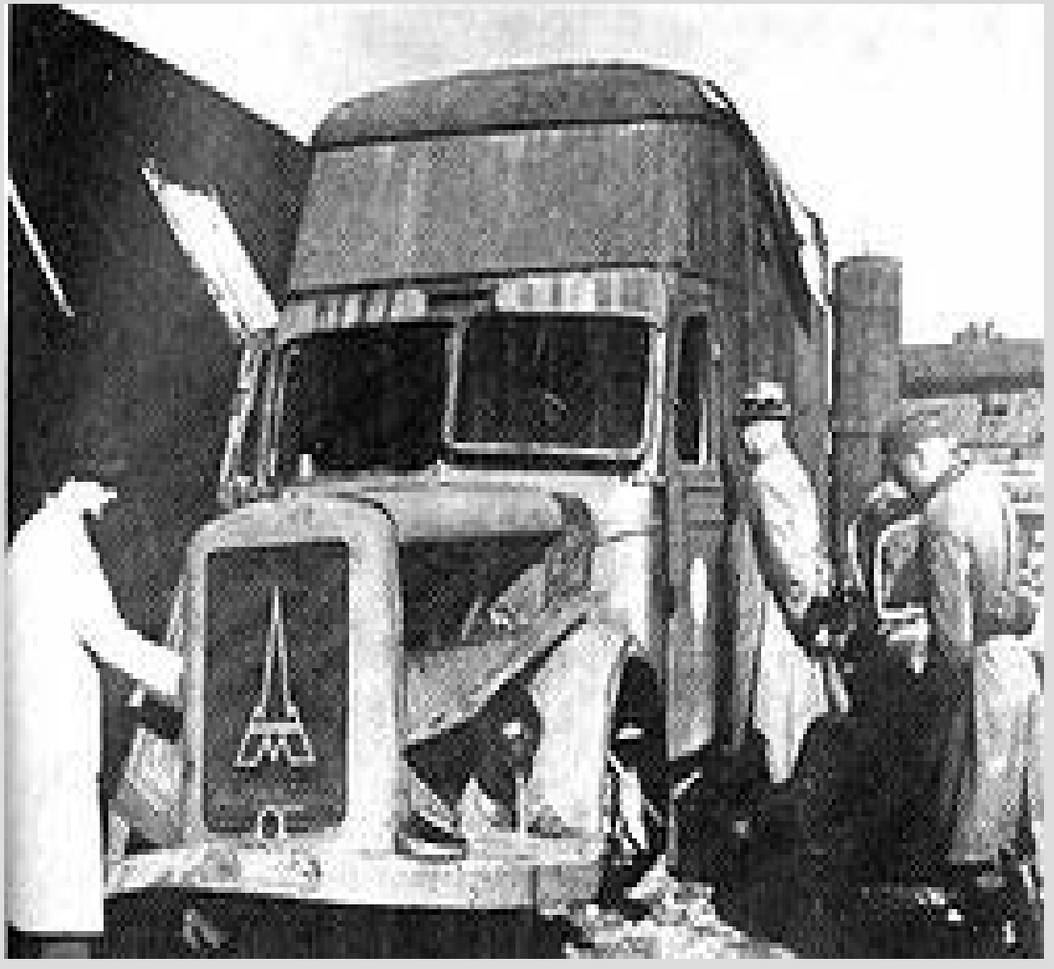
CO victim

- Emile Zola
- French Writer
  - Germinal
  - J'accuse
- 21 sep 1902



CO abused

- Chelmno death camp
- WW II, 1941, Polen, Lödz
- 153 000 death
- Aktion T4 (euthanasy program)

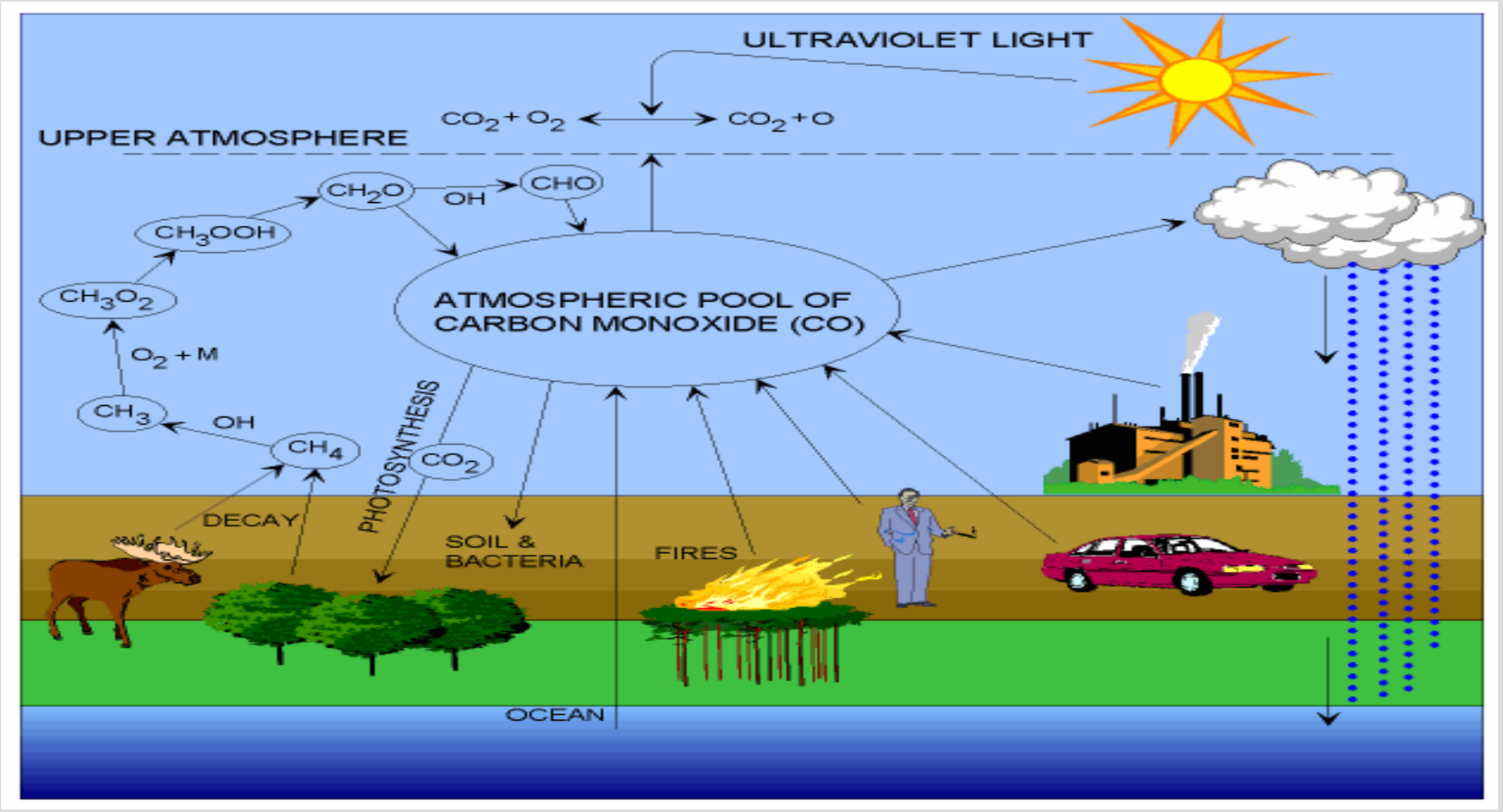


CO use

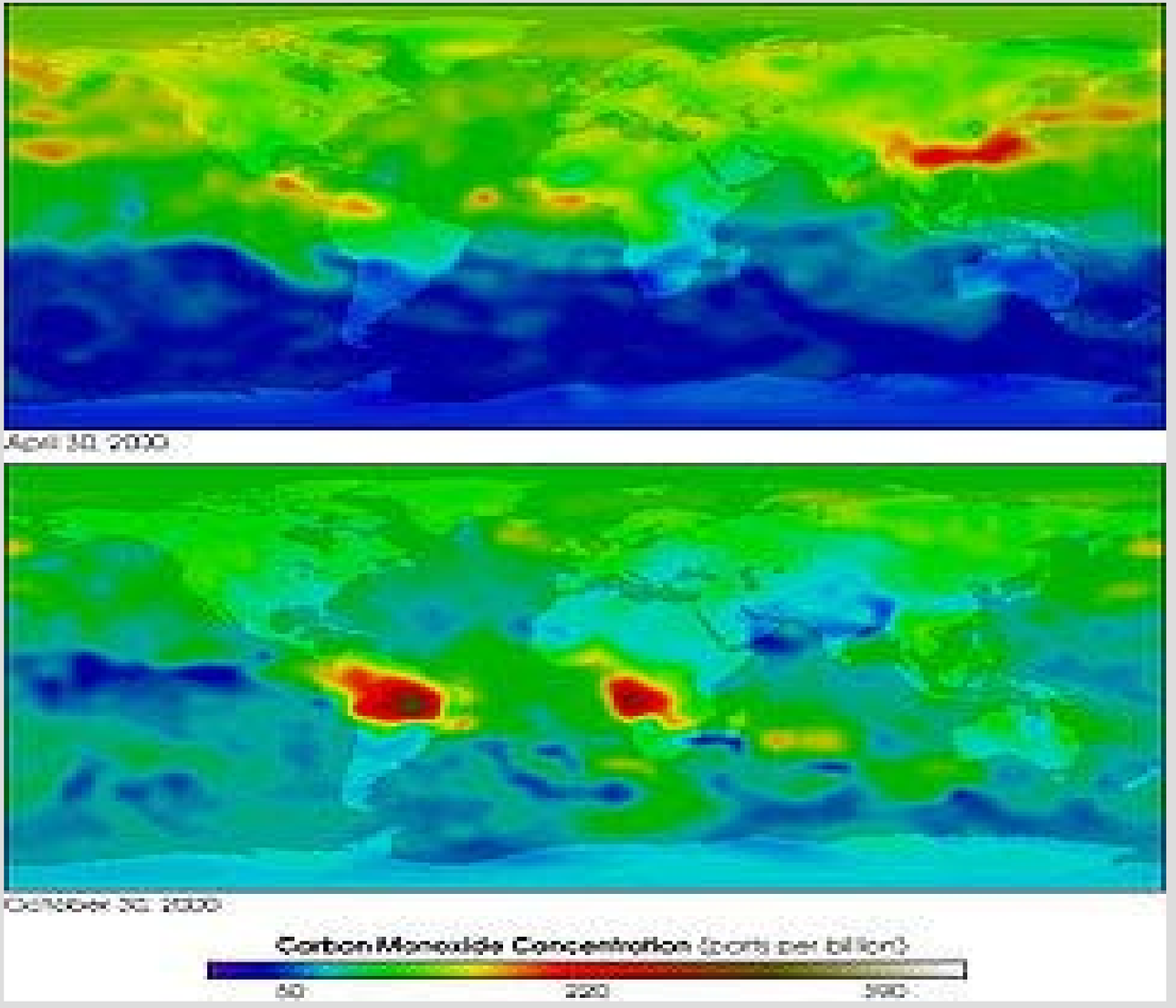
"Construction of a Simplified Wood Gas Generator for Fueling Internal Combustion Engines in a Petroleum Emergency"

The US Federal Emergency Management Administration
March 1989

Exogenous sources CO



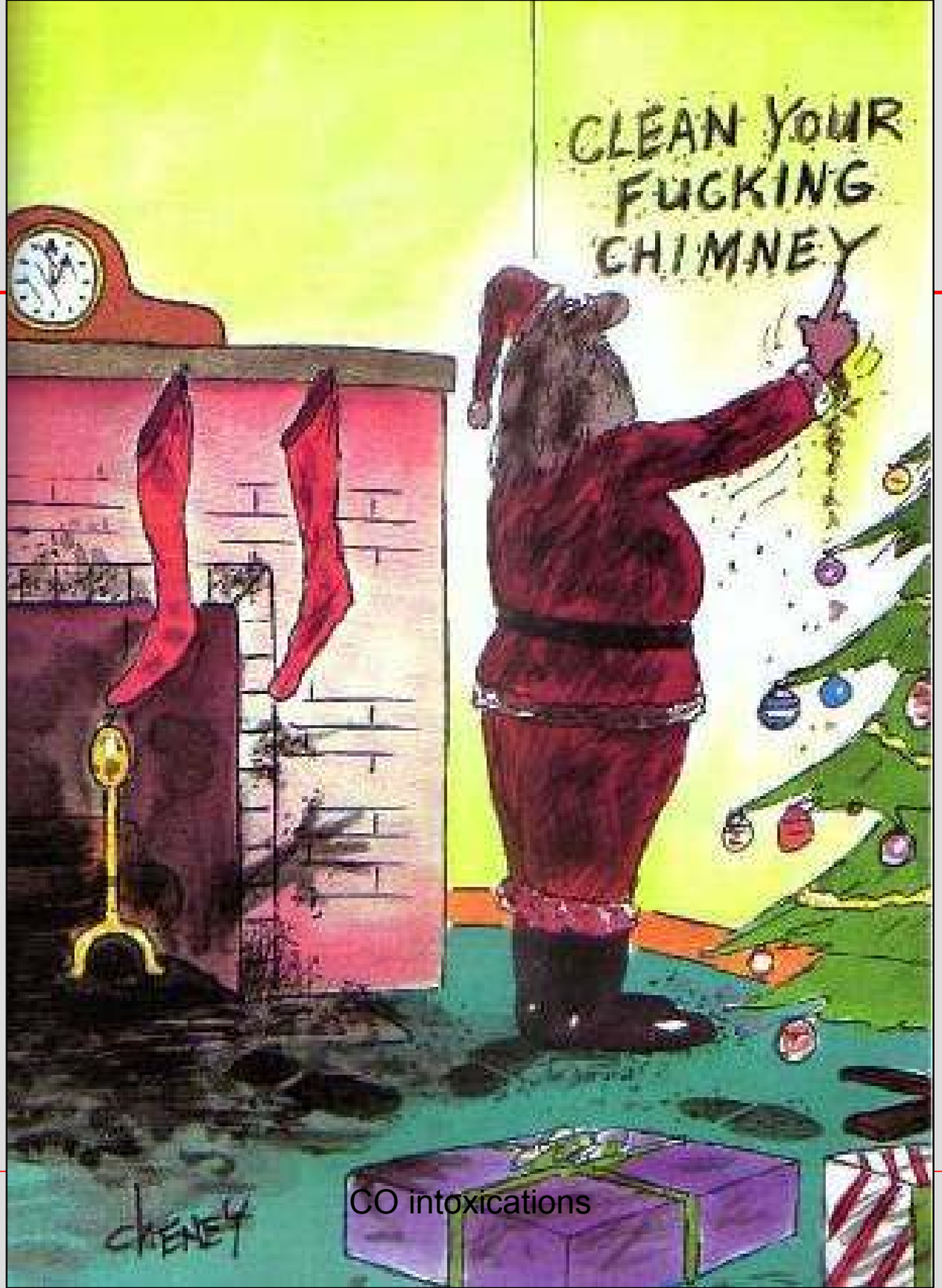
Volcano activity, Amazon wood



Ppm: parts per million

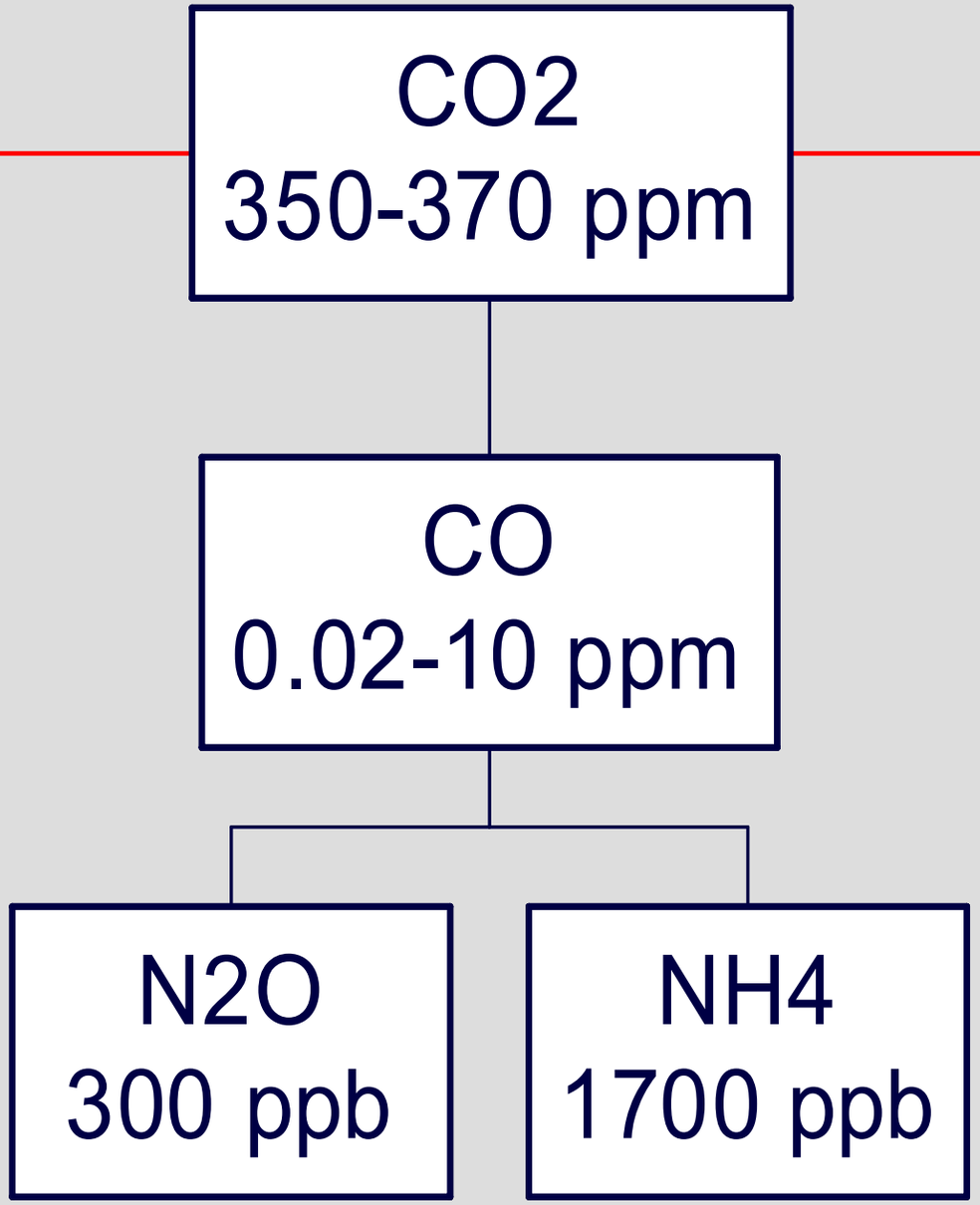
- 1% = 10.000 ppm
- 0.05% = 500ppm
- Atmospheric conc:
  < 0,001%

5	%	CO	=	50,000	PPM	CO
4	%	CO	=	40,000	PPM	CO
3	%	CO	=	30,000	PPM	CO
2	%	CO	=	20,000	PPM	CO
1	%	CO	=	10,000	PPM	CO
0.5	%	CO	=	5,000	PPM	CO
0.4	%	CO	=	4,000	PPM	CO
0.3	%	CO	=	3,000	PPM	CO
0.2	%	CO	=	2,000	PPM	CO
0.1	%	CO	=	1,000	PPM	CO
0.05	%	CO	=	500	PPM	CO
0.04	%	CO	=	400	PPM	CO
0.03	%	CO	=	300	PPM	CO
0.02	%	CO	=	200	PPM	CO
0.01	%	CO	=	100	PPM	CO
0.005	%	CO	=	50	PPM	CO
0.0035	%	CO	=	35	PPM	CO

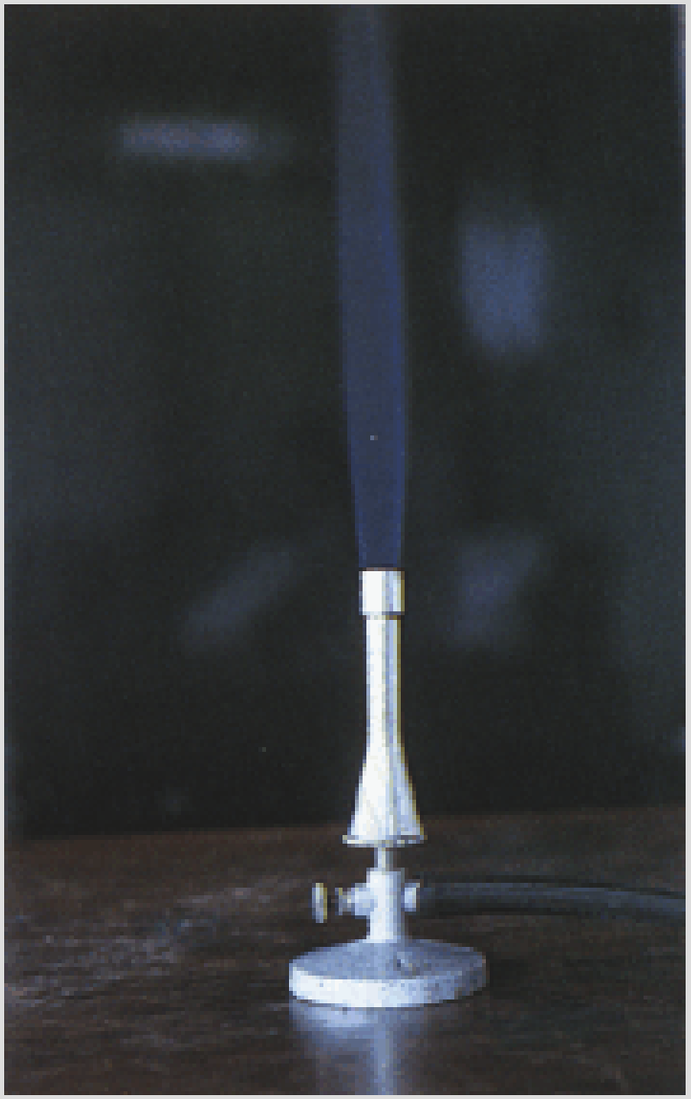

CLEAN YOUR FUCKING CHIMNEY
CHENEY

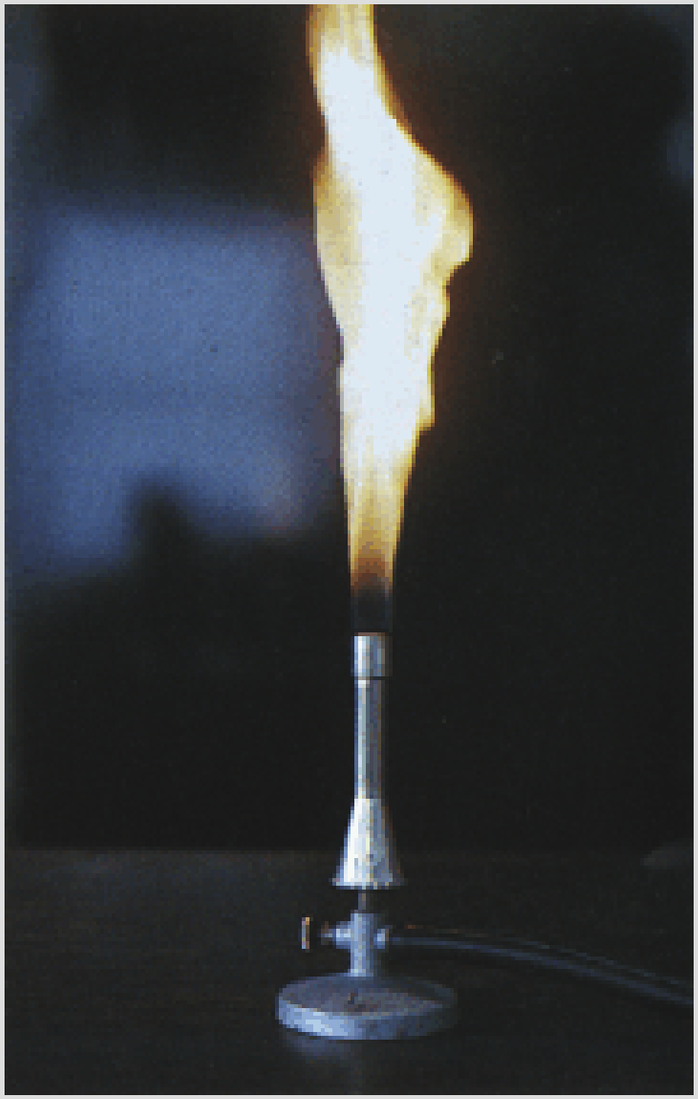
Concentrations at CO source (ppm)

- 0.1 nature reserve seaside
- 0.5 tot 5 average house
- 100 à 200 Mexico City
- 5000 chimney
- 7000 car exhaust (without catalysator)
- 30 000 pure cigarettesmoke


CO2
350-370 ppm
CO
0.02-10 ppm
N2O
300 ppb
NH4
1700 ppb

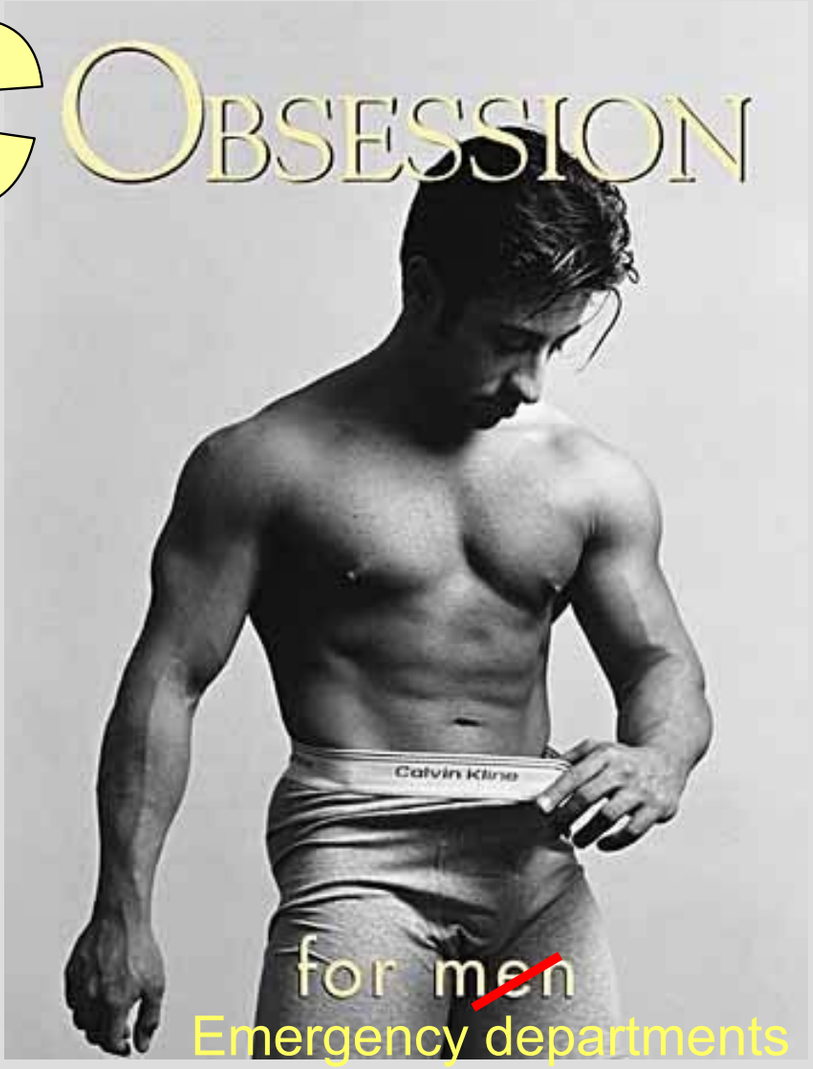
Incomplete Burning



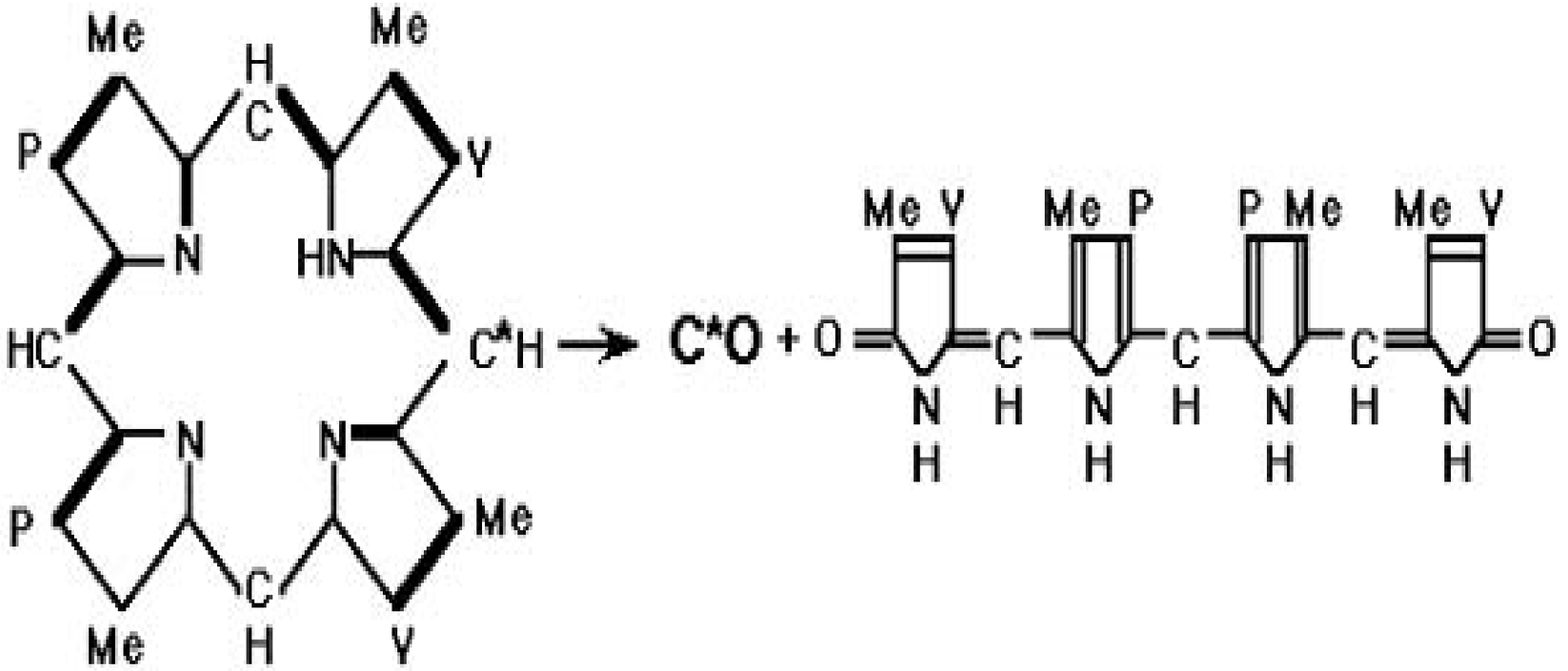


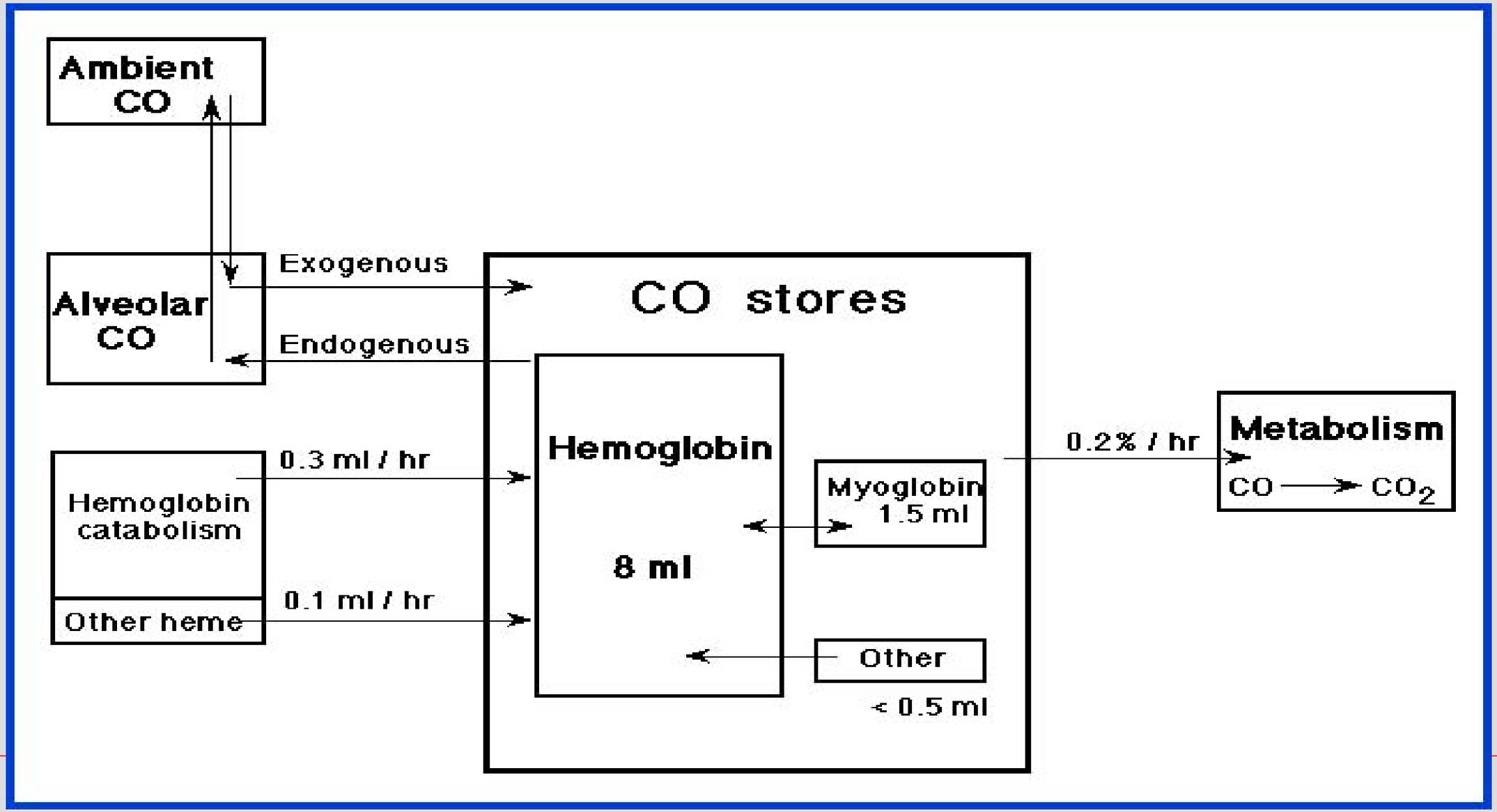
CO and Human Being

- Endogenous CO
  - Production
  - Metabolism
- Toxico-pathophysiology
  - Pharmacodynamics
  - Pharmacokinetics
  - Pregnancy
  - Symptoms
  - Therapy



Endogenous CO production




Ambient CO
Alveolar CO
Exogenous
Endogenous
CO stores
Hemoglobin
8 ml
Myoglobin 1.5 ml
Other
< 0.5 ml
0.2% / hr
Metabolism
CO → CO2
Hemoglobin catabolism
0.3 ml / hr
Other heme
0.1 ml / hr

CO levels

- Non smoker: 3 % (0 doesn’t exist !!)
- Smokers: 10 – 15 %

Technical Paper 11

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
JOSEPH A. HOLMES, DIRECTOR

THE USE OF MICE AND BIRDS FOR DETECTING CARBON MONOXIDE AFTER MINE FIRES AND EXPLOSIONS

BY

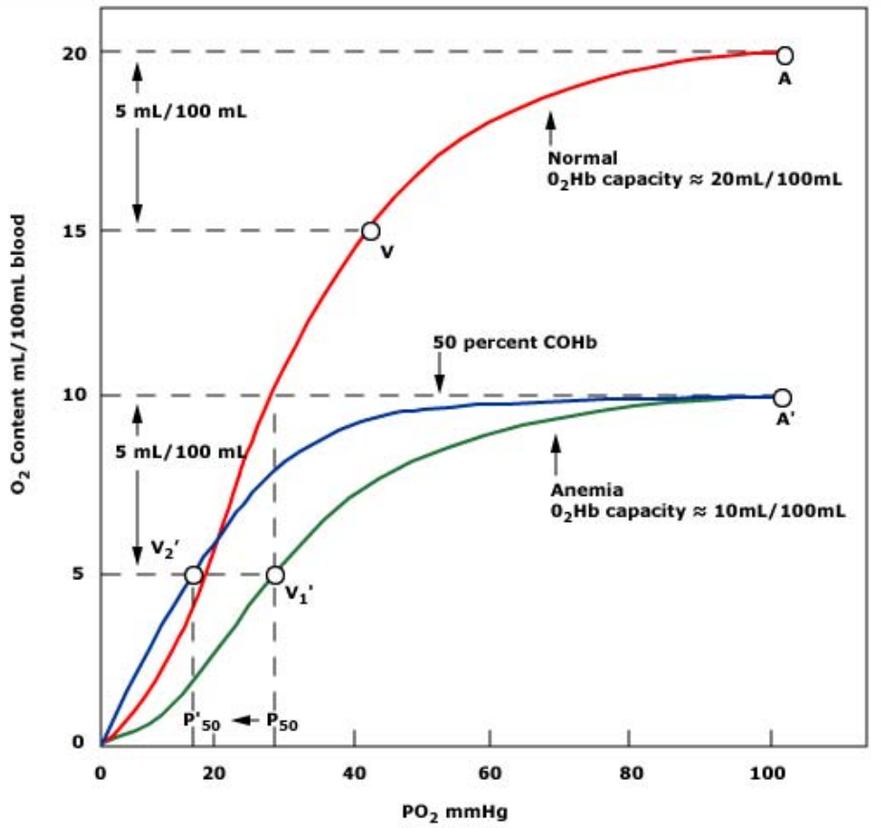
GEORGE A. BURRELL

WASHINGTON
GOVERNMENT PRINTING OFFICE
1912

CO and hemoglobin

- CO molecular very similar to O2 en CO2
- Hb affinity CO: 240 times > O2
- removes O2 from Hb and very strong adhesion
- 4 bindingplaces O2 on Hb
- Allosteric change impairs ‘off-load’ of oxygen to peripheral tissues

Effect of carboxyhemoglobinemia on oxygen content and delivery



Red curve demonstrates the normal relationship between arterial (A) and venous (V) oxygen content. In general, a difference in arterial and venous oxygen content of 5 mL per 100 mL blood is expected at rest. The green line depicts the effect of a 50 percent decrease in hemoglobin concentration, which decreases arterial (A') and venous (V'1) oxygen content but does not change the partial pressure at which hemoglobin is 50 percent saturated (P_{50}). The blue curve shows the effect of a 50 percent carboxyhemoglobinemia (COHb), which both decreases oxygen carrying capacity (A') and impairs peripheral unloading of oxygen from hemoglobin under conditions of low oxygen tension (V'2), shifting P_{50} to the left (P'_{50}). These changes result in a profound reduction in both oxyhemoglobin saturation and delivery of oxygen to peripheral tissues.

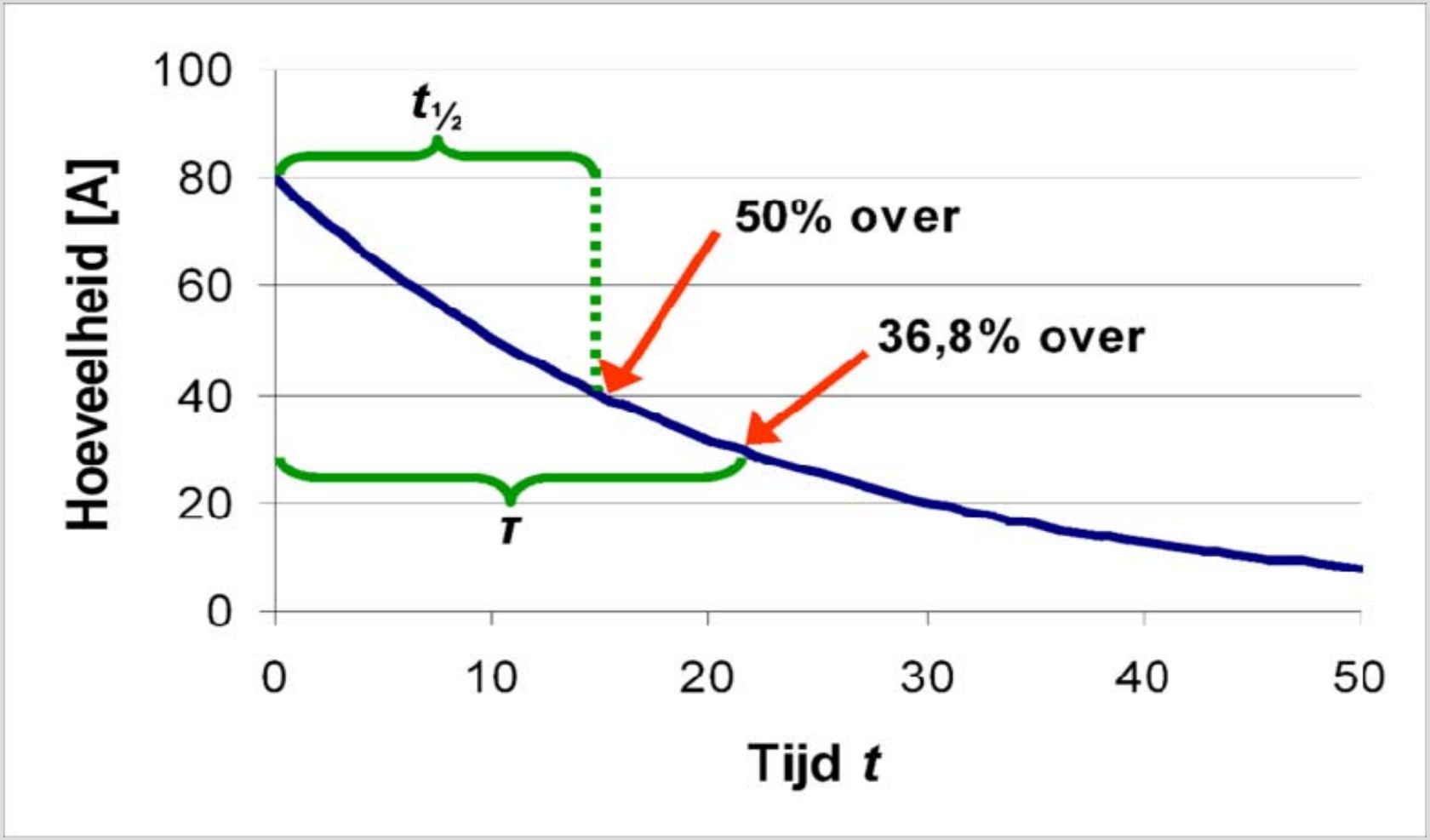
UpToDate

myoglobin

- Hemoprotein myoglobin:
  - 60% more affinity for O2
  - Impaired oxygen consumption
  - Reduced cardiac output and hypotension

Delayed release of CO from myoglobin results in delayed return of symptoms and COHb

Half live (T50)



T50 COHb

- t1/2 = 3 à 5 hrs at 21% O2
- t1/2 = 30 à 80 min at 100% O2
- t1/2 = 15 à 20 min at 2.5 ATM 100%

- IMPORTANT :
  - initial COHb (T0) via t1/2 recalculating
  - moment of intox is important

Cytotoxicity CO: 15% extravascular

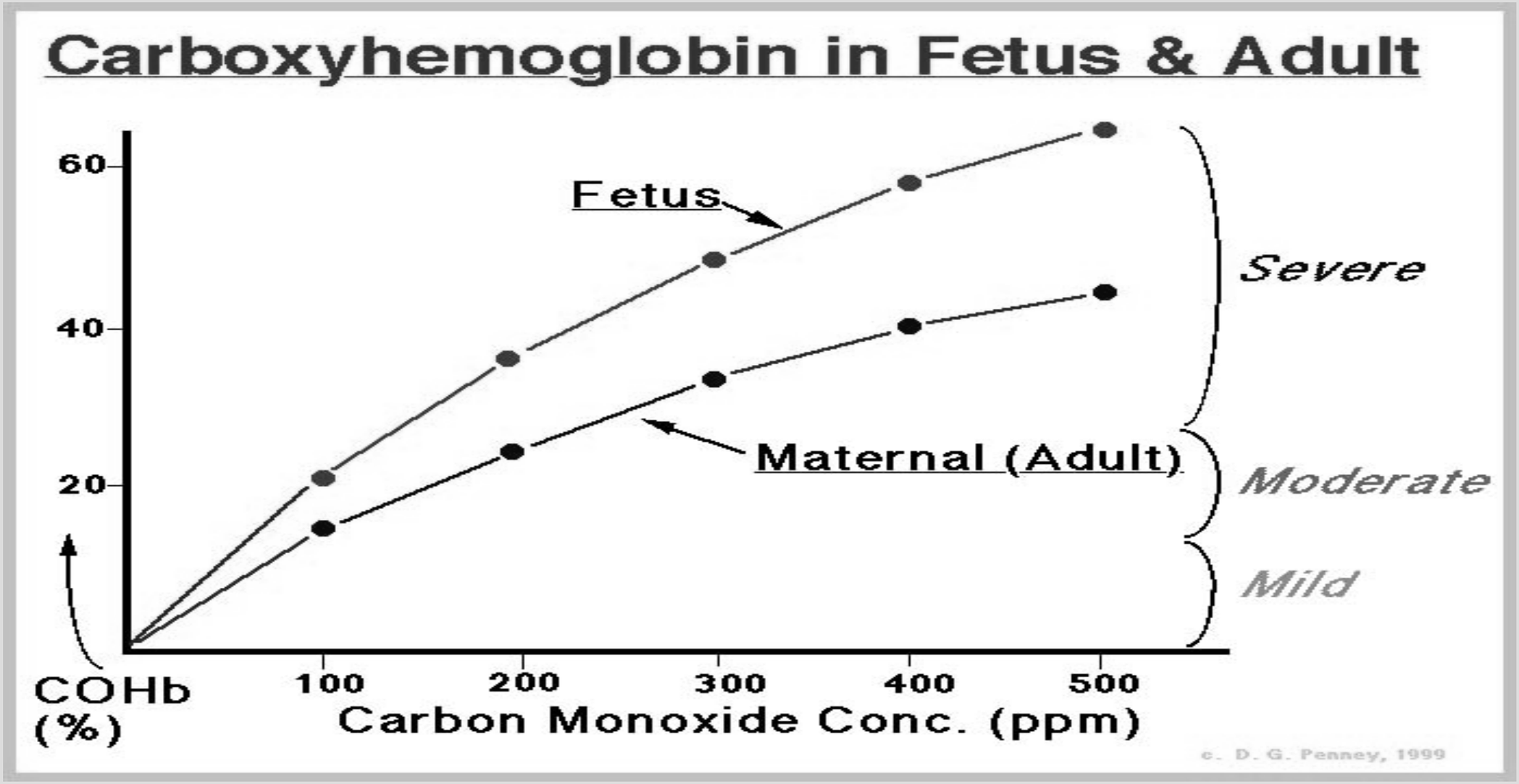
1. Myoglobine
2. Cytochrome
3. Hyperoxidase lipids
   - perivascular polynuclair cells
   - protease --> xanthine deshydrogenase --> xanthine oxydase
4. Glutamate release

Cytochrome oxidase

- Mitochondrial respiratory enzyme chain
- CO binds with cytochrome oxidase
  - Aerobic metabolism endangered
  - ATP synthesis reduced

- Anaerobic mechanisms started:
  - Lactic acidosis
  - Cell death

CO and pregnancy

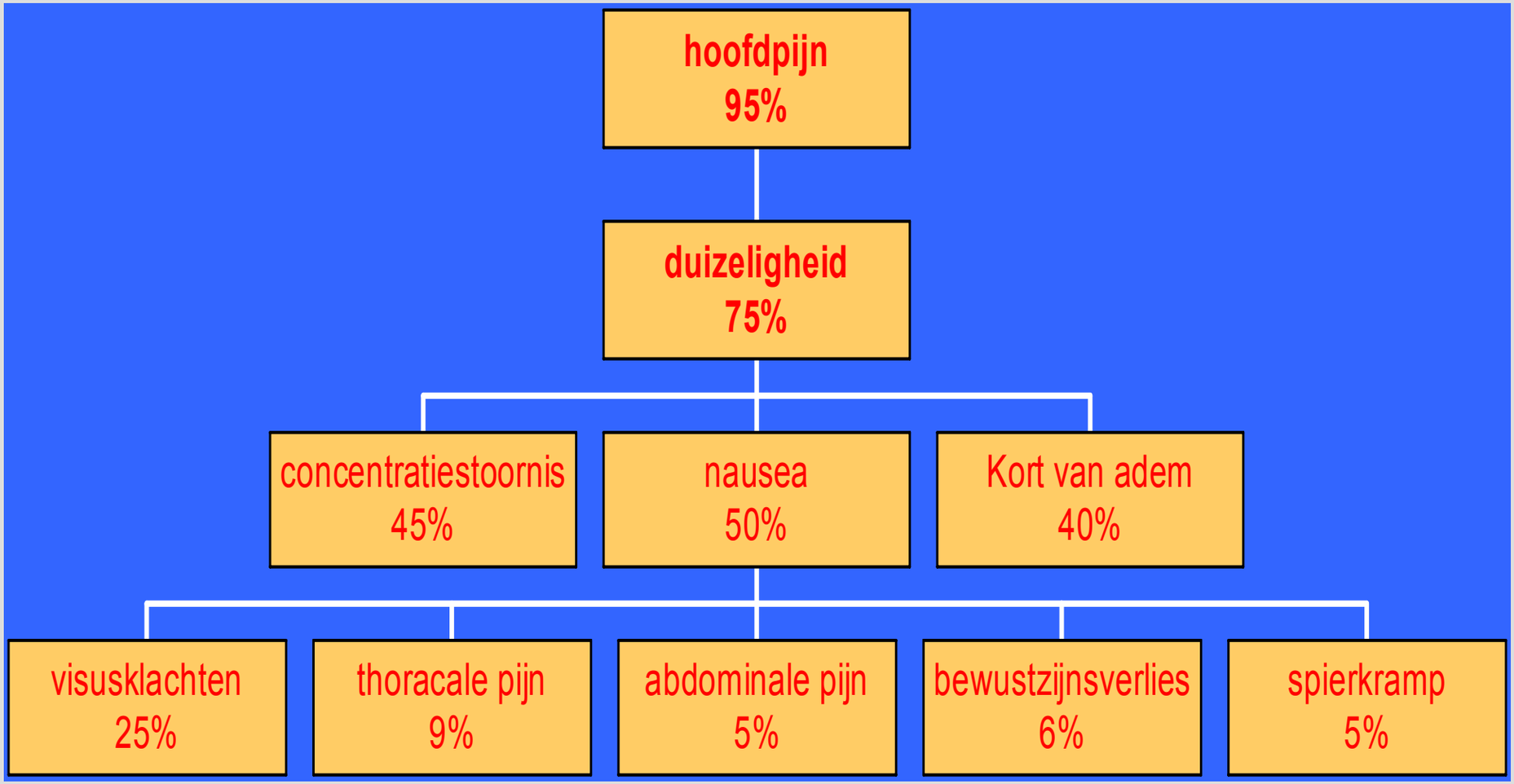


CO: Diagnosis !

Symptoms CO intoxication

- Typical ???
  - Cherryred lips (carboxymyoglobine !)
- Atypical:
  - tachycardia
  - tachypnoeic
    - Late sign!! In cellular hypoxia
    - Carotic bodies (PaO2 sens) drive resp centr
  - Pulmonary edema

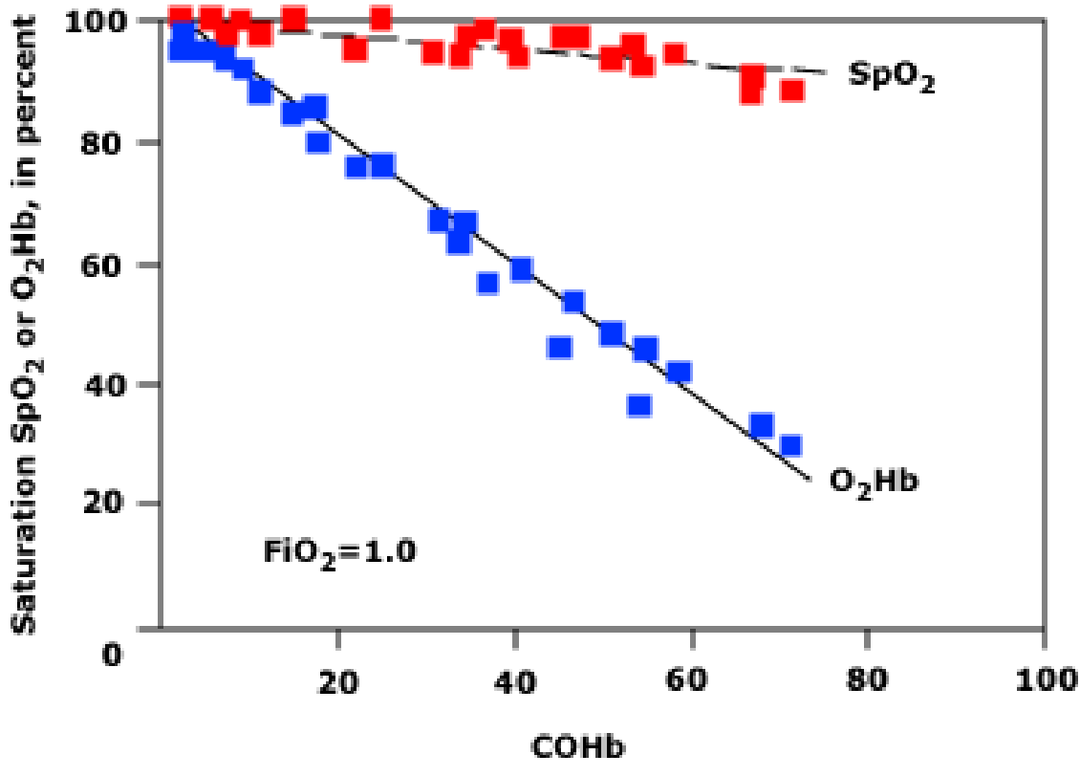
headache


hoofdpijn
95%
duizeligheid
75%
concentratiestoornis
45%
nausea
50%
Kort van adem
40%
visusklachten
25%
thoracale pijn
9%
abdominale pijn
5%
bewustzijnsverlies
6%
spierkramp
5%

COHb and peripheral O2 saturation

- oxyHb : absorbs infrared (850-1000nm)
- deoxyHb : absorbs red light (600-750nm)
- Detection after absorption of arterial & venous
- at peak (=pulse) more absorption arterial blood
- SaO2 via algorythm in software ratio red/infrared

Effect of carboxyhemoglobin on measured oxygen saturation by pulse oximetry

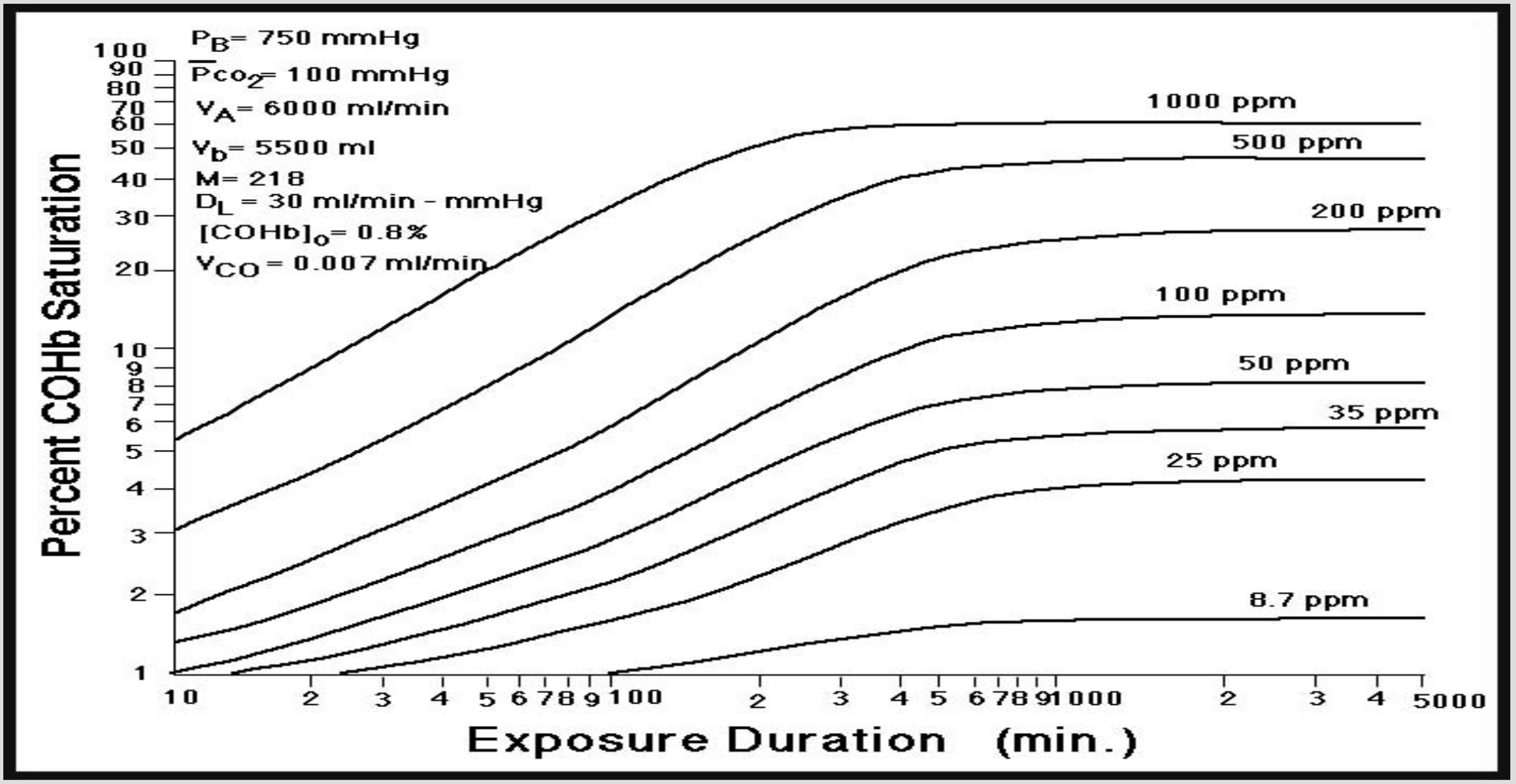


SpO2 and O2Hb versus carboxyhemoglobin (COHb) at FiO2=1.0. SpO2 consistently overestimates saturation in the presence of COHb. At COHb=70 percent, SpO2 is still roughly 90 percent, while O2Hb has fallen to 30 percent.

Redrawn from Barker, SJ, Tremper, KK, Anesthesiology 1987; 66:677.

UpToDate

COHb versus time



Chronic CO intoxication

- North American study : chronic flu like symptoms without fever: 20% raised COHb

- Think about CO:
  - Chronic fatigue
  - Reduced consciousness
  - Lack of concentration
  - Chronic headache,…

Central nervous system

- Brain lipid peroxidation (degradation of unsaturated fatty acids)
  - Caused by NO (endothelial cell and platelet released)
  - O2free radicals (peroxynitrine)
- Brain: mitochondrial dysfunction, leukocyte sequestration, apoptosis
  - Demyelinization of white matter (Grinker myelinopathy)

Central nervous system

- Cognitive defects:
  - Affecting memory
  - Affecting learning
  - Movement disorders

  - Bilateral necrosis of whiter matter, globus pallidus,cerebellum, cerebral cortex

Delayed neurological syndrome

- White matter : Myeline damage (frontal & parieto-occipital)
  - aphasia, dysgraphia, dyscalculia
- Grey matter : globus pallidus & hypocampus
  - end-arterial area

Delayed neurological syndrome

Neurologic

parkinson and choreoatethosis

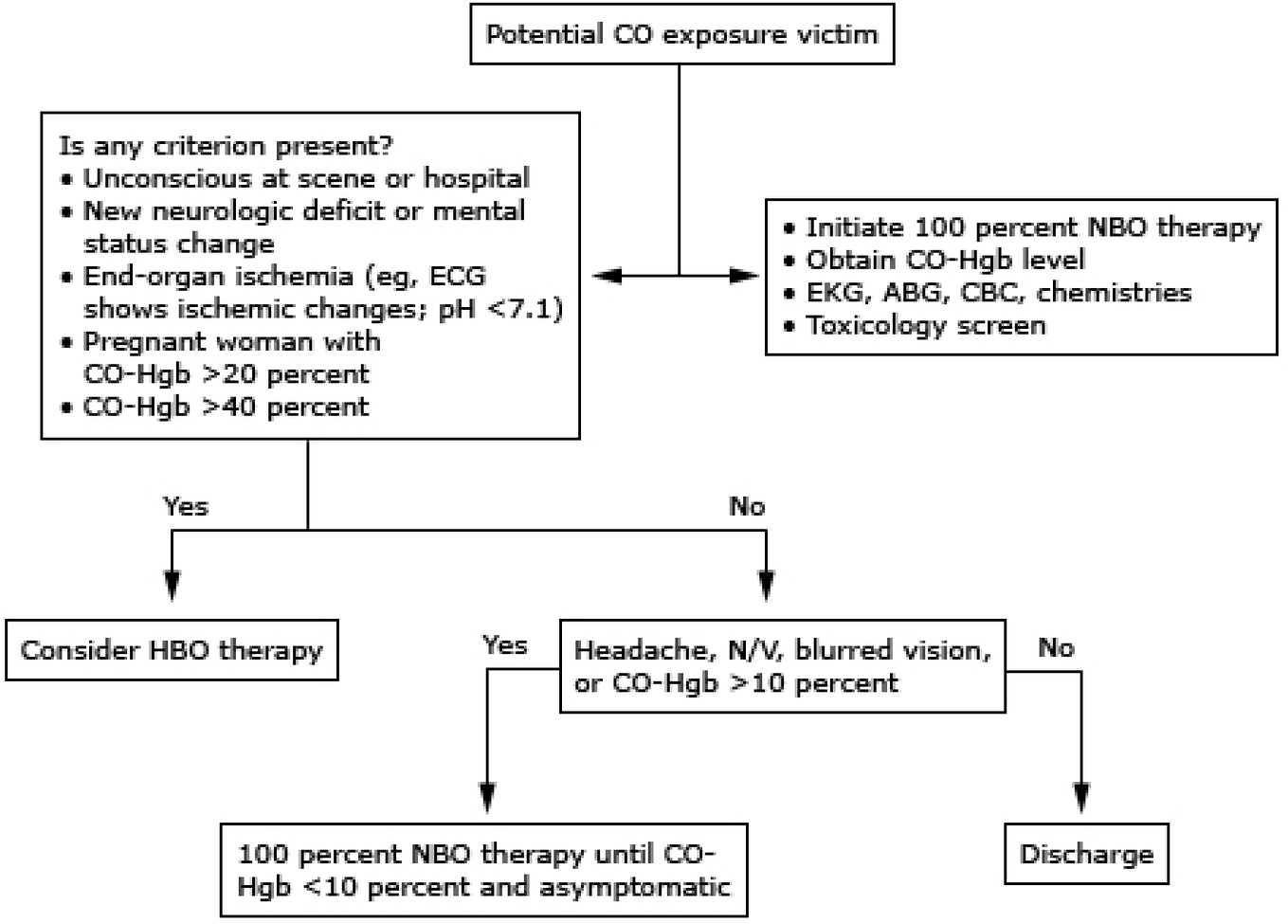
Psychiatric

behaviour, identity, psychosis

Therapy

- ACHOBEL Algorythm (www.achobel.be)

Algorithm for using normobaric and hyperbaric oxygen following carbon monoxide exposure



Adapted from O'Brien, C, Manaker, S. Carbon monoxide and smoke inhalation. The Intensive Care Manual. Hanson, Lanken, Manaker (Eds), WB Saunders, Philadelphia, 2001.

ENJOY THE WATER

Overview of carbon monoxide poisoning

To obtain emergent consultation with a medical toxicologist, call the United States Poison Control Network at 1-800-222-1222, or access the World Health Organization's list of international poison centers (www.who.int/ipcs/poisons/centre/directory/en).

History

Duration and mechanism of exposure

Assess for major symptoms: loss of consciousness, confusion, symptoms consistent with hypoxia (ie, chest pain)

Assess for minor symptoms: headache, nausea/vomiting

Assess pregnancy status

Physical examination

Careful evaluation of mental status

Physical examination usually unremarkable

Diagnostic evaluation

Check CO level via co-oximetry of arterial or venous blood

Check acid-base status on (preferably arterial) blood gas

Check ECG in all patients; check cardiac enzymes in patients ≥65, patients with significant cardiac risk factors, and younger patients with chest pain or symptoms suggestive of ischemia

Consider CNS imaging in patients with altered mental status to rule out other etiologies

Check cyanide level and consider empiric treatment in patients with smoke inhalation injury

Treatment

Secure airway, breathing, and circulation

- Intubate as clinically indicated
- Apply high-flow oxygen to all CO poisoned patients regardless of pulse oximetry or arterial pO2

Direct fire department to assess for environmental exposure and remove victims

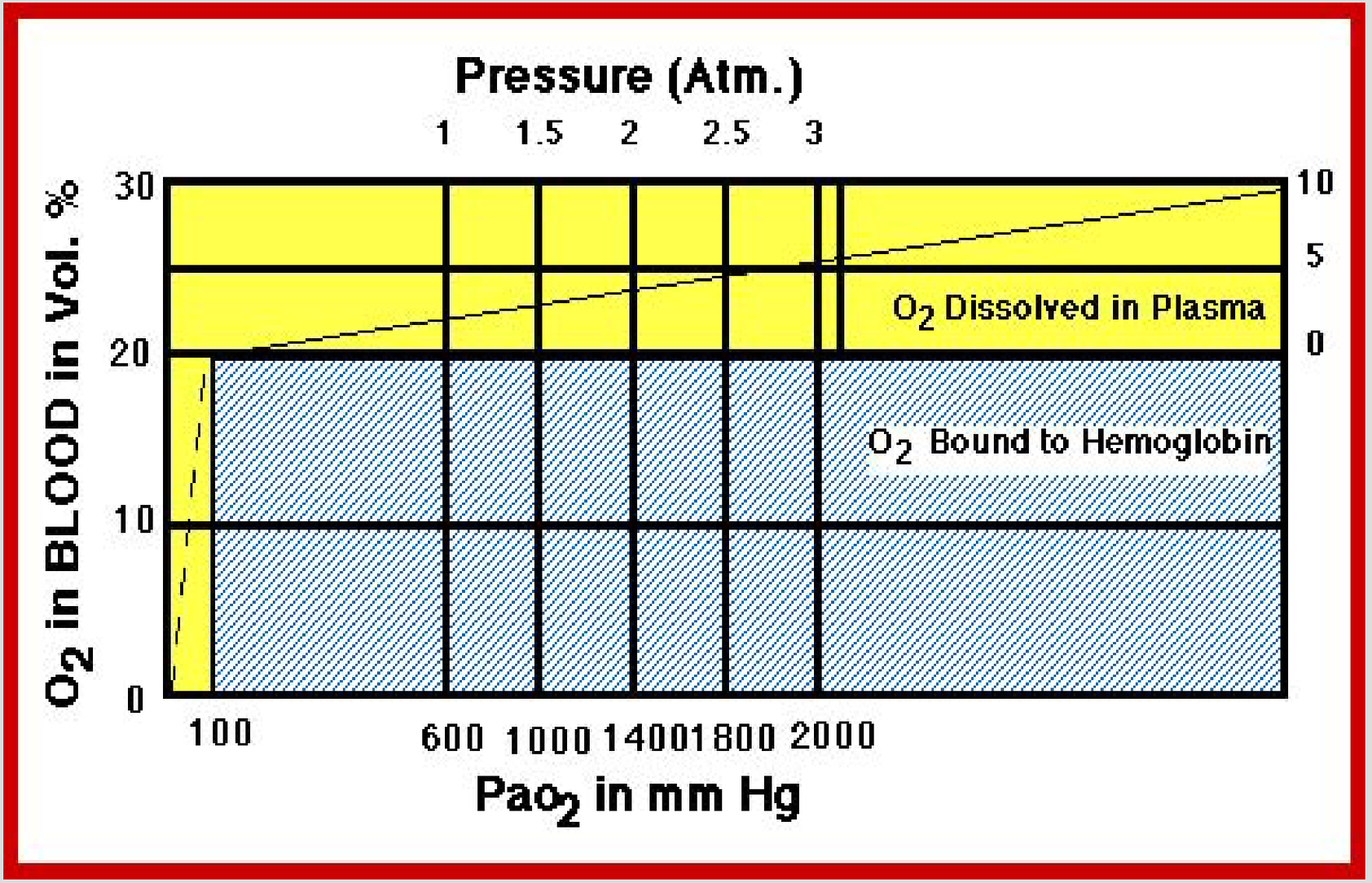
We suggest hyperbaric oxygen (HBO) for:

- CO level >25 percent (>20 percent if pregnant)
- Loss of consciousness
- Severe metabolic acidosis (pH <7.1)
- Concern for end-organ ischemia (chest pain, ECG changes, altered mental status)

UpToDate


HYTECH
Noodtelefoon
Monitor 1
HYTECH
Brandblusser HK
Noodstop Besturing
Handbediening maskers
HYTECH

Effect van hyperbare zuurstof



Effect of hyperbaric Oxygen: arterial oxygen content

$CaO_2 = (Hb * 1.38 * SaO_2) + (PaO_2 * 0.003)$

Hb: 15

$CaO2 = (15 * 1.38 * 1) + (100 * 0.003)$

$= 20.7 + 0.3$

$= 21$ ml O_2

Effect of hyperbaric oxygen

$CaO_2 = (Hb * 1.38 * SaO_2) + (PaO_2 * 0.003)$

Hb: 15

CaO2 = (15 * 1.38 * 1)+ (2000 * 0.003)

= 20.7 + 6

= 26.7 ml O_2

Chemische wapens indeling	
Zuurstofverdringende gassen:	Chloorcyanide (CK) – Blauwzuur (AC) – **Koolstofmonoxide**
Blaartrekkende gassen:	Lewisiet (L) – Zwavel-mosterdgas (HD, H, HT, HL, HQ) – Stikstof-mosterdgas (HN1, HN2, HN3)
Zenuwgassen:	*G-Agents:* Tabun (GA) – Sarin (GB) – Soman (GD) – Cyclosarin (GF) | *V-Agents:* VE – VG – VM – VX
Verstikkende gassen:	Chloorgas – Chloorpicrine (PS) – Fosgeen (CG) – Difosgeen (DP)
Irritantia:	Agent 15 (BZ) – KOLOKOL-1
Traangassen:	Pepperspray (OC) – CS-gas – CN-gas – CR-gas

Medico Legal aspects

- COHb well detected postmortem
- Less influenced by putrefaction
- COHb % in the body accurate measurement of COHb postmortem even after long delay

door CO, r kritiek

Vorige zaterdag deed zich een tragisch ongeval voor n de straat te elle. Een 15-jarig meisje wam om het leven door CO. rgiftiging. Het slachtoff- kte terwijl ze ee- n. Een vri- hulp

-vergiftiging in de Hekkerstraat

n

vond rond 20 uur moest erse brandweer uitrukken voor een an CO-vergiftiging. In het , werd an Guillemacre onwel in

de badkamer. Hij riep zijn vrien- din om hulp. Beiden vertoonden sporen van CO-ver- giftiging en werden naar het A van Aalst gebracht. Het ongi is vermoedelijk te wijten aar waterverwarmer. Luitenant Pol De Neef wa

der al in de Hekkerstraat: er was iets grondig misgegaan met de verlichte kerstbomen aan de ge- vels. er dreiging van De Neef

Vijf mensen door kachelgas vergiftigd in Kapellen

ANTWERPEN — Vijf men- zelf bevangen. en met de ij overgebra huis in Kape t Stuivenbe werpen, dat pparatuur fers van CC ndelen. Eé le in kritiel chtoffers het pand tgenoot D Putte en

(28), die er op

was een bekende figuur in Durmegemeente. Hij was terreinafgevaardigde de s kracht achter VK Hamme Voetbalploeg die nome aan de leiding staat in de provinciale recks. Be halve werkte Achiel Sy een producent van bina in Waasmunster. nkele vrienden va net en zijn vader P ten gisteravond san t Geemzicht in de orger Bart De

-Niklaas

-vergiftiging — Zondag om 10.45 uur bevond het echtpaar uit de 70 zich met hun twee kinderen adkamer. Plots werden de vier gezinsleden onwel. Ze kon- elf de dienst 100 verwittigen en werden overgebracht naar kenh erzorging mochten ze het ziekenhuis opnieuw en. Z CO-vergiftiging opgelopen.

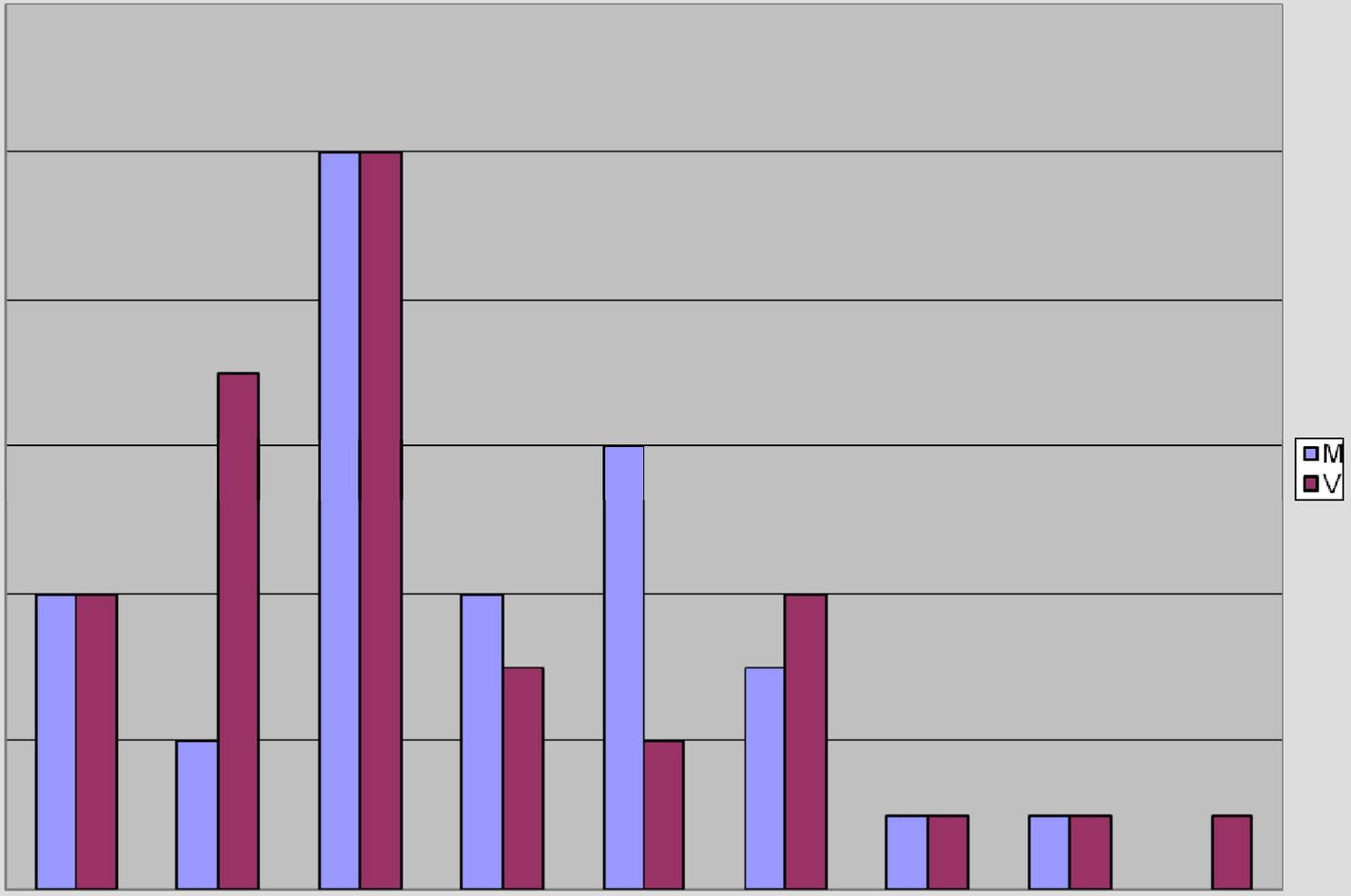
Trucker dood

CO-verg in Nieuw

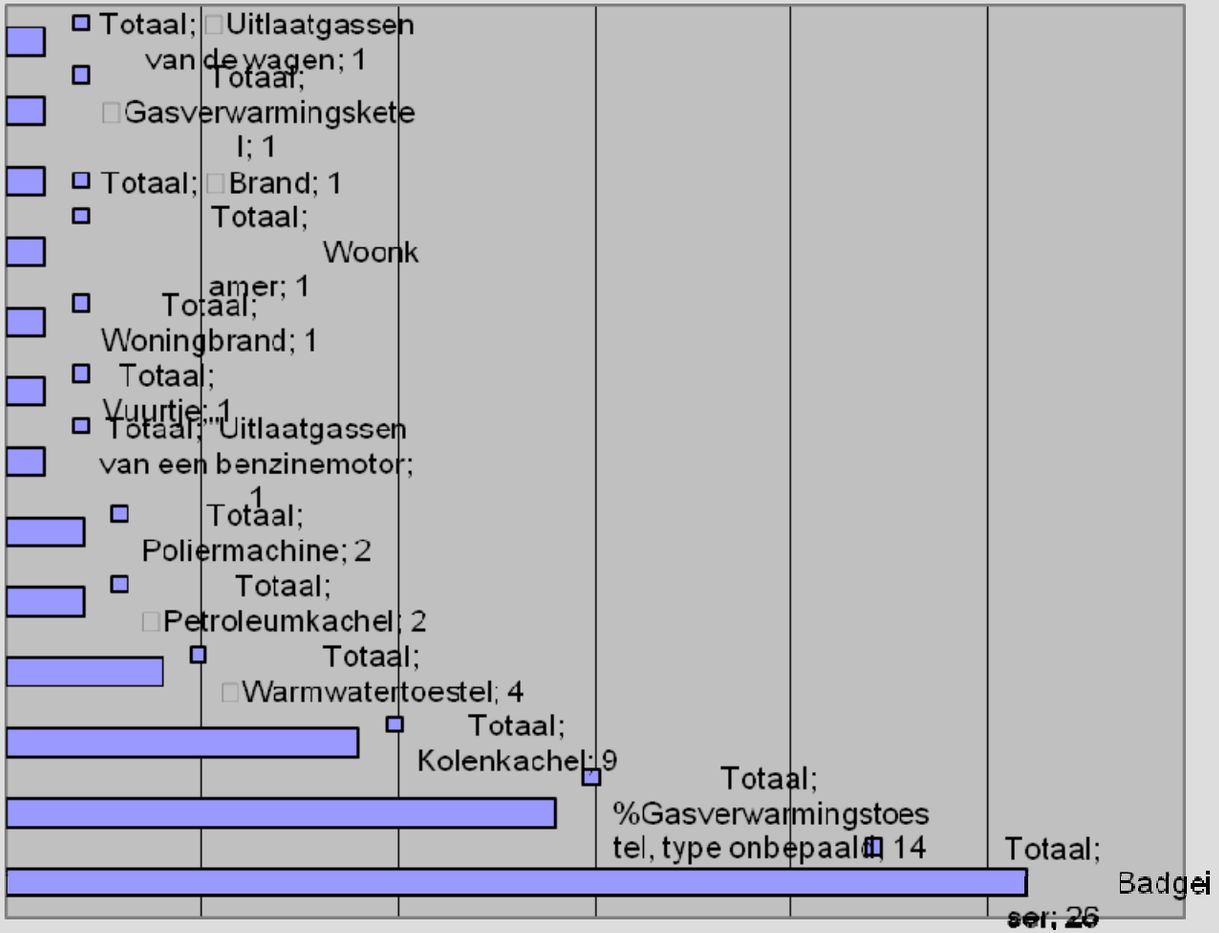
Nieuwerkerk

Een gezin, m van respectievel

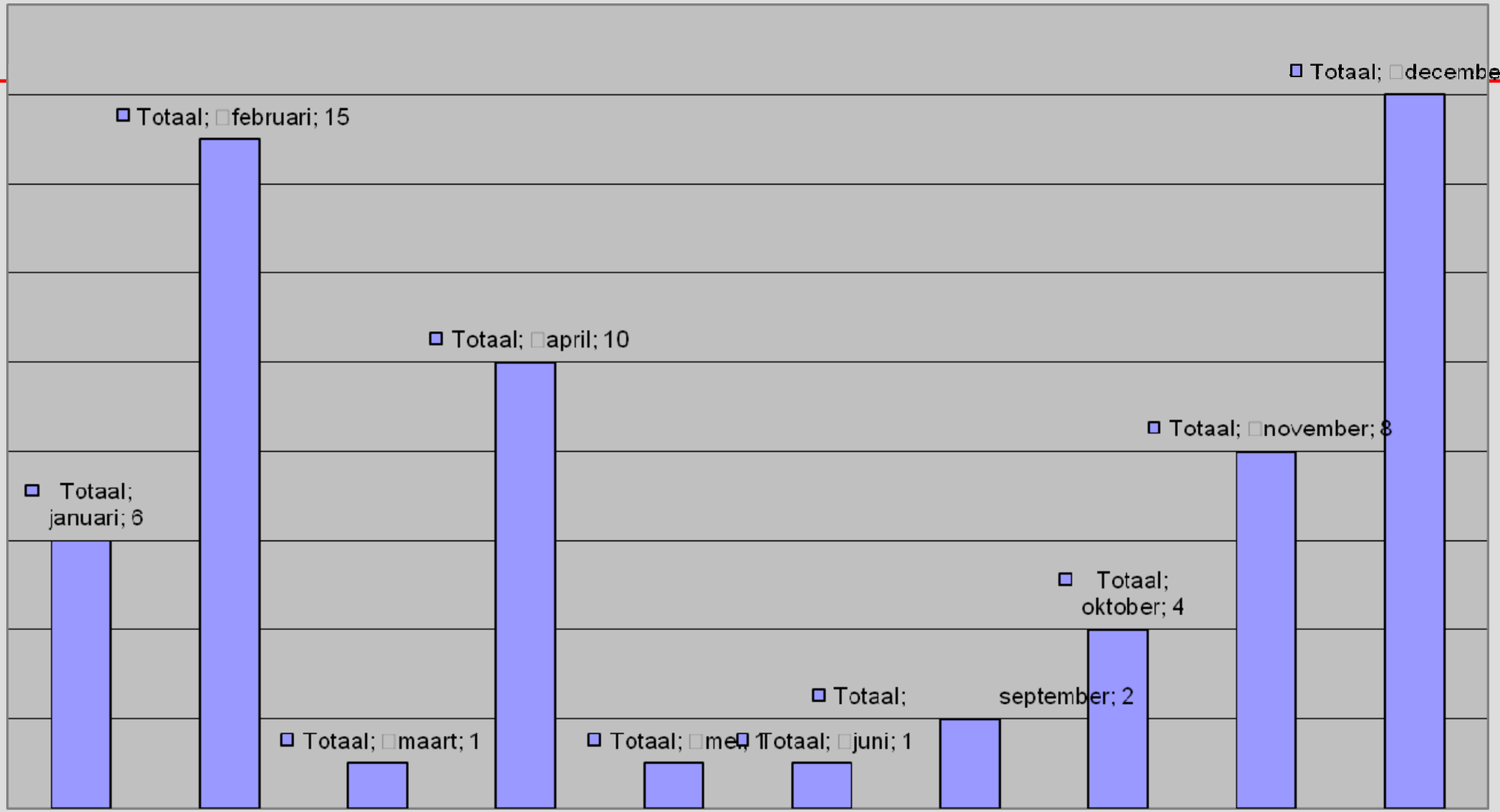
age



causes


Totaal; Uitlaatgassen van de wagen; 1
Totaal; Gasverwarmingsketel; 1
Totaal; Brand; 1
Totaal; Woonkamer; 1
Totaal; Woningbrand; 1
Totaal; Vuurtje; 1
Totaal; Uitlaatgassen van een benzinemotor; 1
Totaal; Poliermachine; 2
Totaal; Petroleumkachel; 2
Totaal; Warmwatertoestel; 4
Totaal; Kolenkachel; 9
Totaal; %Gasverwarmingstoestel, type onbepaald; 14
Totaal; Badgeiser; 26

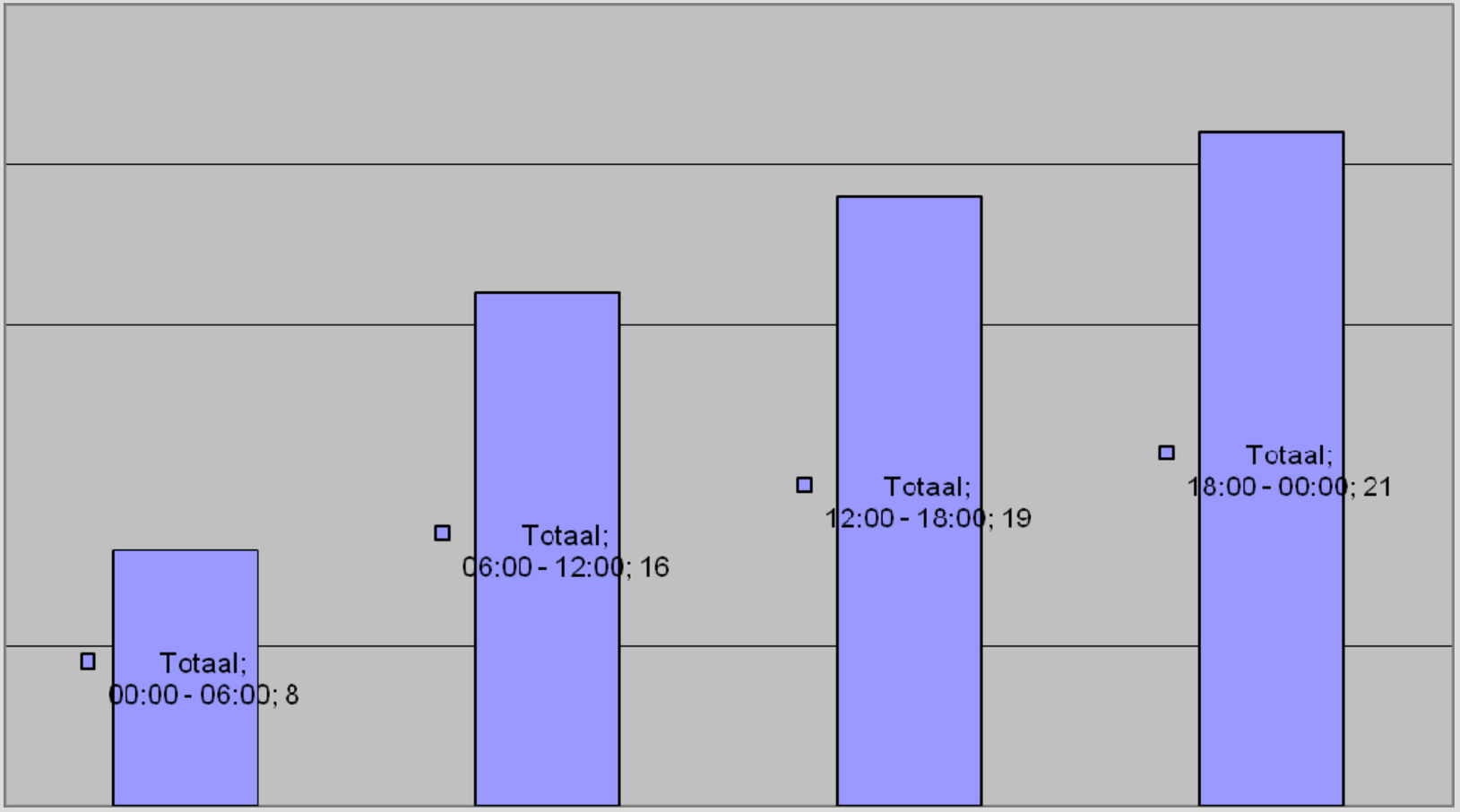
Period


Totaal; januari; 6
Totaal; februari; 15
Totaal; maart; 1
Totaal; april; 10
Totaal; mei; 1
Totaal; juni; 1
Totaal; september; 2
Totaal; oktober; 4
Totaal; november; 8
Totaal; december; 16

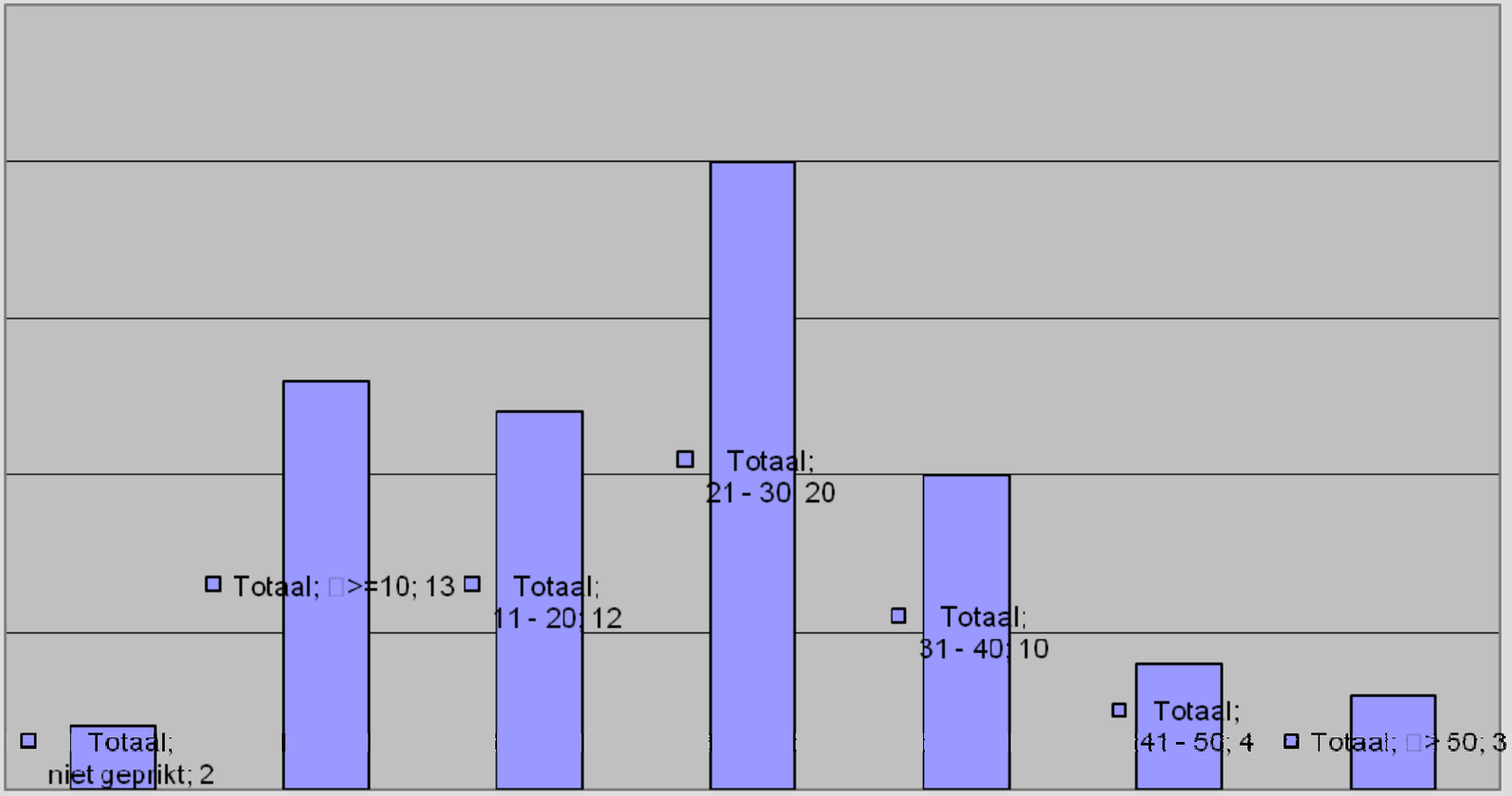
Healthy living in Flanders…?

Aalst	14
Gent	12
Sint-Amandsberg	6
Wetteren	5
Ledeberg	4
Lieferinge	4
Nazareth - Eke	3
Nederhasselt	3
Lede	2
Denderhoutem	2
Sint Jans Molenbeek	2
Dilbeek	1
Evergem	1
Lessines	1
Mariakerke	1
Melle	1
Oudenaarde	1
Torhout	1

Time of admission



Carboxyhemoglobin %

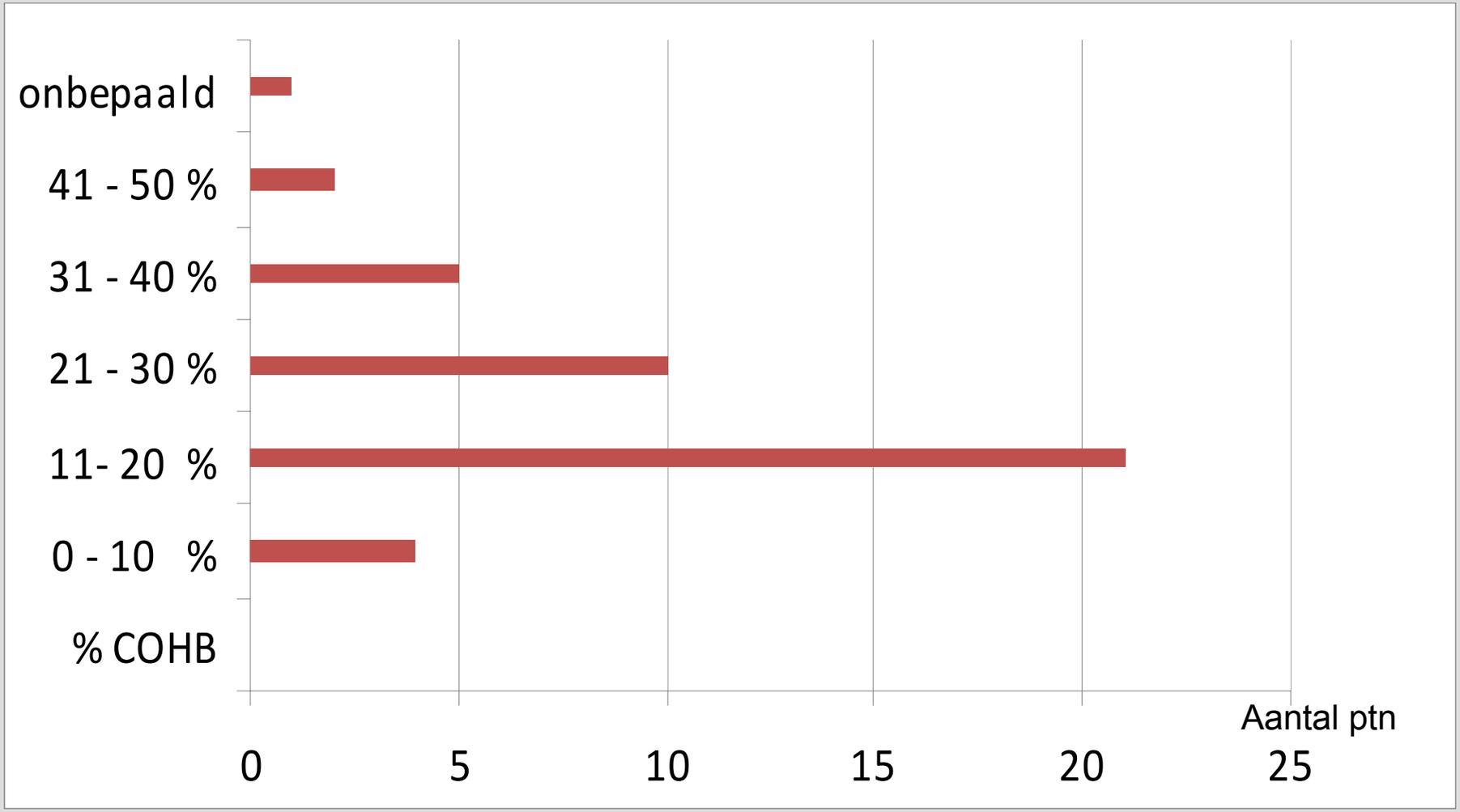


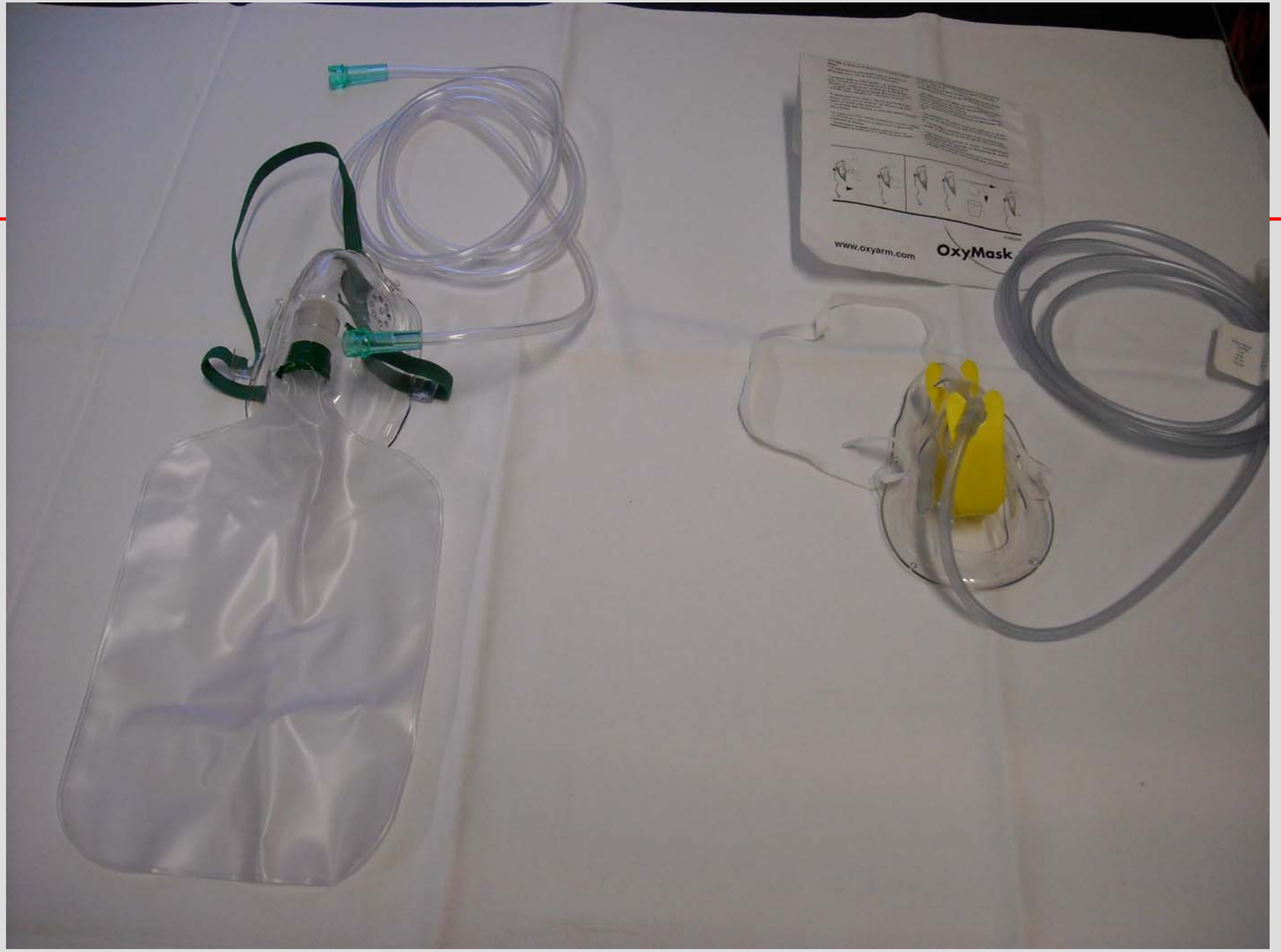
Alarmerende cijfers 2009

% COHB	Aantal ptn
0 - 10 %	4
11- 20 %	21
21 - 30 %	10
31 - 40 %	5
41 - 50 %	2
onbepaald	1

8 Kinderen en 35 Volwassenen

Carboxyhemoglobine % 2009

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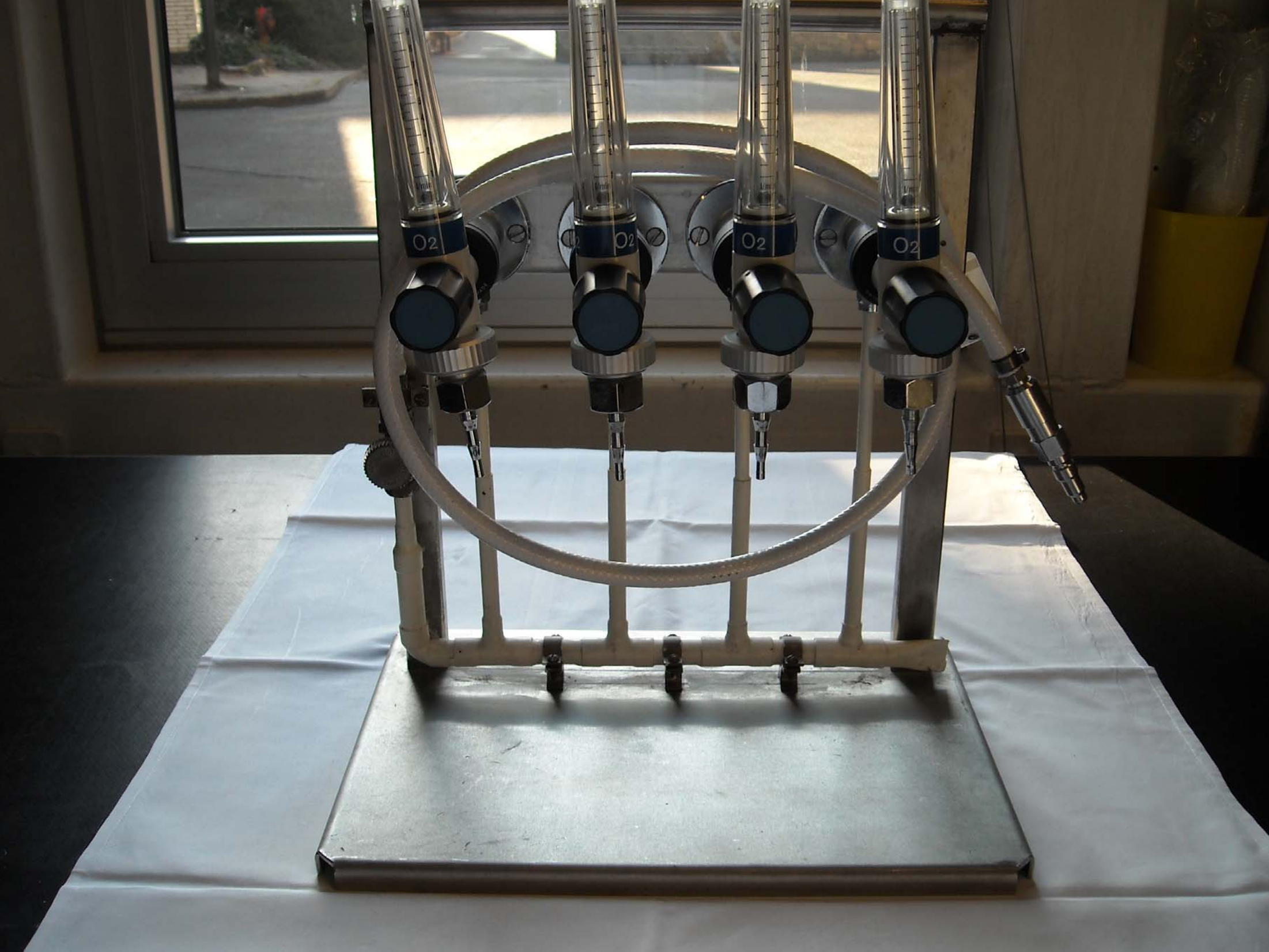

O2
O2
O2
O2


STILLEVEN MET FRUITSCHAAL EN PLANT...
LECTRR

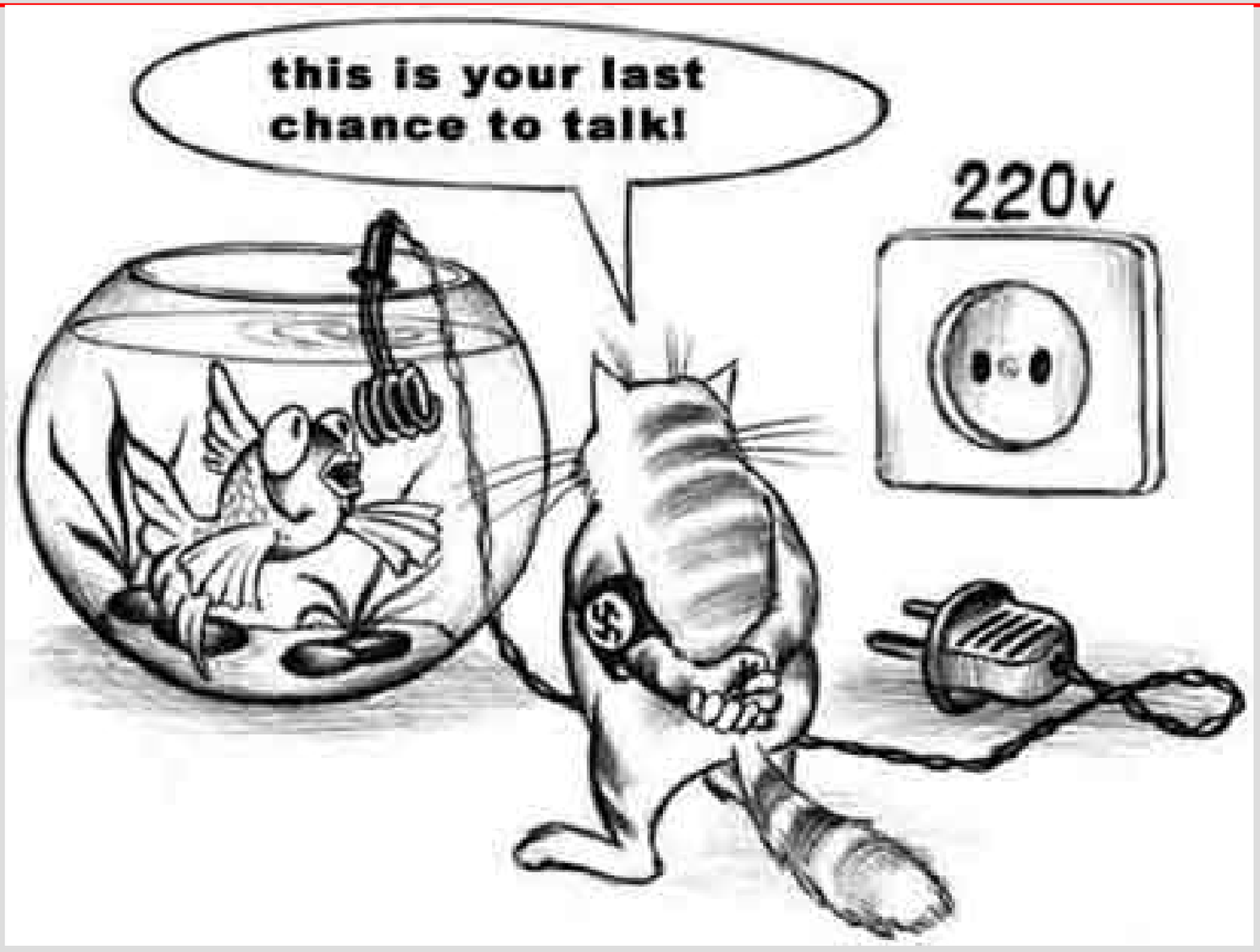
Disappointment

The content of my abstract has been ‘censored’ by the organisation…

Part of my text has been removed without my approval

Omitted text

- “… We have to thank and to congratulate our colleague Dr Peter Germonpré and his team. Peter is the driving force for over 20 years in making aware Belgium that CO is the silent serial killer. “


this is your last chance to talk!
220v