中國醫藥大學附設醫院毒物科

H_2S中毒
--緊急醫療應變及治療

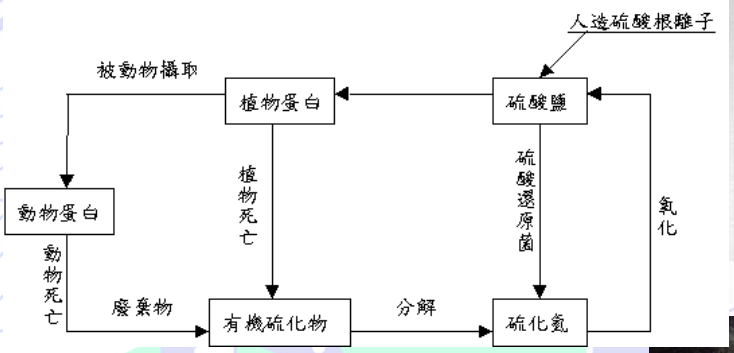
洪東榮 主任

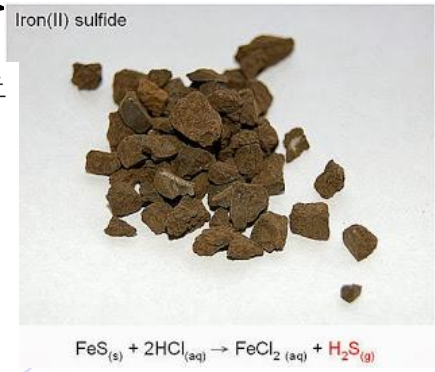
中國醫學大學附設醫院 毒物科

北縣板橋市昨天傳出工安意外，3名工人進入7公尺深的人孔蓋底槽陷入昏迷，消防局獲報營救，但仍有2名工人不幸死亡。（台北縣消防局提供） 2007/07/04自由時報

Sources of Hydrogen Sulfide

- 有機物分解作業—污水廢水處理 垃圾
- 硫酸及含硫鹽類
- 用於農業 釀造
- 重水製造
- 膠水製造
- 皮革製造—廢水池可達940 ppm
- 硫化橡皮
- 油氣探勘





petroleum refining, nautral gas, waste management, food procesing, fishing, asphalt production, rayon production, processing of dyes & sugar

警方指出，陳男把含有硫化氫的溶劑倒入桶子和臉盆內，腳邊則擺了清潔劑、鹽酸、硫酸等開封瓶罐，並緊閉車內門窗，靠在椅背上等氣體揮發，最後吸入過多有毒氣體身亡。**男吸硫化氫自殺 驚悚封街移毒 車窗留「毒氣」警語 怕傷無辜 一警吸入即吐**

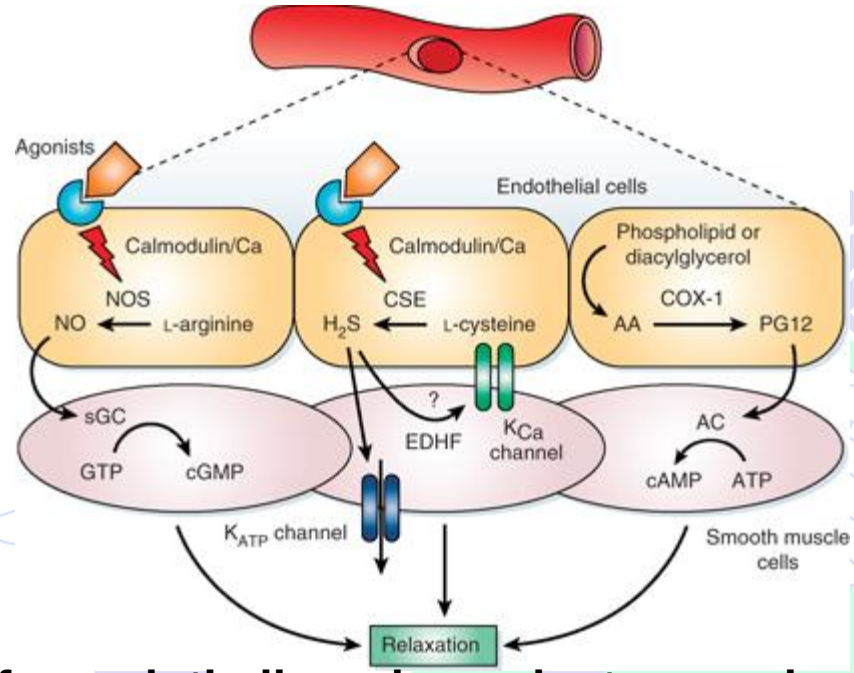
2009年03月13日

中國醫藥大學附設醫院毒物科

樹林帝盟科技驚傳意外 回收廢液突冒毒氣 瞬間奪兩命

May 21, 2007	14:40	搶救氯氣波及 亞東醫院急診室封閉

May 22, 2007	9:30	Several health care workers complained of subjective discomfort.
	15:30	More workers complained the same symptoms. (sore throat, skin itching and bitter feeling in their mouth)



Molecular basis for endothelium-dependent vasorelaxation. With different substrates, NO, H_2S, and PGI2 are produced from the endothelium by NOS, CSE, and COX-1, respectively. They are released from the endothelium and act on the adjacent smooth muscle cells to induce relaxation. NO and H_2S are also produced in smooth muscle cells. For brevity of description, smooth muscle production of these substances is not included in this diagram. NOS, NO synthase; CSE, cystathionine -lyase; COX-1, cyclooxygenase-1; AA, arachidonic acid; EDHF, endothelium-derived hyperpolarizing factor.

Figure 1. Exposure–response curves for hydrogen sulphide by species, adapted from an unpublished report by Dr Robert Rogers for the Alberta Energy Resources Conservation Board, 1990.

Occup. Mad. Vol. 46, No. 5. pp. 367-371.1996

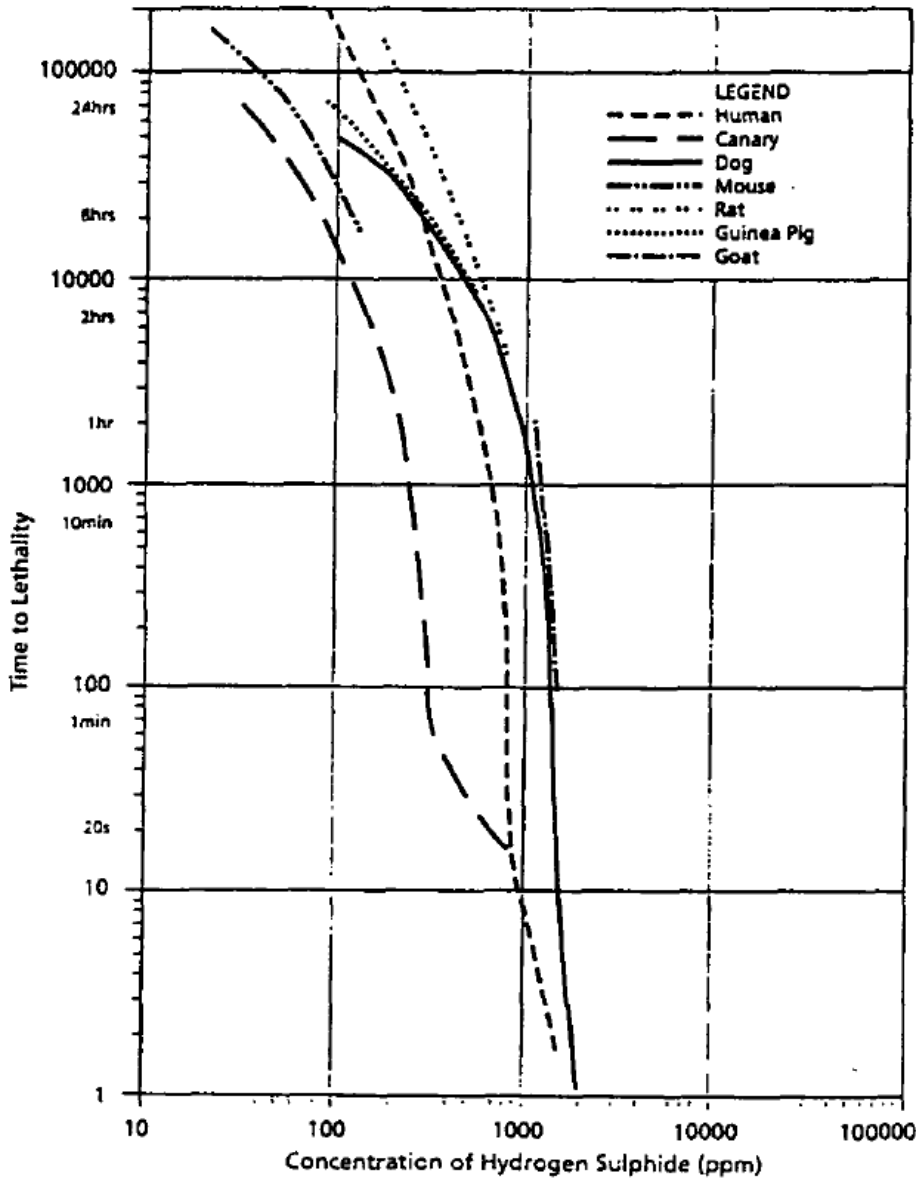
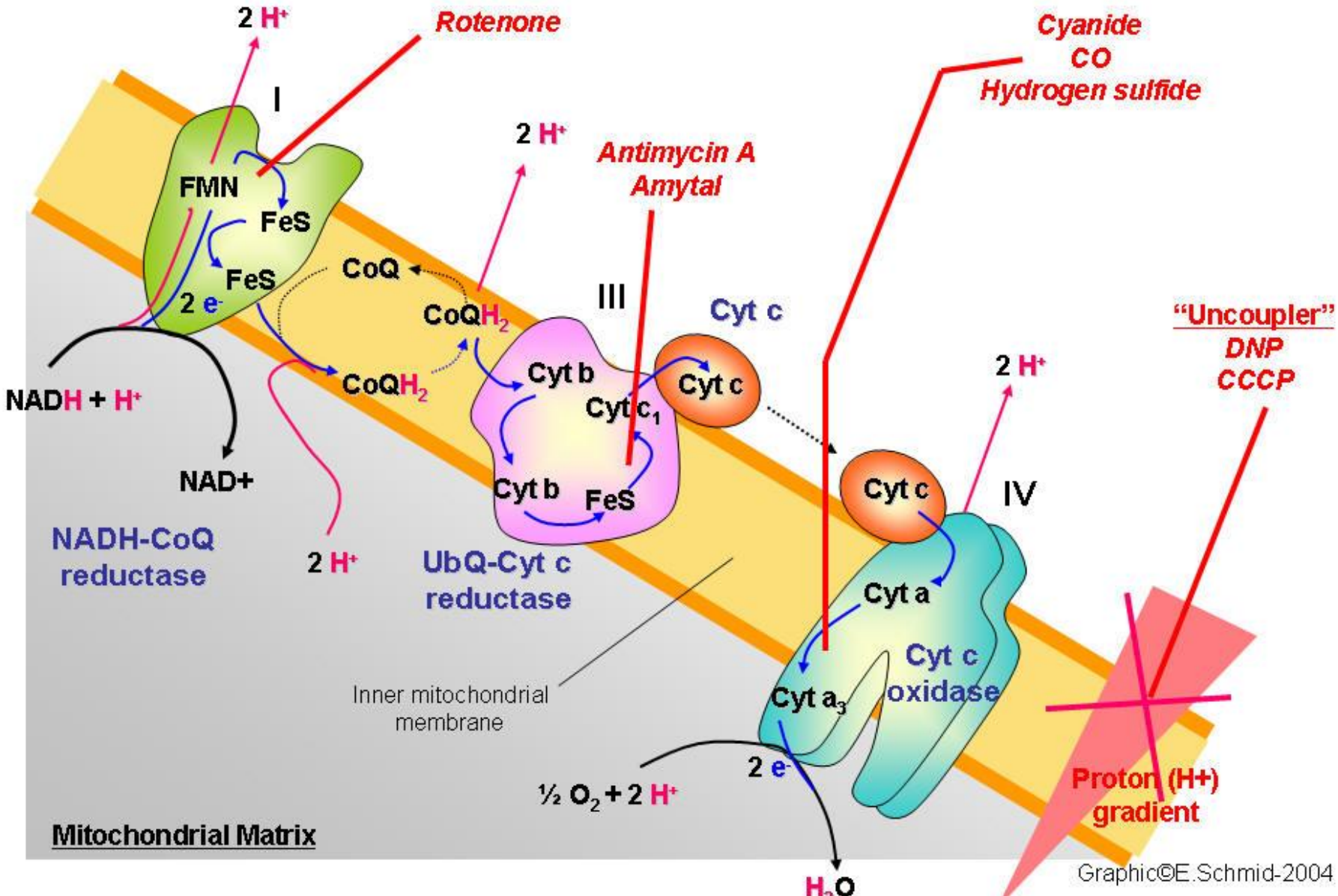
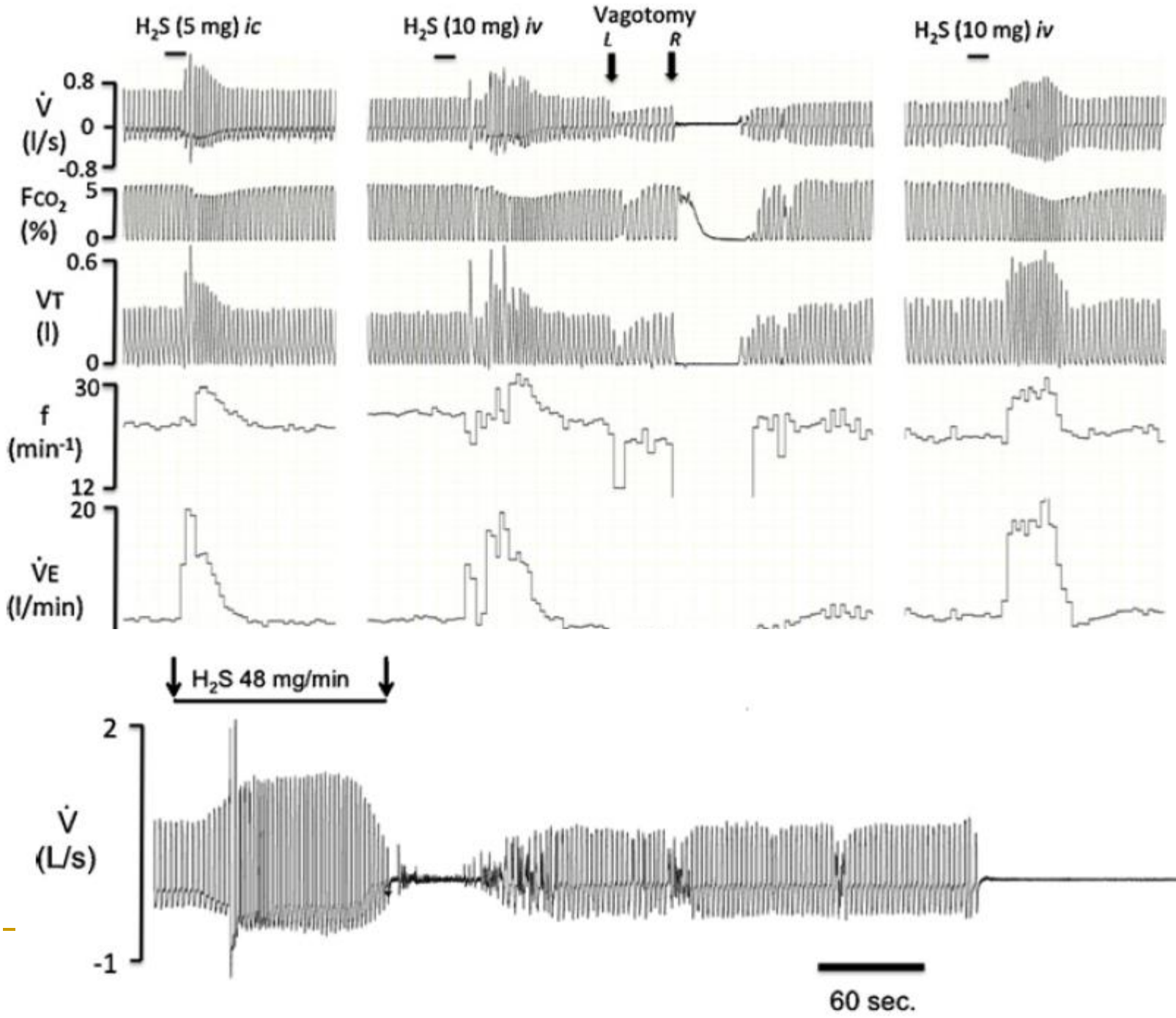


Table 1. Health effects of hydrogen sulphide at various exposure levels

Concentration (ppm)	*Effects*
0.01–0.3	Odour threshold (highly variable)
1–5	Moderate offensive odour, may be associated with nausea, tearing of eyes, headaches or loss of sleep with prolonged exposure; healthy young male subjects experience no decline in maximal physical work capacity
10	8 hour occupational exposure limit in Alberta
15	15 min occupational exposure limit in Alberta
20	Ceiling occupational exposure limit evacuation level in Alberta, odour very strong
20–50	Keratoconjunctivitis (eye irritation) and lung irritation. Possible eye damage after several days of exposure; may cause digestive upset and loss of appetite
100	Eye and lung irritation; olfactory paralysis, odour disappears
150–200	Sense of smell paralyzed; severe eye and lung irritation
250–500	Pulmonary oedema may occur, especially if exposure is prolonged
500	Serious damage to eyes within 30 min; severe lung irritation; unconsciousness and death within 4–8 hours; amnesia for period of exposure; 'knockdown'
1,000	Breathing may stop within one or two breaths; immediate collapse

Probable Mechanism of Hydrogen Sulfide Poisoning




H2S (5 mg) ic
H2S (10 mg) iv
Vagotomy
L
R
H2S (10 mg) iv
0.8
V̇
(l/s)
0
-0.8
5
FCO2
(%)
0
0.6
VT
(l)
0
30
f
(min-1)
12
20
V̇E
(l/min)
Dog
H2S 48 mg/min
2
V̇
(L/s)
-1
60 sec.
sheep

硫化氫的中毒症狀

- 眼睛:角膜結膜炎導致流淚燒灼感，疼痛及紅腫, **Gas eyes**
- 低血壓 心律不整
- 呼吸抑制 發紺 及肺水腫
- 神智昏迷
- 噁心 嘔吐
- **Rotten egg smell on clothes or body fluid**

Table 2 Clinical symptoms after H_2S exposure[a]

"Felt ill"	Headache	Depression
Visual "fogging"	Insomnia	Irritability
Conjunctivitis	Sore throat/cough	Amnesia
Photophobia	Chest pain	Disequilibrium
Tearing	Dyspnea	Convulsions
Eye pain	Hemoptysis	Pulmonary edema
Nausea	Lethargy	Cyanosis
Vomiting	Abnormal peripheral reflexes	Unconsciousness
Anorexia	Weakness of extremities	Bradycardia

[a] Compiled from several sources (2, 7, 108).

Table 6. Odors That Suggest A Diagnosis.

Odor	Possible source
Bitter almonds	Cyanide
Carrots	Cicutoxin (water hemlock)
Fruity	Diabetic ketoacidosis, isopropanol
Garlic	Organophosphates, arsenic, dimethyl sulfoxide (DMSO), selenium
Gasoline	Petroleum distillates
Mothballs	Naphthalene, camphor
Pears	Chloral hydrate
Pungent aromatic	Ethchlorvynol
Oil of wintergreen	Methylsalicylate
Rotten eggs	Sulfur dioxide, hydrogen sulfide
Peanut butter	Vacor (rodenticide)

硫化氫中毒的除污

呼吸的除污

- 最重要的方法是適當換氣。
- 將病患救離暴露來源，給予適當換氣和充足 的100%氧氣

眼睛的除污

- 硫化氫氣體對眼睛會引起極度的刺激，且硫化物會形成對眼睛具腐蝕性的鹼性水溶液。
- 應立即除去隱形眼鏡並用大量的清水或生理食鹽水持續沖洗結膜囊，在運送途中和在醫院時仍應持續沖洗。假如情況不允許至少在現場沖洗20分鐘以上

皮膚的除污

- 硫化氫(氣體)的暴露通常不需要皮膚的除污。
- 病患衣服像腐臭的蛋臭味(rotten egg)，可脫除病患的衣服並用大量清水和溫和清潔劑沖洗。

硫化氫中毒的治療

- 除污
- 初步檢視和復甦
  - Airway(呼吸道+頸椎保護)
  - Breathing(呼吸)
  - Cardiovascular(心臟血管)
  - Disability(神經系統)
  - Exposure(暴露)

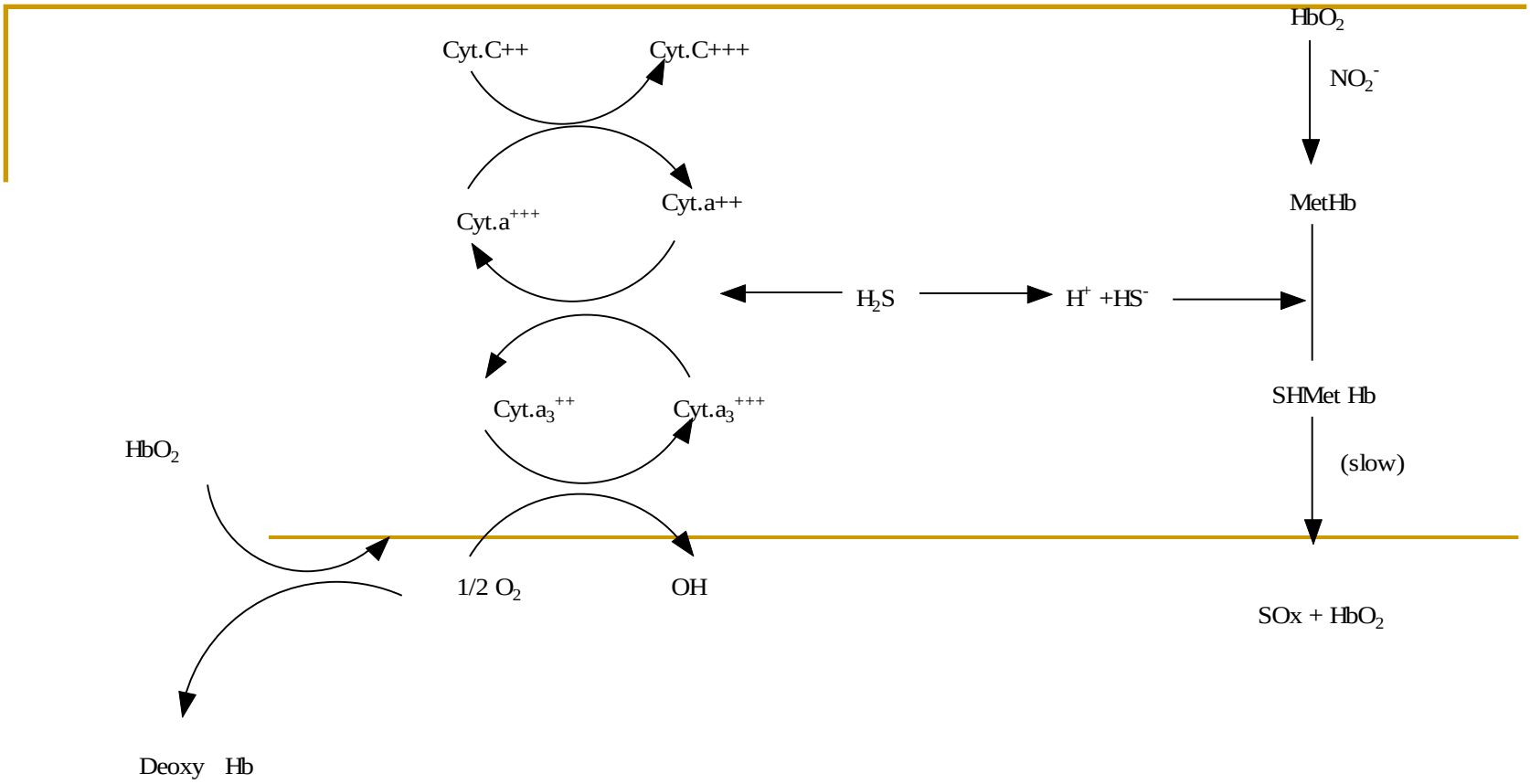
硫化物(sulfides)中毒的解毒劑

- 亞硝酸戊酯(amyl nitrite)
- 亞硝酸鈉(sodium nitrite)
- 高壓氧(HBO)？

硫化氫中毒的治療

- 100% 氧氣及洗胃
- 以 $NaHCO_3$ 調整酸中毒
- Amyl nitrite，置於鼻旁吸入15-30秒/次(可連續使用5分鐘)
- 3% Sodium nitrite 依量靜注 大人或大於25Kg小兒: 300mg (10ml)小兒 10mg/Kg
- 高壓氧治療

Probable Mechanism of Hydrogen Sulfide Poisoning



H_2S Rx Mechanism

Adapted from Smith RP, Gosselin RE: Hydrogen sulfide poisoning, J Occup Med 1974,21:94. Used with permission

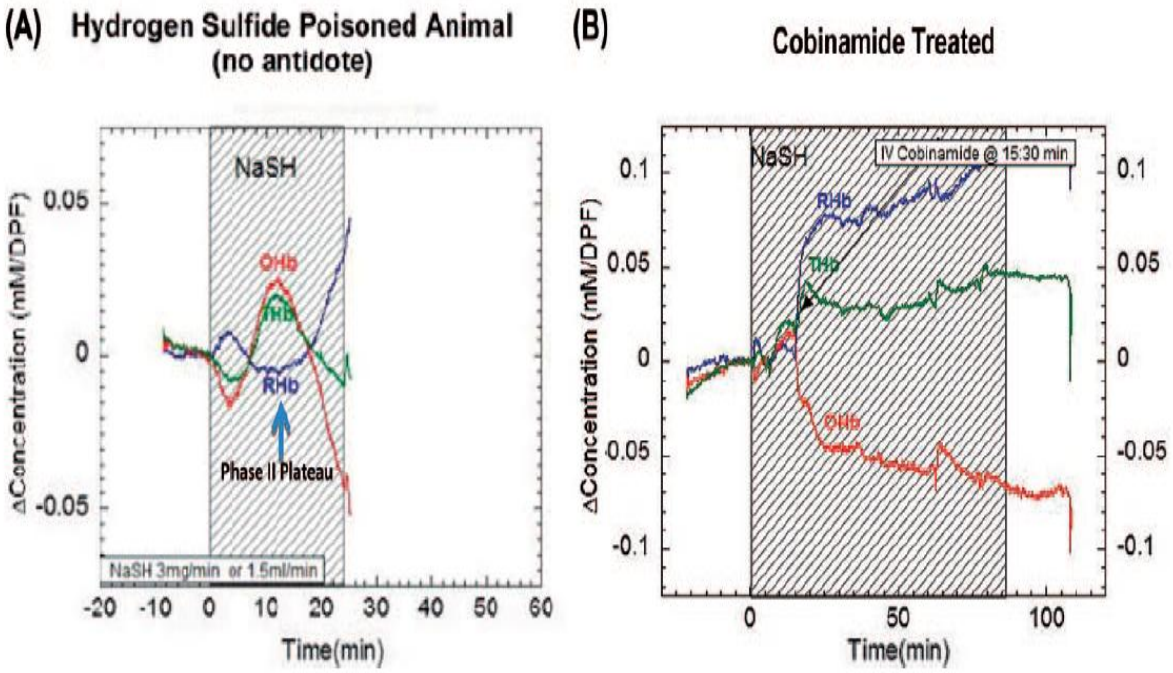
Utilization of Hyperbaric Oxygen Therapy and Induced Hypothermia After Hydrogen Sulfide Exposure

Mir J Asif DO and Matthew C Exline MD

Hydrogen sulfide is a toxic gas produced as a by-product of organic waste and many industrial processes. Hydrogen sulfide exposure symptoms may vary from mild (dizziness, headaches, nausea) to severe lactic acidosis via its inhibition of oxidative phosphorylation, leading to cardiac arrhythmias and death. Treatment is generally supportive. We report the case of a patient presenting with cardiac arrest secondary to hydrogen sulfide exposure treated with both hyperbaric oxygen therapy and therapeutic hypothermia to achieve full neurologic recovery. *Key words: hydrogen sulfide; hyperbaric oxygen; therapeutic hypothermia.* [Respir Care 2012;57(2):307–310. © 2012 Daedalus Enterprises]

The vitamin B12 analog cobinamide is an effective hydrogen sulfide antidote in a lethal rabbit model

Clinical Toxicology (2014), **Early Online:** 1–8



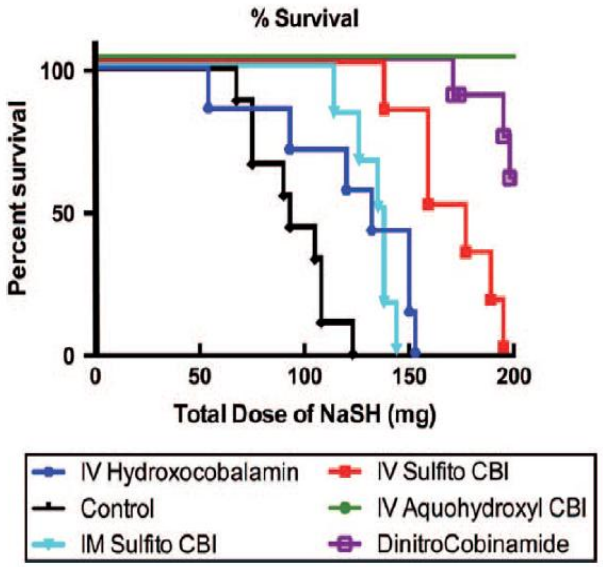


Fig. 3. Survival curve for animal groups receiving continuous infusion of NaHS at 3 mg/min until expiration.

Table 1. Experiment summary.

Group #	Treatment Group	*N*	mg of NaHS (mean) ± SEM	range (mg)	*p* vs. control	*p* vs. IV cobalamin
1	Control (NaHS alone)	9	93.8 ± 6.2	67.5–123	–	0.1 = NS
2	IV Hydroxocobalamin	7	121.7 ± 13.9	54–153	0.1 = NS	–
3	IV Aquohydroxocobinamide	6	261.5 ± 2.4	252–270	< 0.0001	< 0.0001
4	IV Sulfitocobinamide	6	170 ± 8.8	138–195	< 0.0001	< 0.02
5	IM Sulfitocobinamide	6	133 ± 4.4	114–144	< 0.0003	0.48 = NS
6	IM Dinitrocobinamide	8	165.4 ± 19.4	87–267	< 0.01	0.09