DEFENSIE
LA DÉFENSE

VOORRANG AAN VREDE
PRIORITÉ À LA PAIX

Clinical Indications for Hyperbaric Oxygen Therapy in 2011
Part 1

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Military Hospital Brussels

.be

What is HBO therapy ?

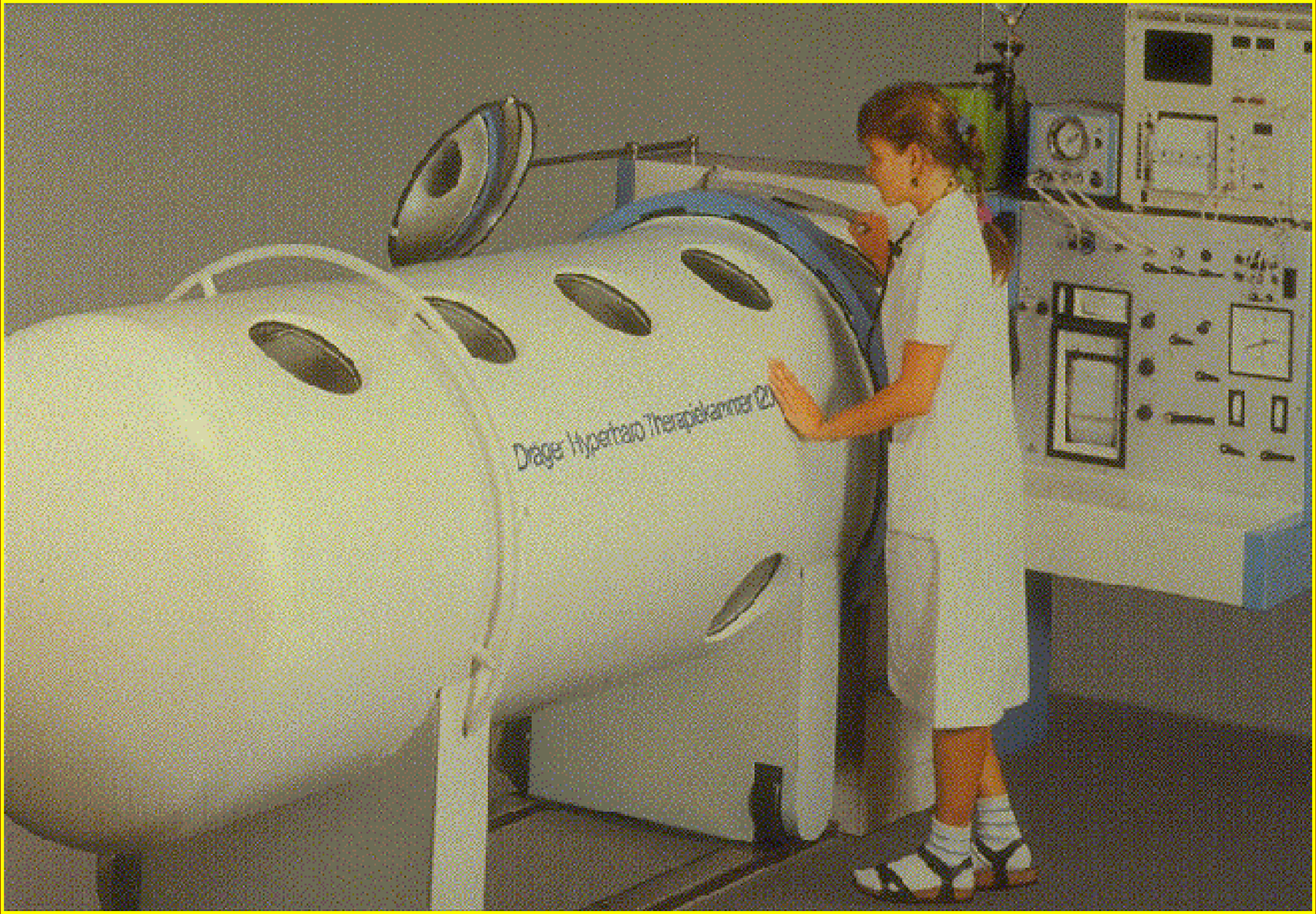
"Breathing oxygen under pressure for therapeutical purposes"

- Increase of oxygen transport
- Increase of oxygen delivery

- Oxygen "as a drug"
  - Indications, dose, side effects

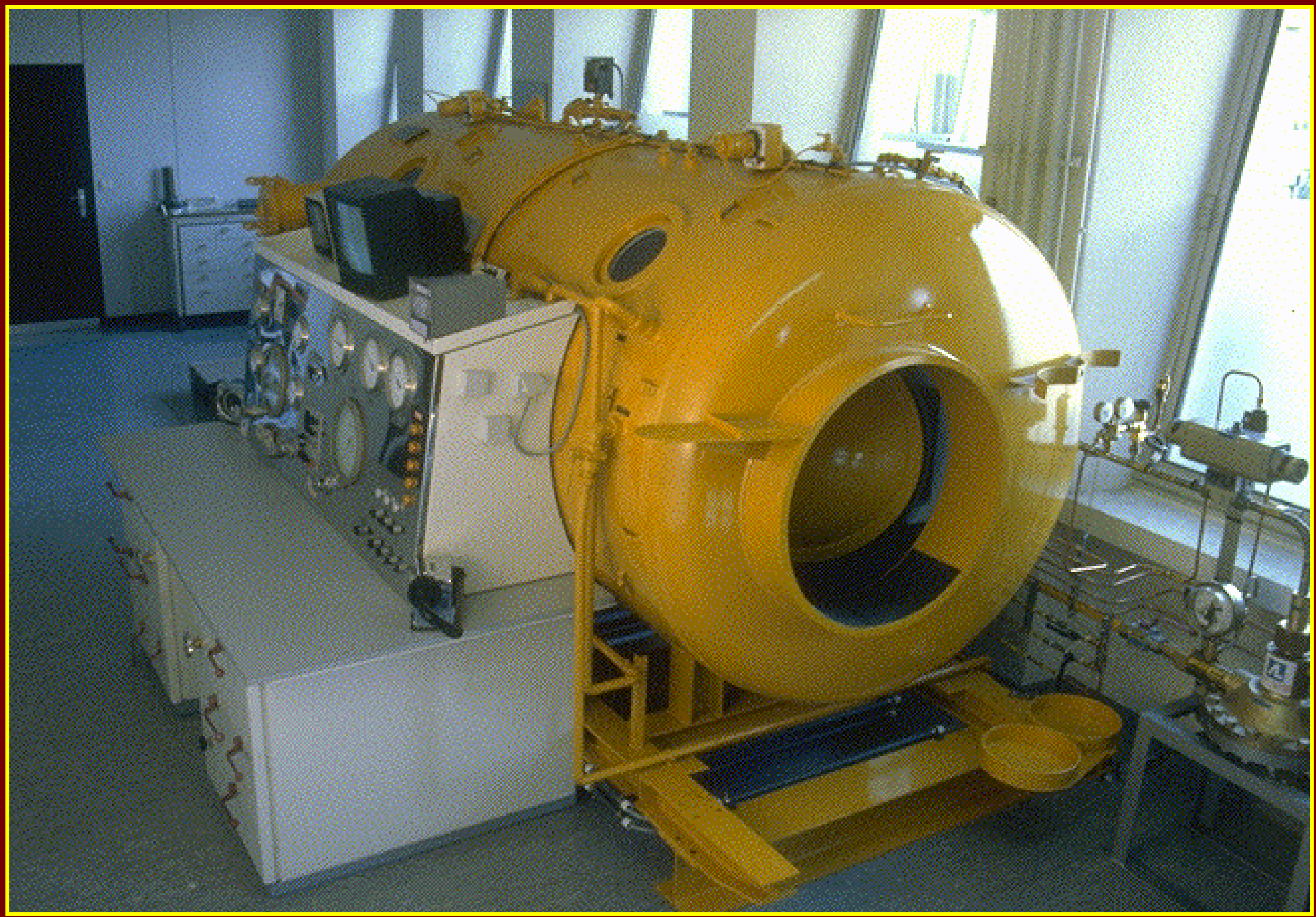
How to administer HBO ?

- “Monoplace” hyperbaric chambers



How to administer HBO ?

- “Monoplace” hyperbaric chambers
- “Multiplace” hyperbaric chambers



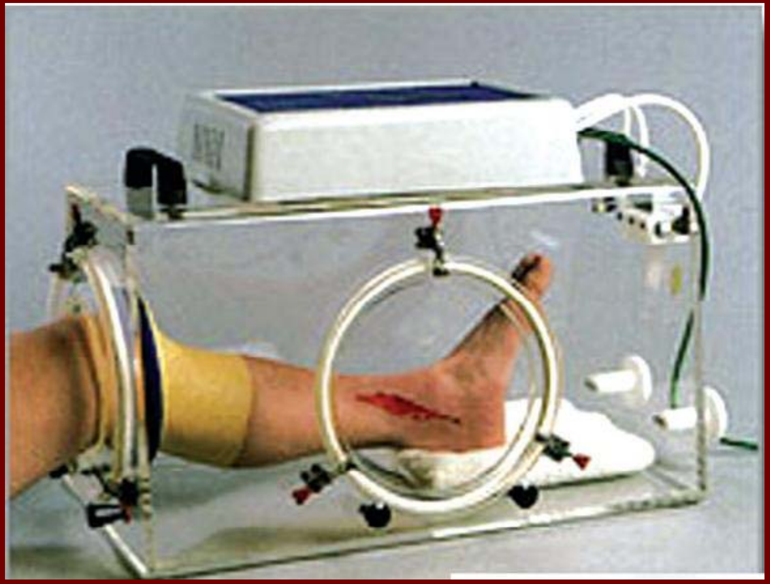
How to administer HBO ?

- “Monoplace” hyperbaric chambers
- “Multiplace” hyperbaric chambers

- Pressure of at least 2 ATA
- Duration of at least 60 minutes of O_2

How to administer HBO ?

- Pressure of at least 2 ATA
- Duration of at least 60 minutes of O2
- "Topical" application of oxygen is NOT HBO Therapy !



Effects of breathing oxygen at pressure

- Increase of P (alv) O_2
- Increase of P (art) O_2
- Increase of P (ven) O_2

- Hemoglobin saturation in venous blood = 100%

Oxygen transport in blood

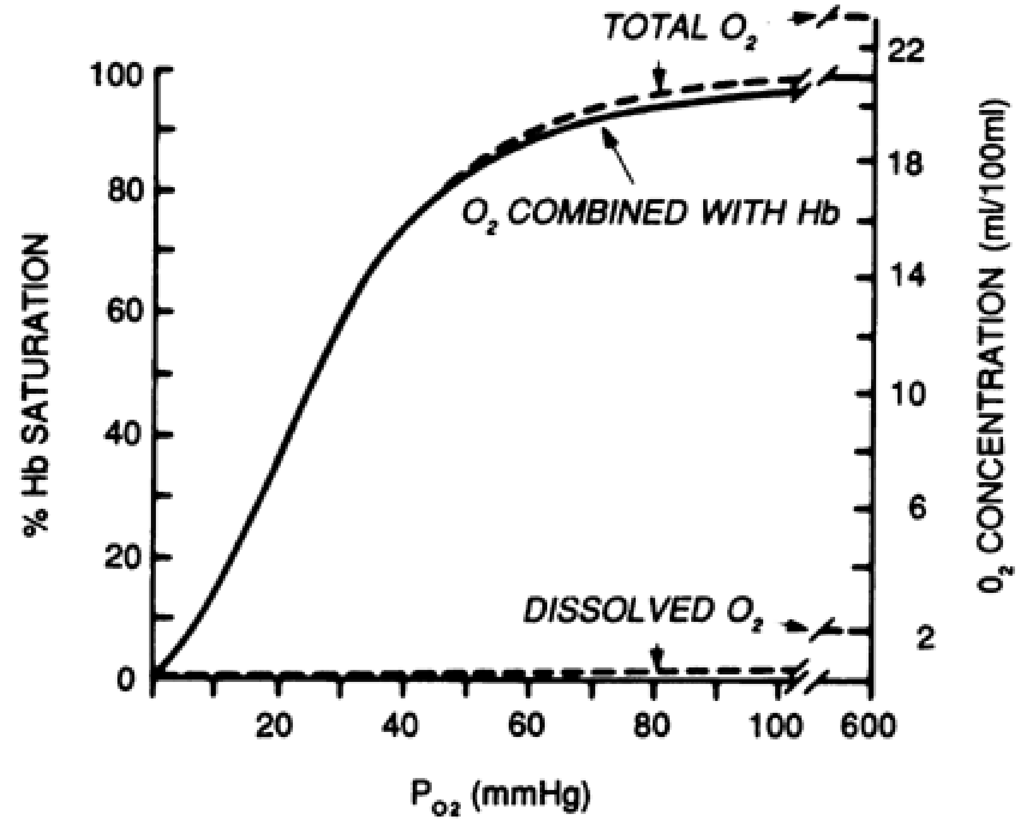
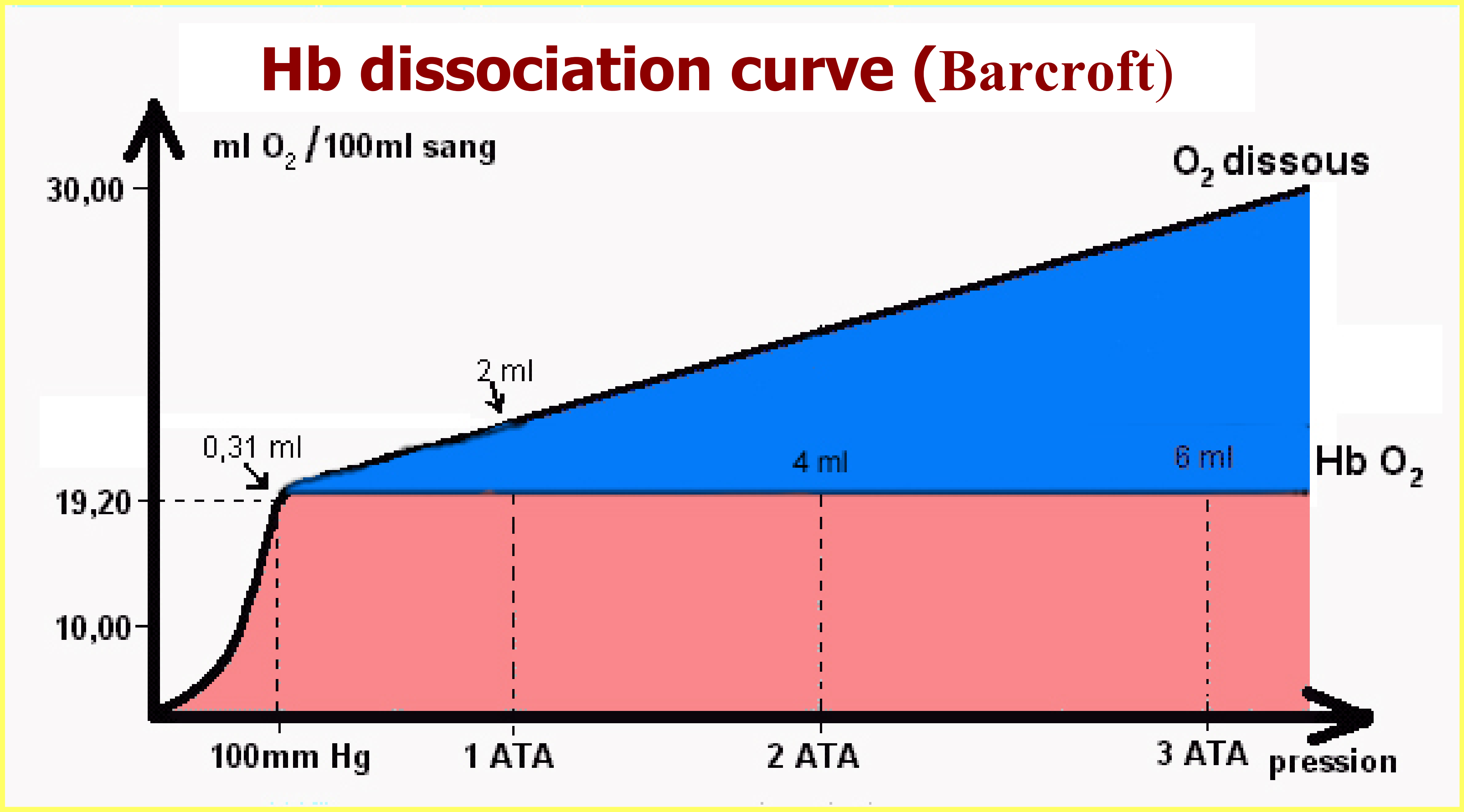


Figure 6.1. O_2 dissociation curve *(solid line)* for pH 7.4, P_{CO_2} 40 mm Hg, and 37°C. The total blood O_2 concentration is also shown for a hemoglobin concentration of 15 gm/100 ml of blood.

$Ca(O_2) = (Hb \times SaO_2 \times 1.34) + (PaO_2 \times 0.003)$

Oxygen transport in blood



$$Ca(O_2) = (Hb \times SaO_2 \times 1.34) + (PaO_2 \times 0.003)$$

Oxygen transport in blood

- Physiological O_2 consumption

TABLE 14-1. – MEAN VALUES FOR BLOOD O_2, CO_2 AND pH IN HEALTHY RESTING YOUNG MEN*

	ARTERIAL BLOOD	MIXED VENOUS BLOOD
1. O_2 pressure (torr)	100	40
2. Dissolved O_2 (ml O_2/100 ml W.B.†)	0.3	0.12
3. O_2 content (ml O_2/100 ml W.B.)	20.3	15.5
4. O_2 combined with Hb (ml O_2/100 ml W.B.)	20.0	15.4
5. O_2 capacity of Hb (ml O_2/100 ml W.B.)	20.6	20.6
6. % saturation of Hb with O_2	97.1	75.0
7. Total CO_2 (ml CO_2/100 ml W.B.)	49.0	53.1
(mmoles CO_2/L)	21.9	23.8
8. Plasma CO_2 (ml CO_2/100 ml plasma)	59.6	63.8
a. Dissolved CO_2 (ml CO_2/100 ml)	2.84	3.2
b. Combined CO_2 (ml CO_2/100 ml)	56.8	60.5
c. Combined CO_2/dissolved CO_2	20/1	18.9/1
d. CO_2 pressure (torr)	40	46.5
9. Plasma pH	7.40	7.376

*Modified from Albritton, E. C. (ed.): *Standard Values in Blood* (Philadelphia: W. B. Saunders Company, 1952).
†W.B. = whole blood.

"Life without blood" ?

Boerema 1959

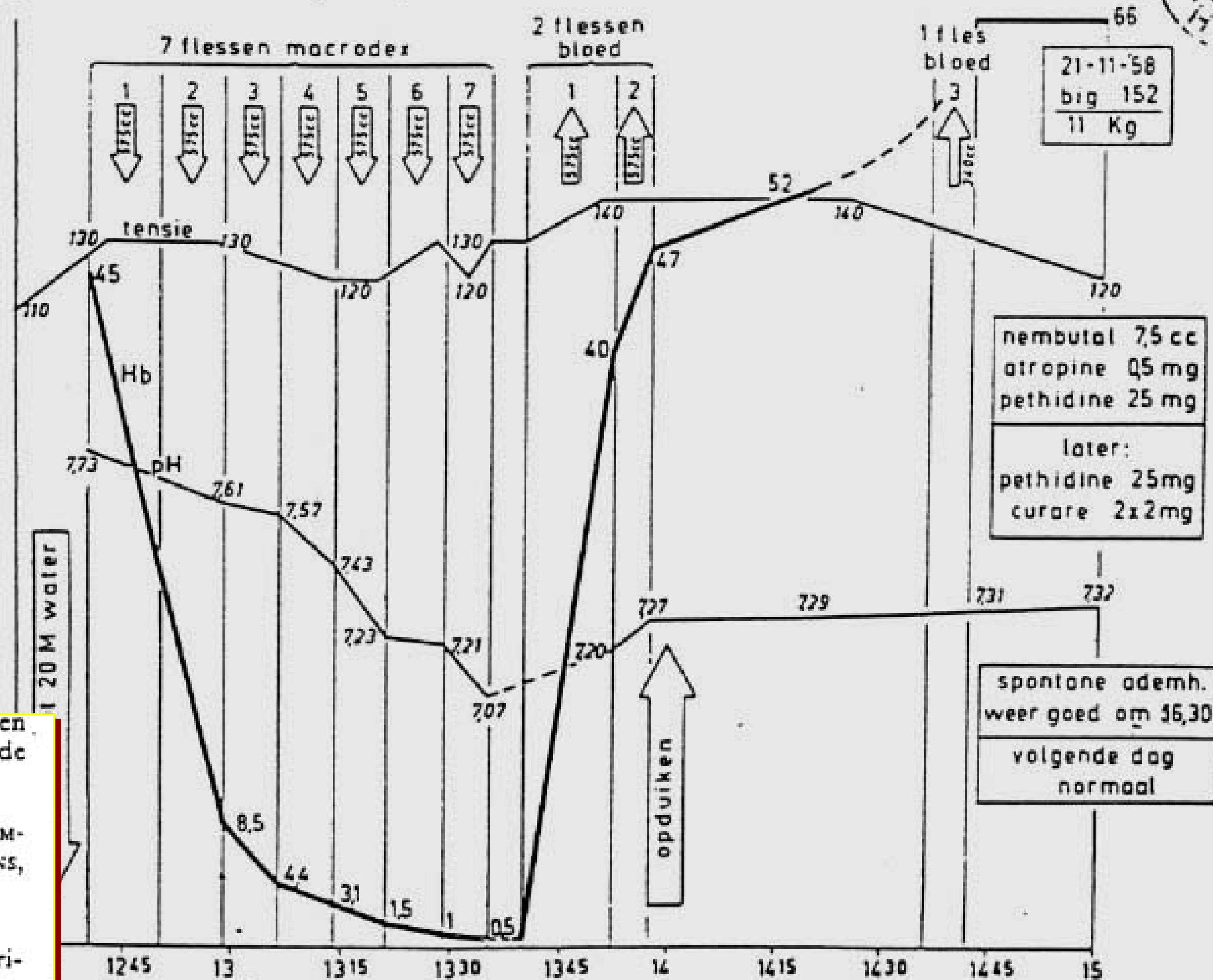
...de vader der leverchirurgie, heeft tot 1 januari 1958 negen patiënten geopereerd. Hij houdt zich dan ook niet aan de indicatie van gemetastaseerd levercarcinoom.

Prof. Dr. I. BOEREMA, Dr. N. G. MEYNE, Dr. W. H. BRUMMELKAMP, S. BOUMA, Dr. M. H. MENSCH, F. KAMERMANS, M. STERN HANF en Dr. W. VAN AALDEREN,

Leven zonder bloed

Toen wij (BOEREMA c.s.) in 1948 begonnen met onze experimenten betreffende hypothermie, was ons einddoel het metabolisme van een warmbloedig dier zover te verlagen, dat alle fysiologische processen vrijwel tot stilstand zouden komen. Als wij hierin slaagden, zou het mogelijk zijn, het hart ...

MEI 1960 NED. T. GENEESK. 104. I. 19



. Verdunning van het bloed bij een druk van 3 atmosfeer met 7 flessen Macrodex. Het laagste hemoglo-[bine]gehalte was 0,5 pct, de p_H daalde tot 7,07. De bloeddruk was vrijwel onveranderd tijdens het gehele experiment. Herstel na infusie van twee flessen bloed. De volgende dag geheel normaal.

Life without blood !

Effects of hyperbaric hyperoxia

- Increased O_2 transport in blood

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- Increased O_2 transport in blood
- Pressure effect (Boyle-Mariotte’s law)

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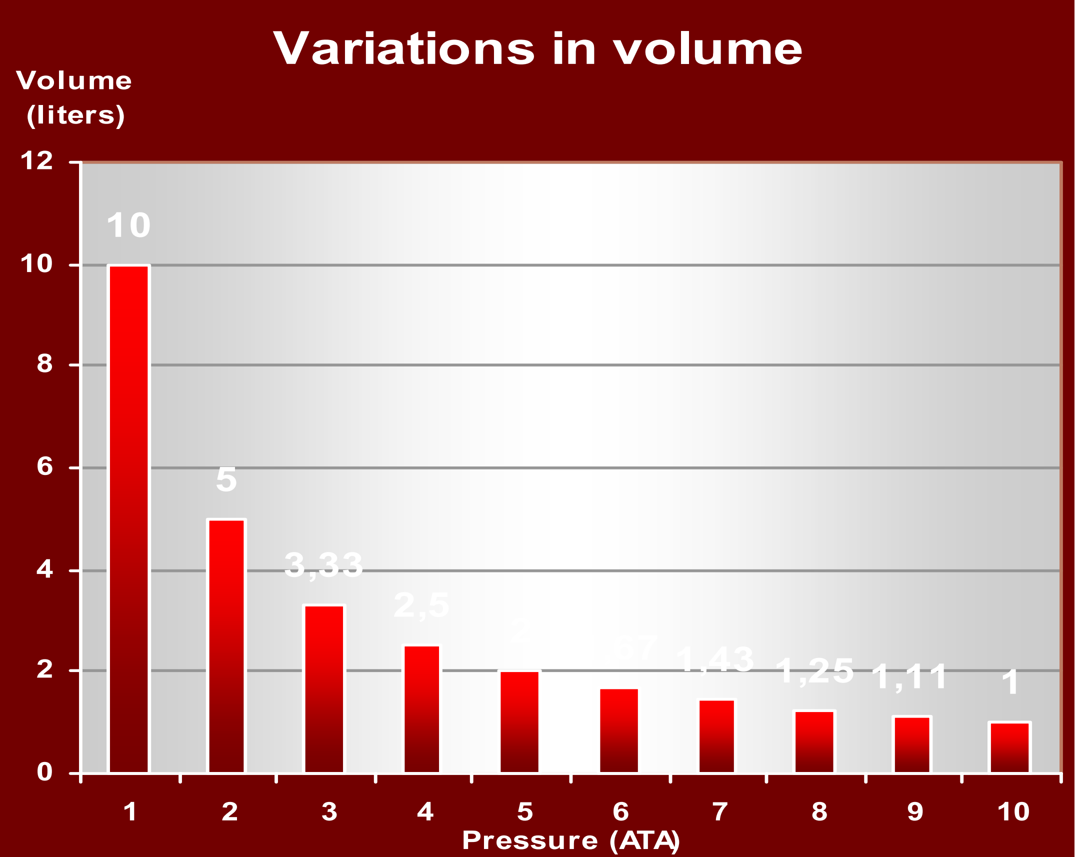

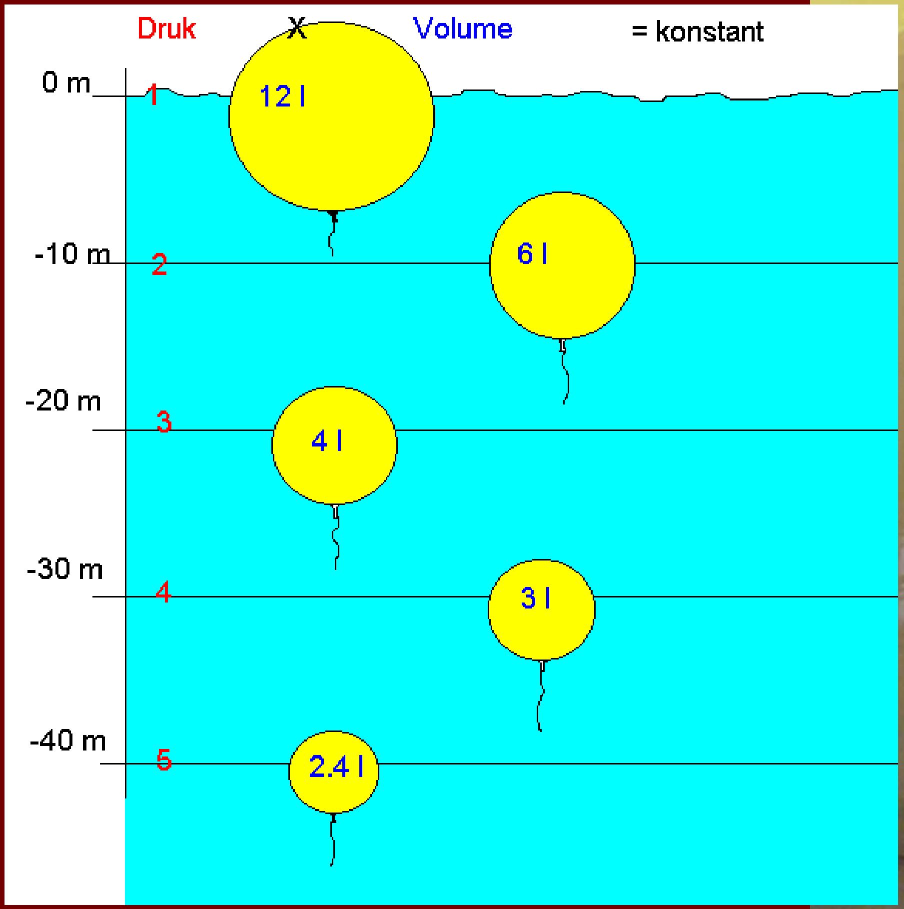

Effects of hyperbaric O_2

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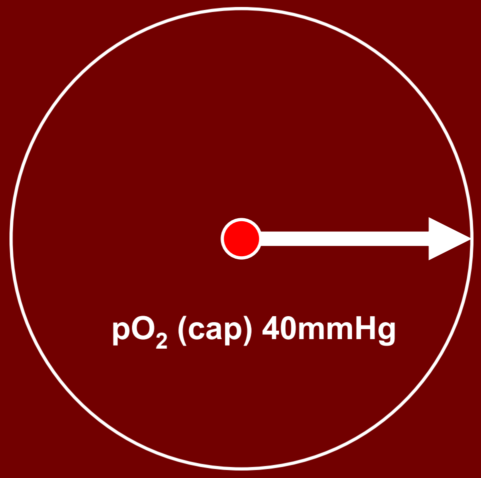

Krogh's Capillary Model

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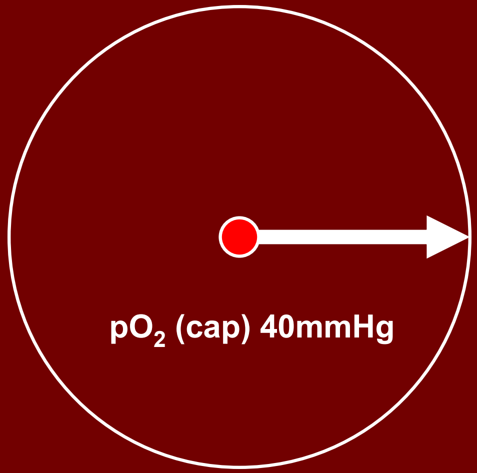

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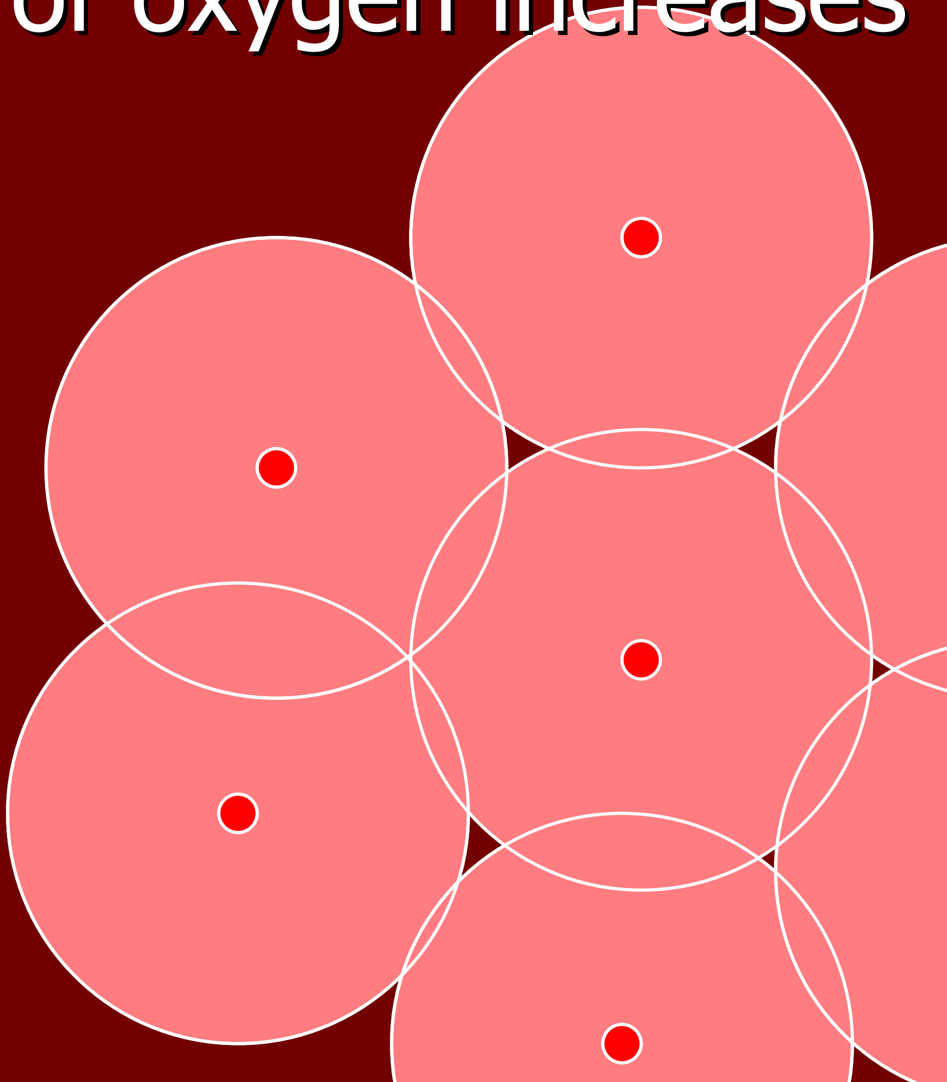

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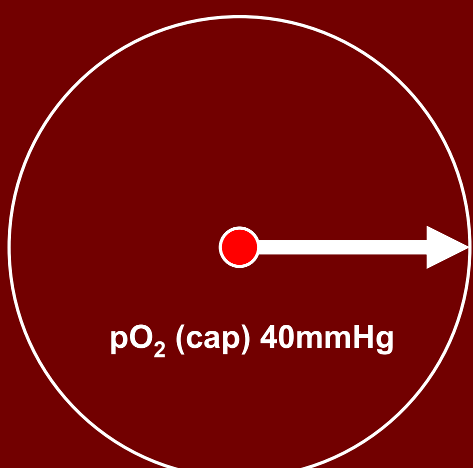

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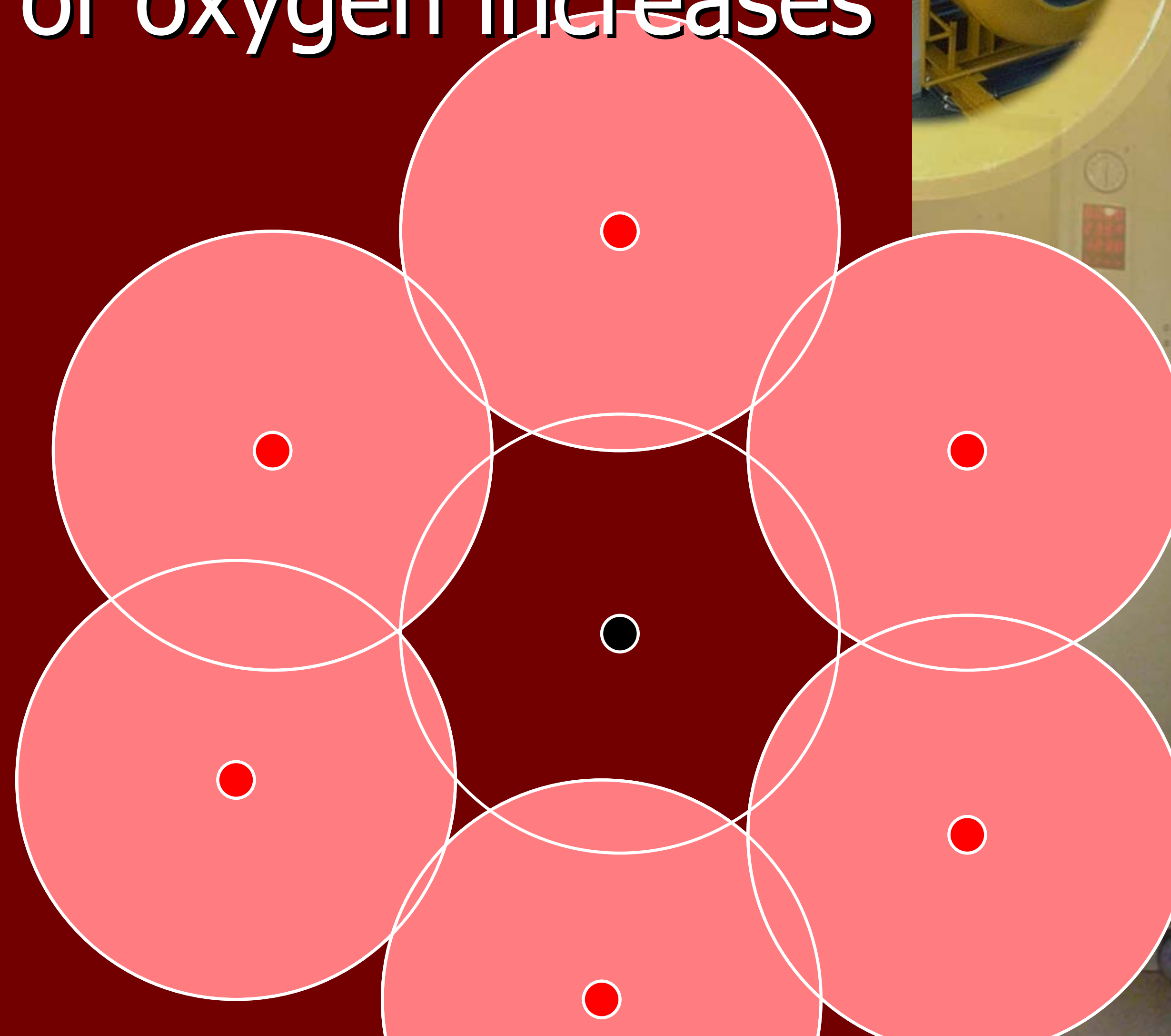

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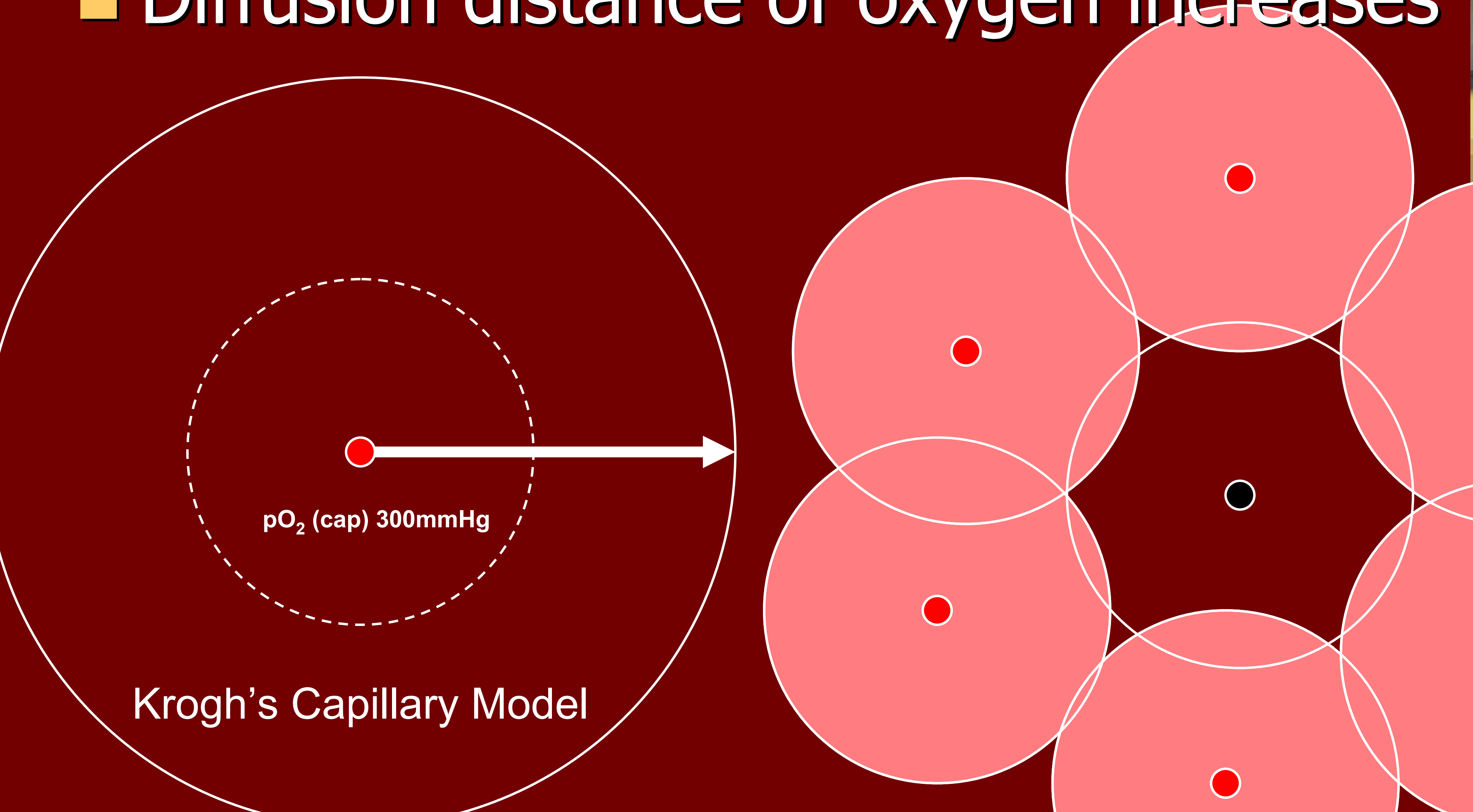

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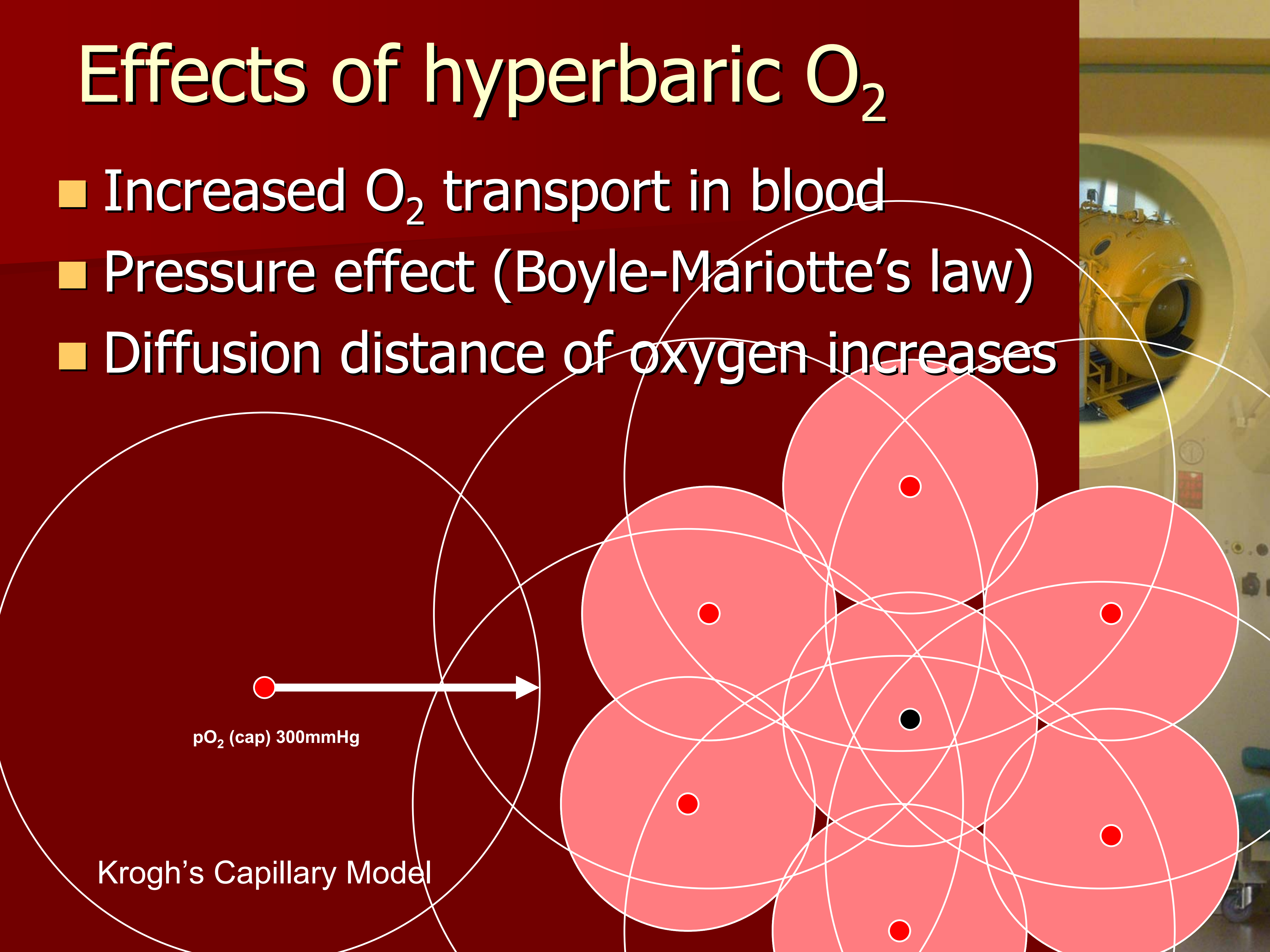

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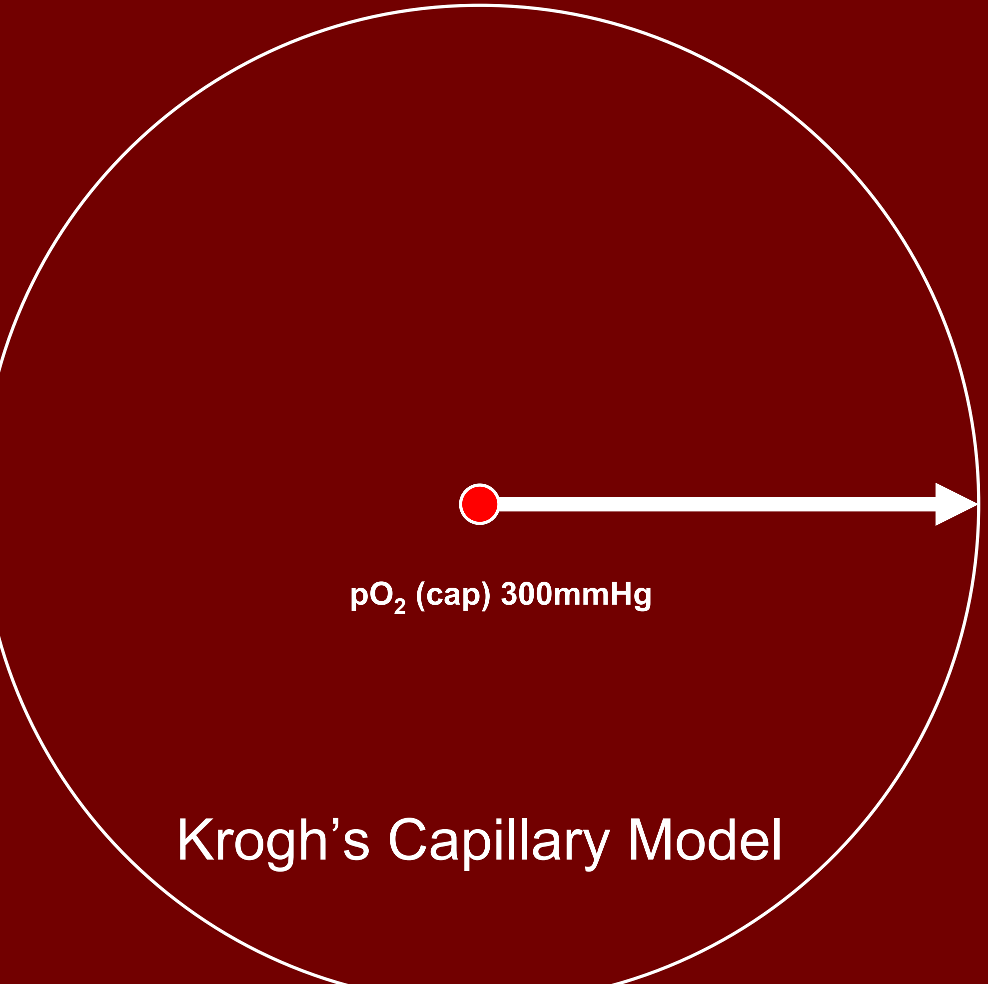
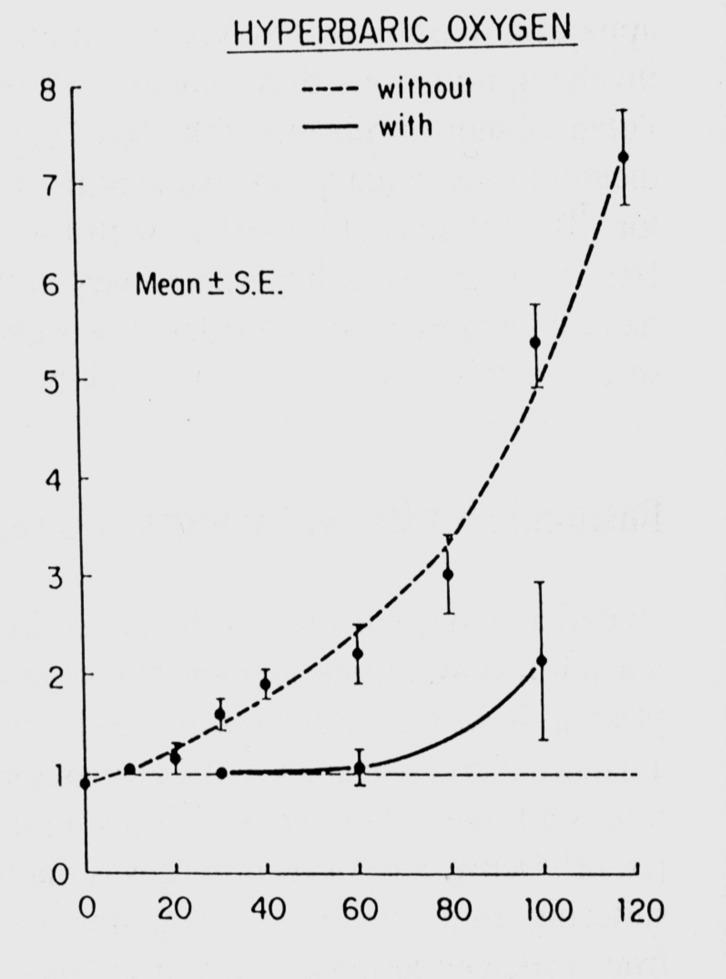
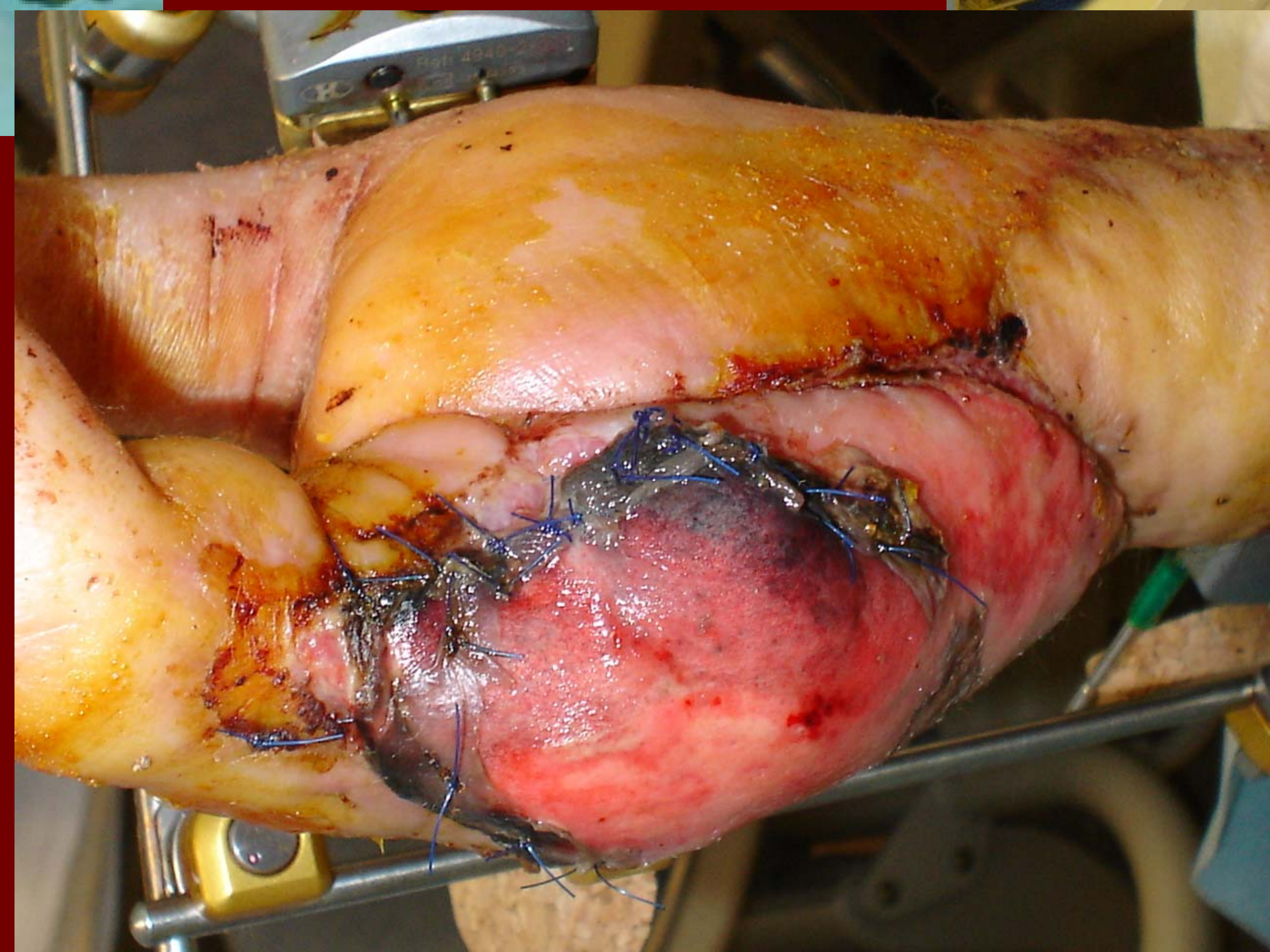






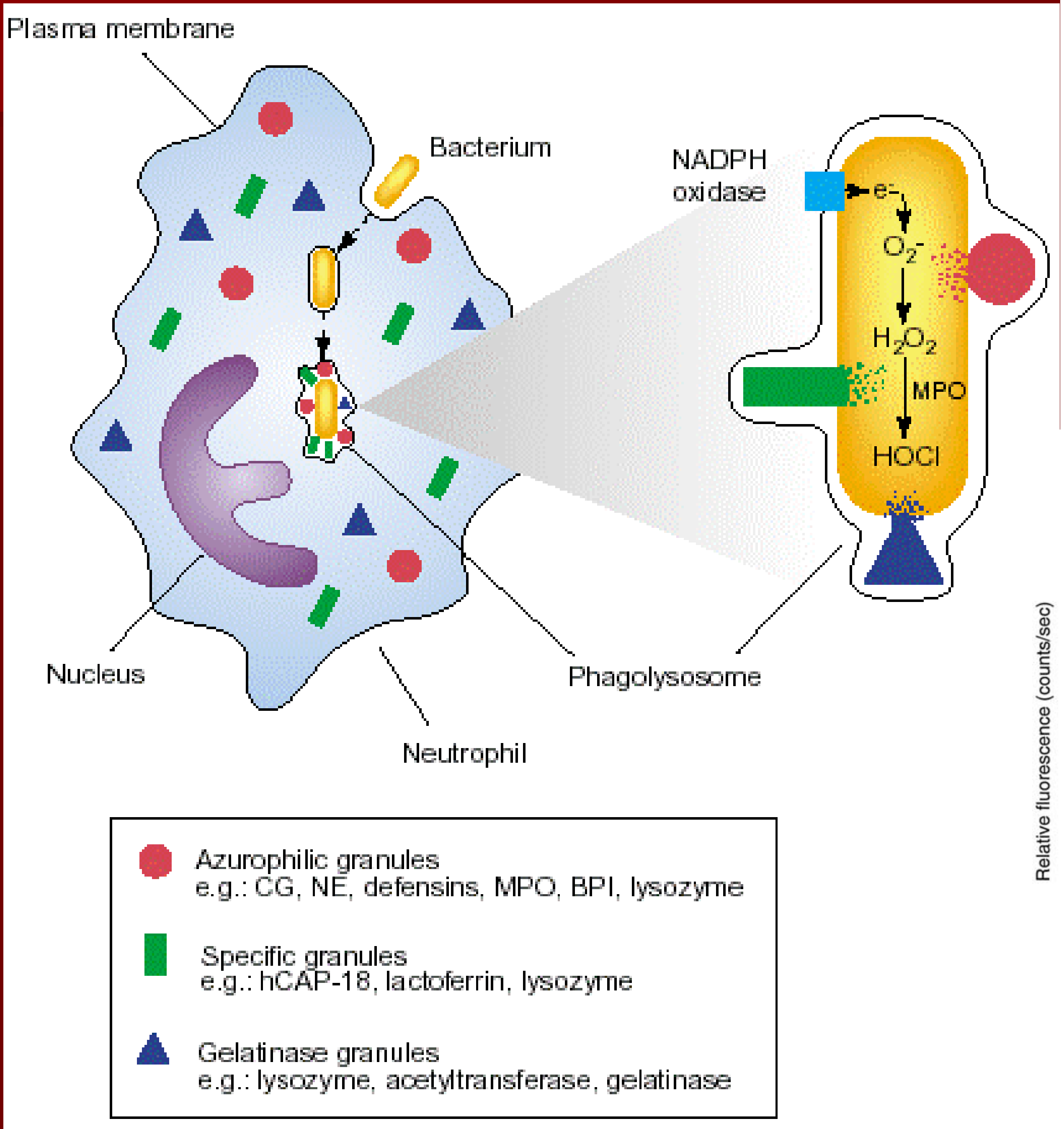

1ère Séance

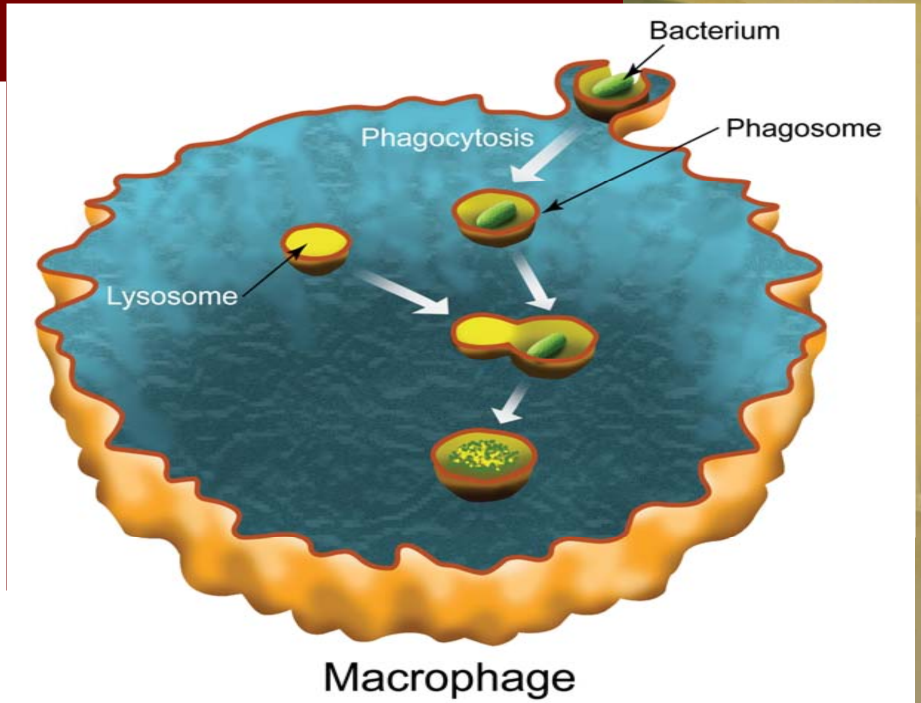

15ème Séance

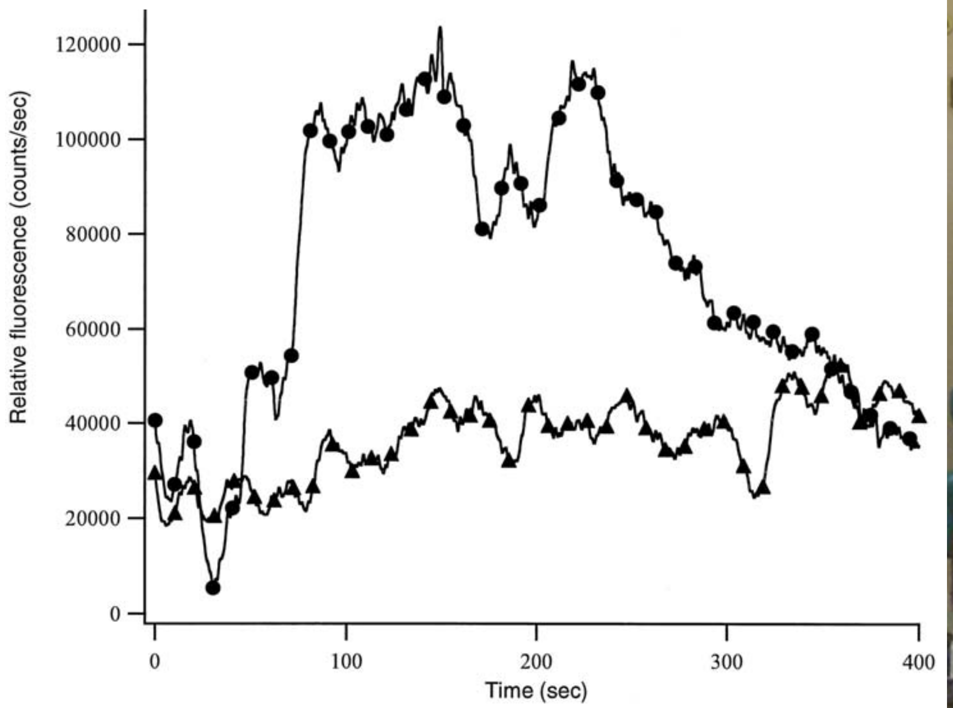
Effects of hyperbaric O_2

- Increased O_2 transport in blood
- Pressure effect (Boyle-Mariotte's law)
- Diffusion distance of oxygen increases
- Anti-infectious defense mechanisms
  - Direct (anaerobic bacteria)
  - Indirect (white blood cell function, ATB)

Effects of hyperbaric O_2

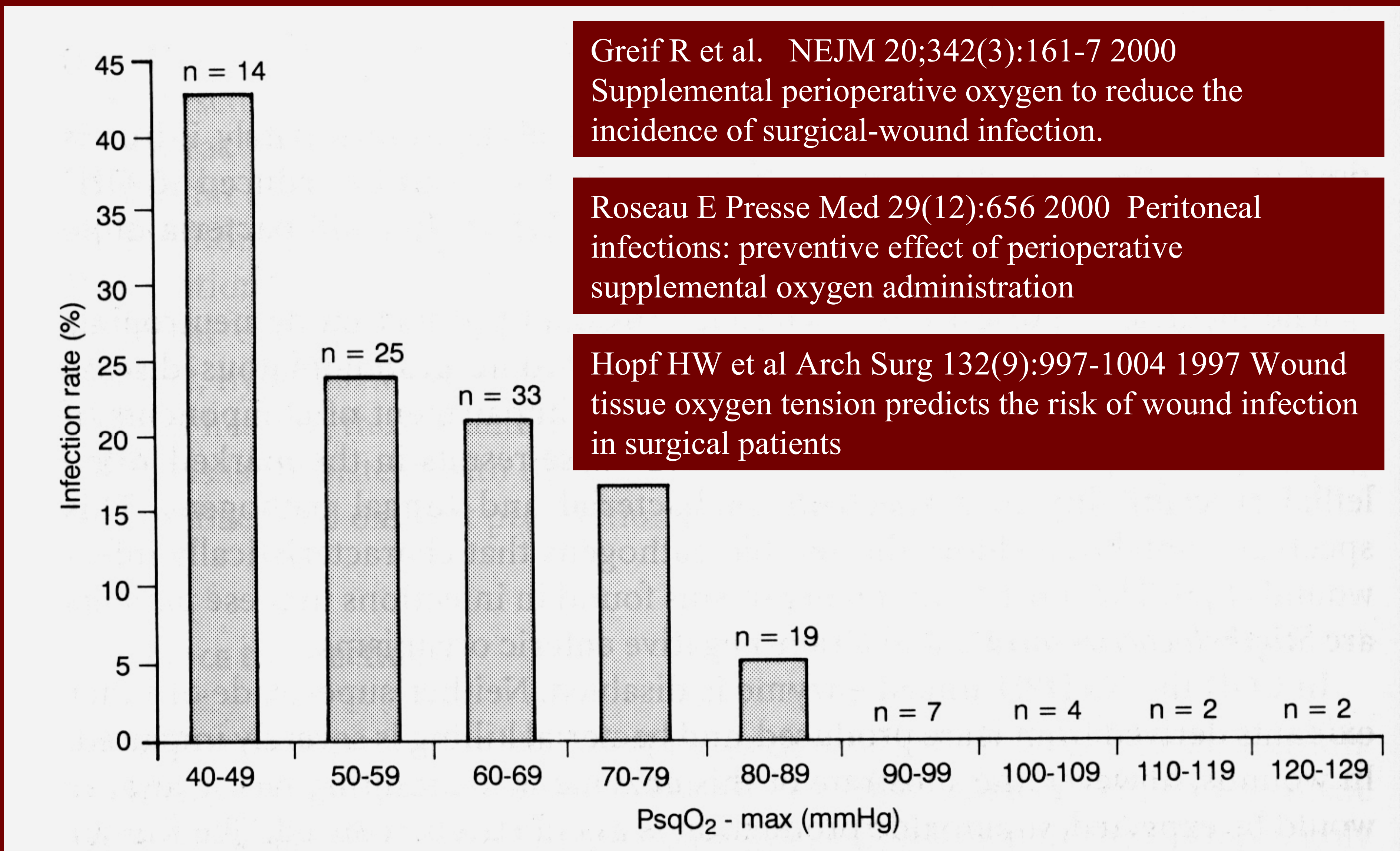






Effects of hyperbaric O_2

Infection rate in 153 operative surgical patients at high risk for infection - correlation with SC pO2 (FiO2 = 0.5)



Greif R et al. NEJM 20;342(3):161-7 2000 Supplemental perioperative oxygen to reduce the incidence of surgical-wound infection.

Roseau E Presse Med 29(12):656 2000 Peritoneal infections: preventive effect of perioperative supplemental oxygen administration

Hopf HW et al Arch Surg 132(9):997-1004 1997 Wound tissue oxygen tension predicts the risk of wound infection in surgical patients

Johnson et al. Ann Surg 1991

Effects of hyperbaric O_2

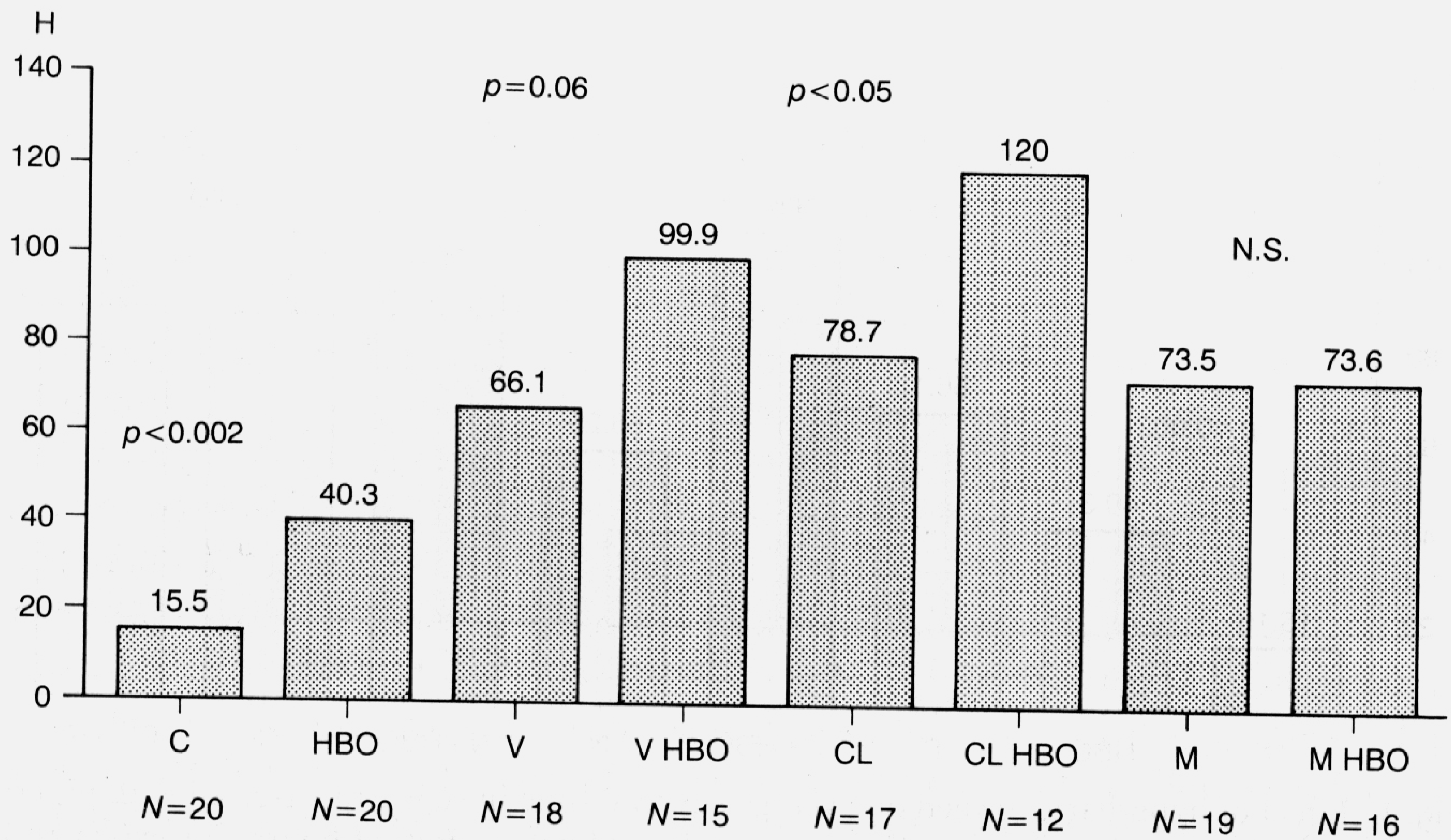


Fig. 5. Effect of hyperbaric oxygen on average survival time in septic rats treated with vancomycin, clindamycin, or metronidazole. (See Fig. 4 for explanation of symbols.)

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- Pressure effect (Boyle-Mariotte's law)
- Diffusion distance of oxygen increases
- Anti-infectious defense mechanisms
  – Direct (anaerobic bacteria
  – Indirect (white blood cell function, ATB)
- Stimulation of granulation tissue

"Oxygen as a drug" : Indications

- Any disease where oxygen (maybe) plays a role ?
- Any disease where no other good treatment is available ?

- "A therapy in search of diseases" (Chest, 1987)

Evidence Based Medicine

- Level I evidence
  - Multiple RCTs of good quality: prospective, placebo controlled
- Level II – III – IV evidence
  - Small RCTs without placebo
  - Retrospective studies with patients as their own historical controls
  - Retrospective studies, uncontrolled
  - Case series
  - Animal studies

HBO Therapy Indication

1. Is there a (local or generalised) lack of oxygen ?
2. Does this hypoxia cause or aggravate the disease ?
3. Can HBO improve tissue oxygenation ?
4. Is there evidence that improving tissue oxygenation improves the disease ?
5. Is there a good “risk-benefit” ratio for this particular patient ?

Undersea and Hyperbaric Medical Society, 2010

1. Air or Gas Embolism
2. Carbon Monoxide Poisoning (incl. CO Poisoning Complicated by Cyanide Poisoning)
3. Clostridial Myositis and Myonecrosis (Gas Gangrene)
4. Crush Injury, Compartment Syndrome and other Acute Traumatic Ischemias
5. Decompression Sickness
6. Arterial Insufficiencies (Central Retinal Artery Occlusion, Enhancement of Healing In Selected Problem Wounds)
7. Severe Anemia
8. Intracranial Abscess
9. Necrotizing Soft Tissue Infections
10. Osteomyelitis (Refractory)
11. Delayed Radiation Injury (Soft Tissue and Bony Necrosis)
12. Compromised Grafts and Flaps
13. Acute Thermal Burn Injury

CONDITION	ACCEPTED		
	Level of Evidence		
	A	B	C
Type I			
CO intoxication		X	
Crush Syndrome		X	
Prevention of Osteoradionecrosis (dental extraction)		X	
Osteoradionecrosis (mandible)		X	
Soft Tissue Radionecrosis (cystitis)		X	
Decompression Accident			X
Gas Embolism			X
Anaerobic or Mixed Bacterial Anaerobic Infections			X
Type II			
Diabetic Foot Lesion		X	
Compromised Skin Graft and Musculocutaneous Flap			X
Osteoradionecrosis (other bones)			X
Radio-induced Proctitis / Enteritis			X
Radio-induced Lesions of Soft Tissues			X
Surgery and Implant in Irradiated Tissue (preventive action)			X
Sudden Deafness			X
Ischemic Ulcer			X
Refractory Chronic Osteomyelitis			X
Neuroblastoma Stage IV			X
Type III			
Post-anoxic Encephalopathy			X
Larynx Radionecrosis			X
Radio-induced C [illegible]	[illegible]	[illegible]	[illegible]
Post-vascular P [illegible]	[illegible]	[illegible]	[illegible]
Limb Re-implant [illegible]	[illegible]	[illegible]	[illegible]
Burns >20 % of [illegible]	[illegible]	[illegible]	[illegible]
Acute Ischemic [illegible]	[illegible]	[illegible]	[illegible]
Selected Non-healing Wounds secondary to Inflammatory Processes			X
Pneumatosis Cystoides Intestinalis			X

Conditions where the use of HBO2 was supported by level A, B or C evidence were considered as accepted indications.

- Level A : At least 2 concordant, large, double-blind, controlled randomized studies with no or little methodological bias.
- Level B : Double-blind controlled, randomized studies but with methodological flaws; studies with only small samples, or only a single study.
- Level C : Consensus opinion of experts.

European Committee for Hyperbaric Medicine

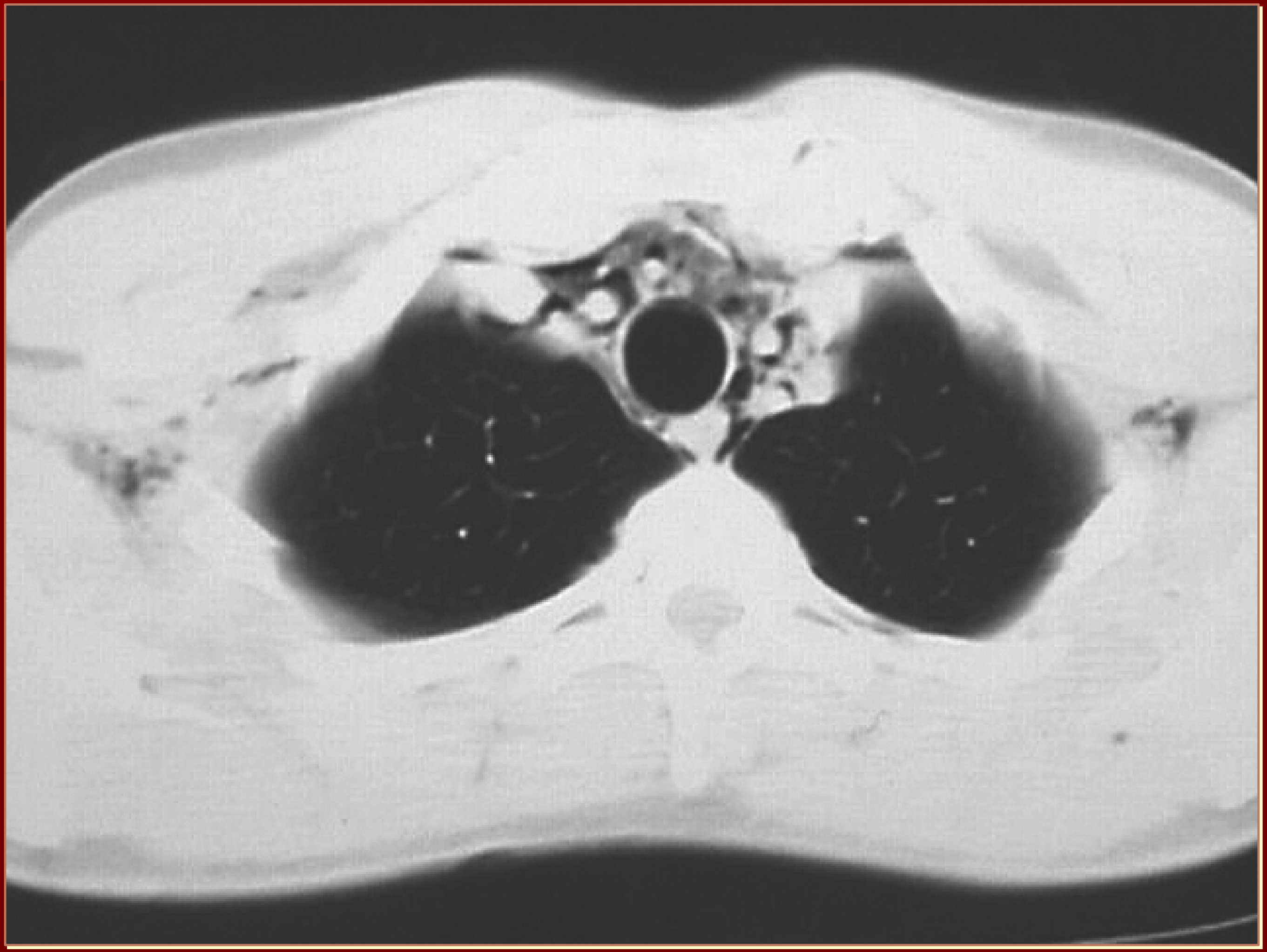
www.echm.org
www.achobel.be

“Military” indications

(Ref RTG-192 NATO Working Group)

- Decompression Sickness
  - Air embolism
- Crush injury
- Carbon Monoxide Poisoning
- Acoustic (noise) trauma
- Burns
- Anaerobic soft tissue infections

Air embolism



Air embolism

Air embolism

Air embolism

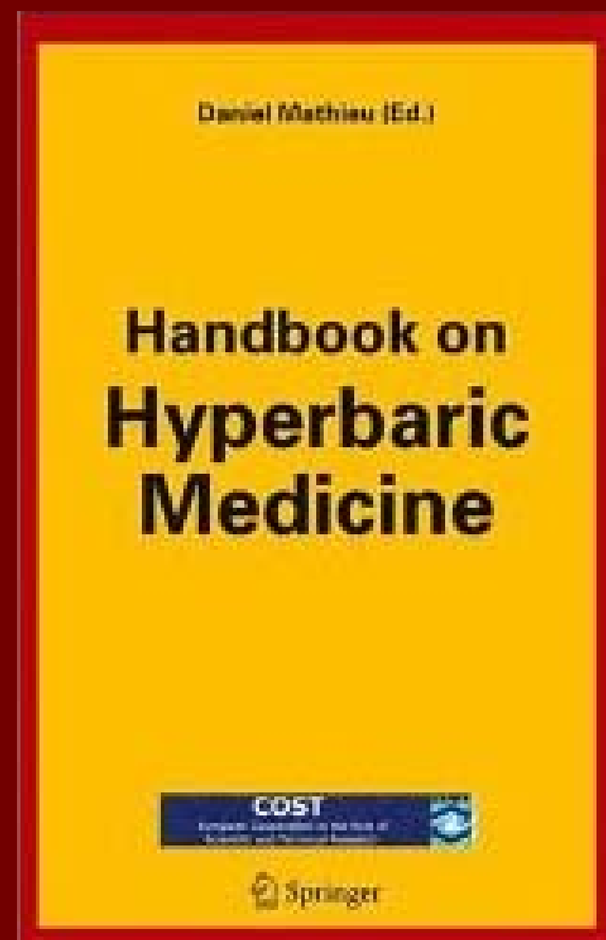
Air embolism

Crush injury

CO Poisoning

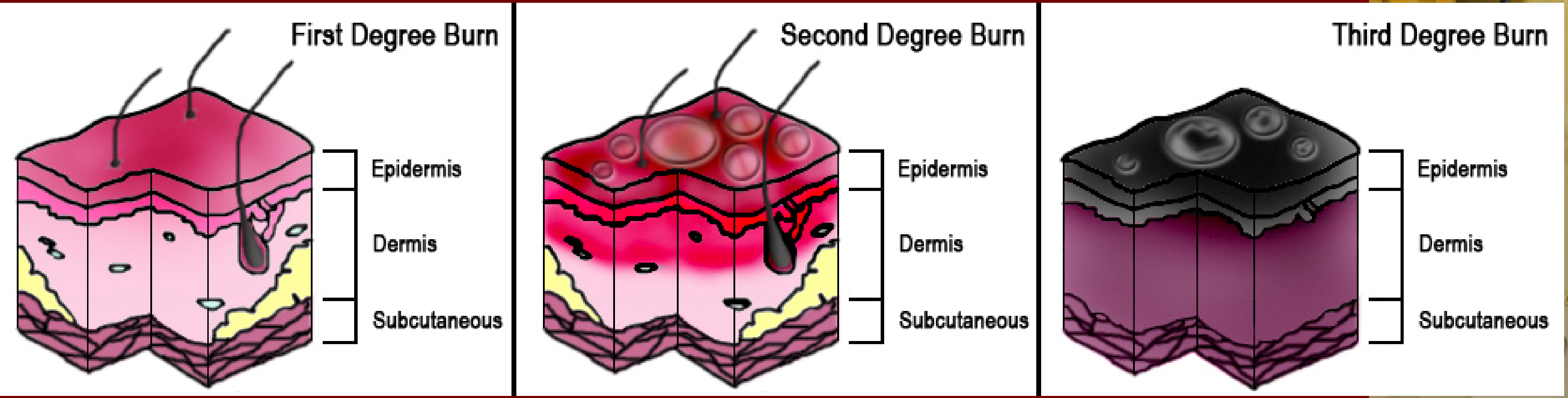
Anaerobic infections

- Animal studies
- Amsterdam Experience



Burns

- 3 Depth degrees of cutaneous burn



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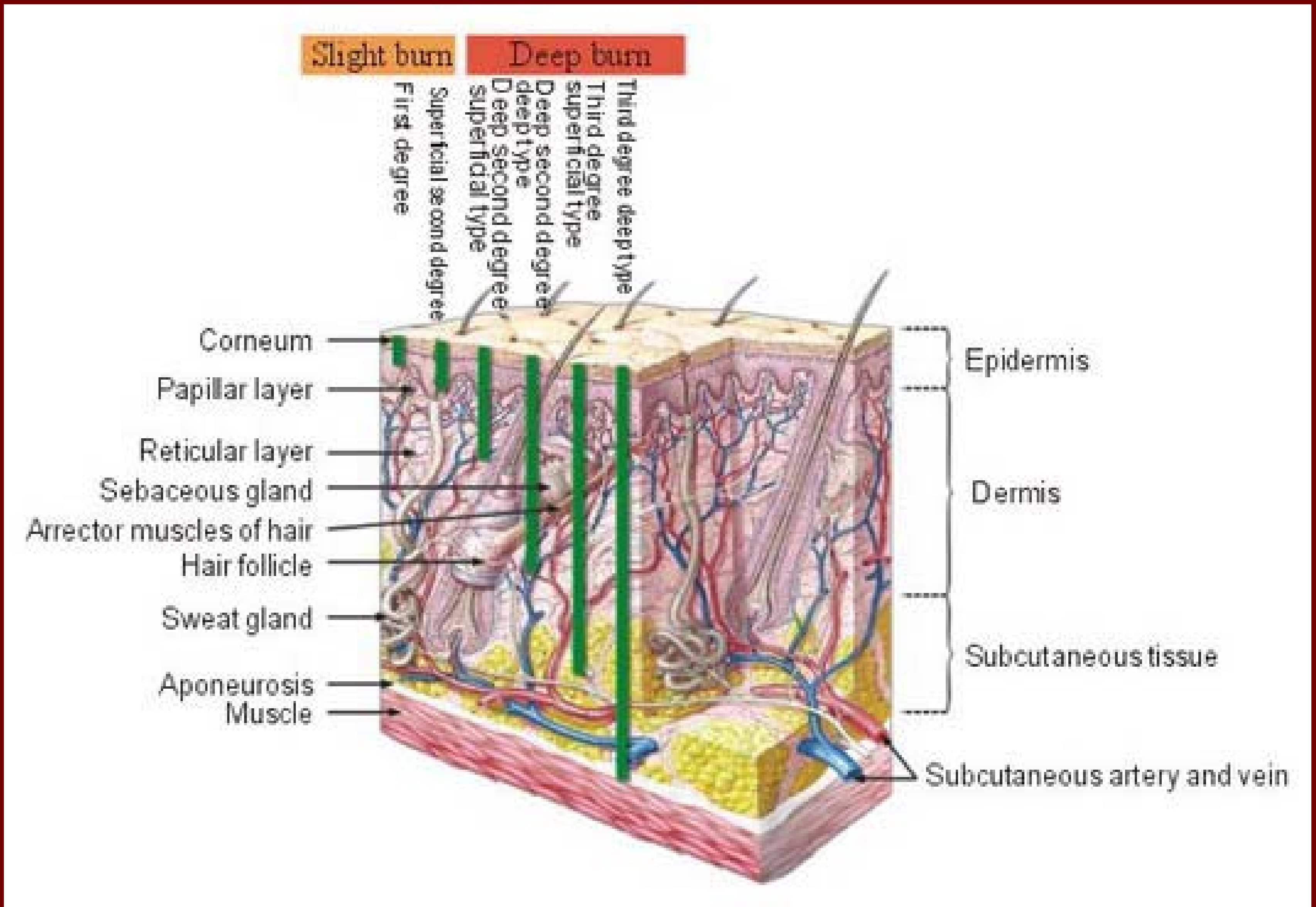

Burns

- 3 Depth degrees of cutaneous burn
- Increasing burn depth over 24 hours
- Jackson concept of 3 zones

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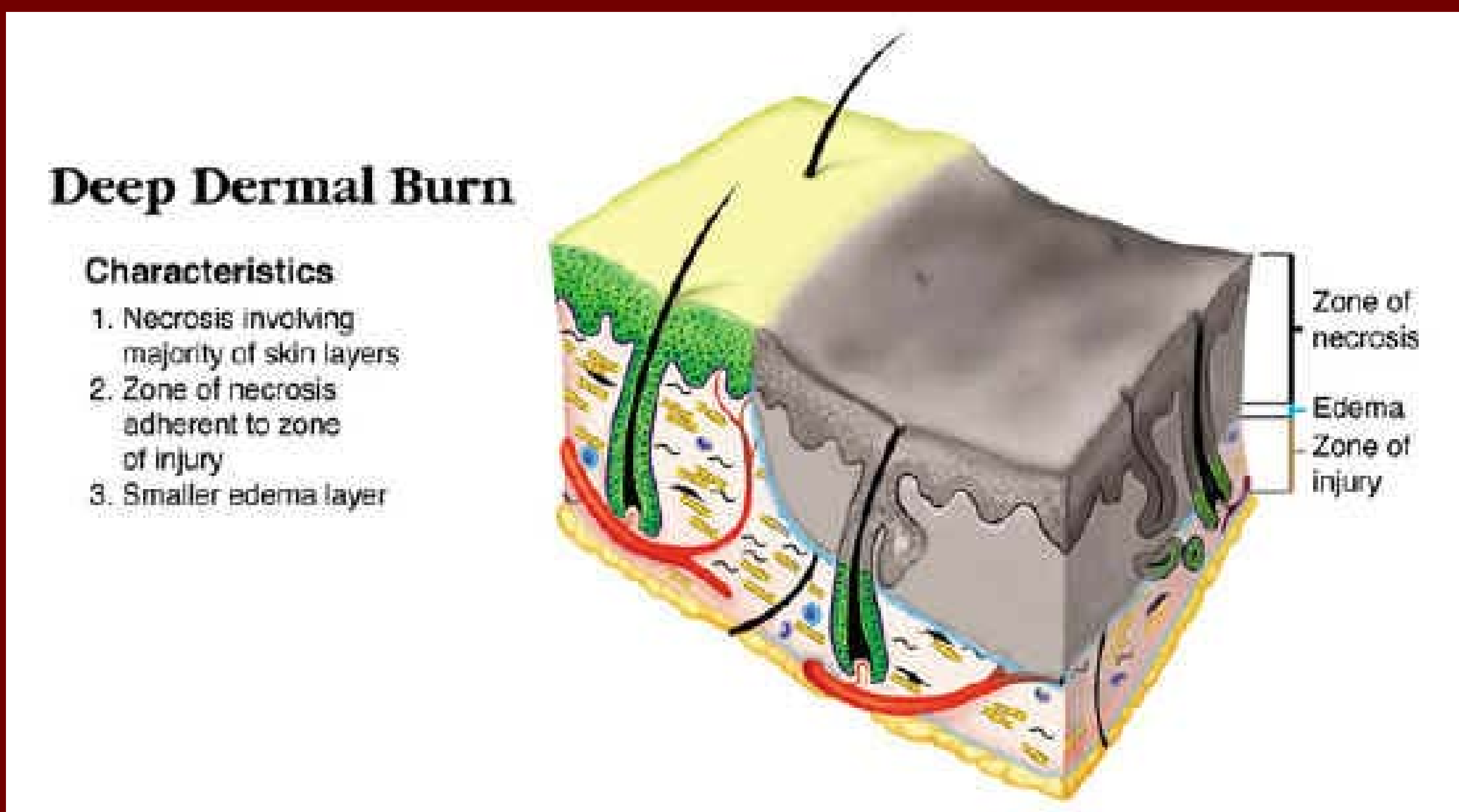


Experimental evidence

- Animal litterature ++
- 1996 CHBO Study on rats
- 2000 CHBO Study 2 on rats

Experimental evidence

Piracetam and HBO in the acute treatment of burns

HYPOTHESIS:
Piracetam and/or Hyperbaric Oxygen Therapy can prevent the progressive deepening of burn injury.

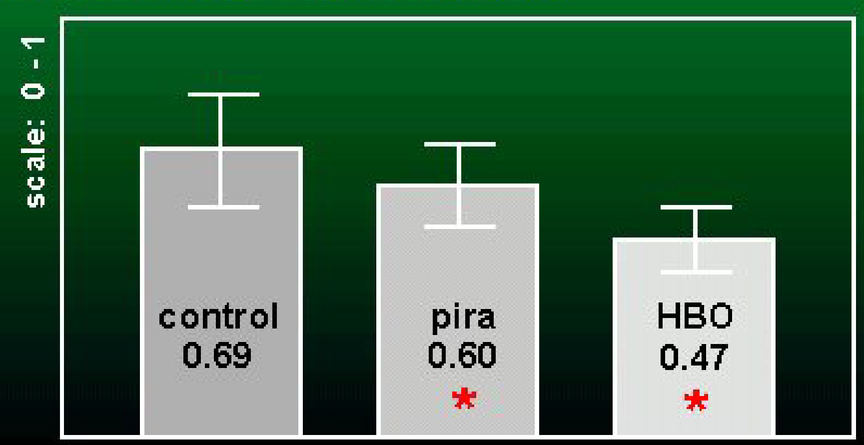
- optimal 'classical' treatment
- realistic time lapse before t...
- histological study

- development and validation of ...
- randomized, prospective, singl...

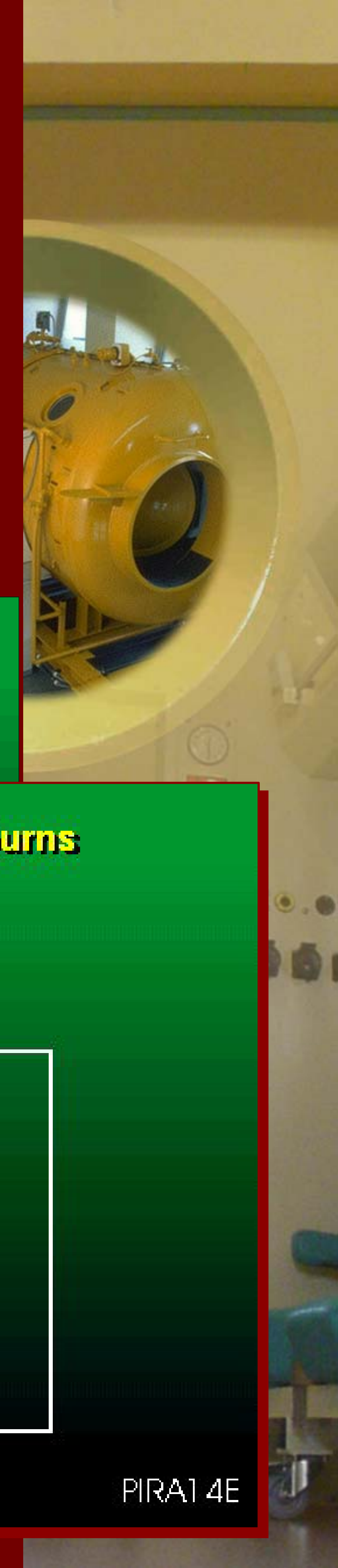
Piracetam and HBO in the acute treatment of burns

RESULTS

3. degree of inflammation



PIRA1 4E



Experimental evidence

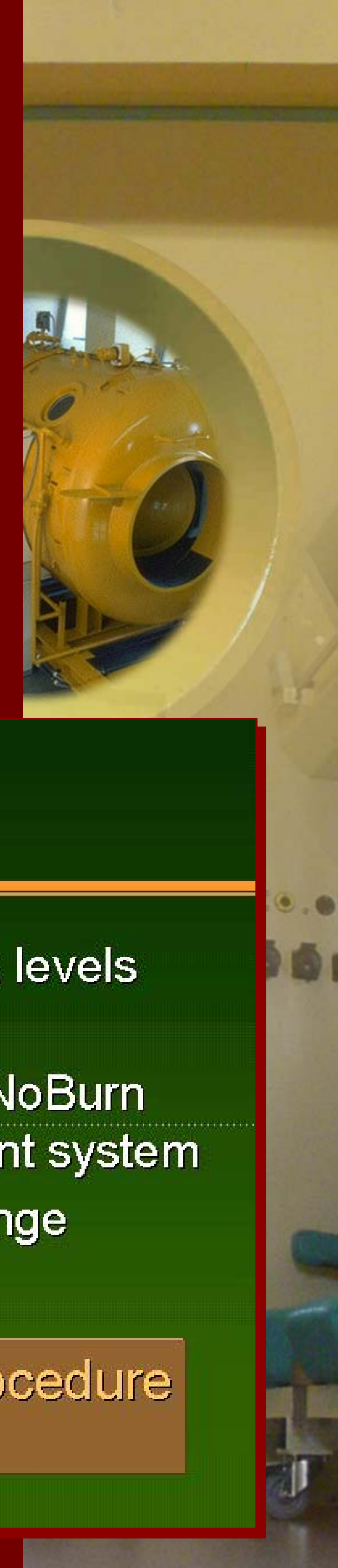
Study Protocol

- Wistar rats 300-350grs, general anesthesia, back shaved & depilated
- 40%TBSA burn by immersion (70°C water, 30sec)
- IP Ringer's Lactate 10mL
- randomisation 3 groups:
  - control sham burn
  - control burn no treatment
  - burn HBOT
- 4 measurement endpoints: 30, 120, 2 after burn

Conclusions

- paradoxically decreased MDA levels ~ less reperfusion damage
- CH50 values restored to ConNoBurn ~ less activation of complement system
- TNFa values within normal range throughout 6 hours

HBOT is a safe therapeutic procedure in this burn model



Experimental evidence

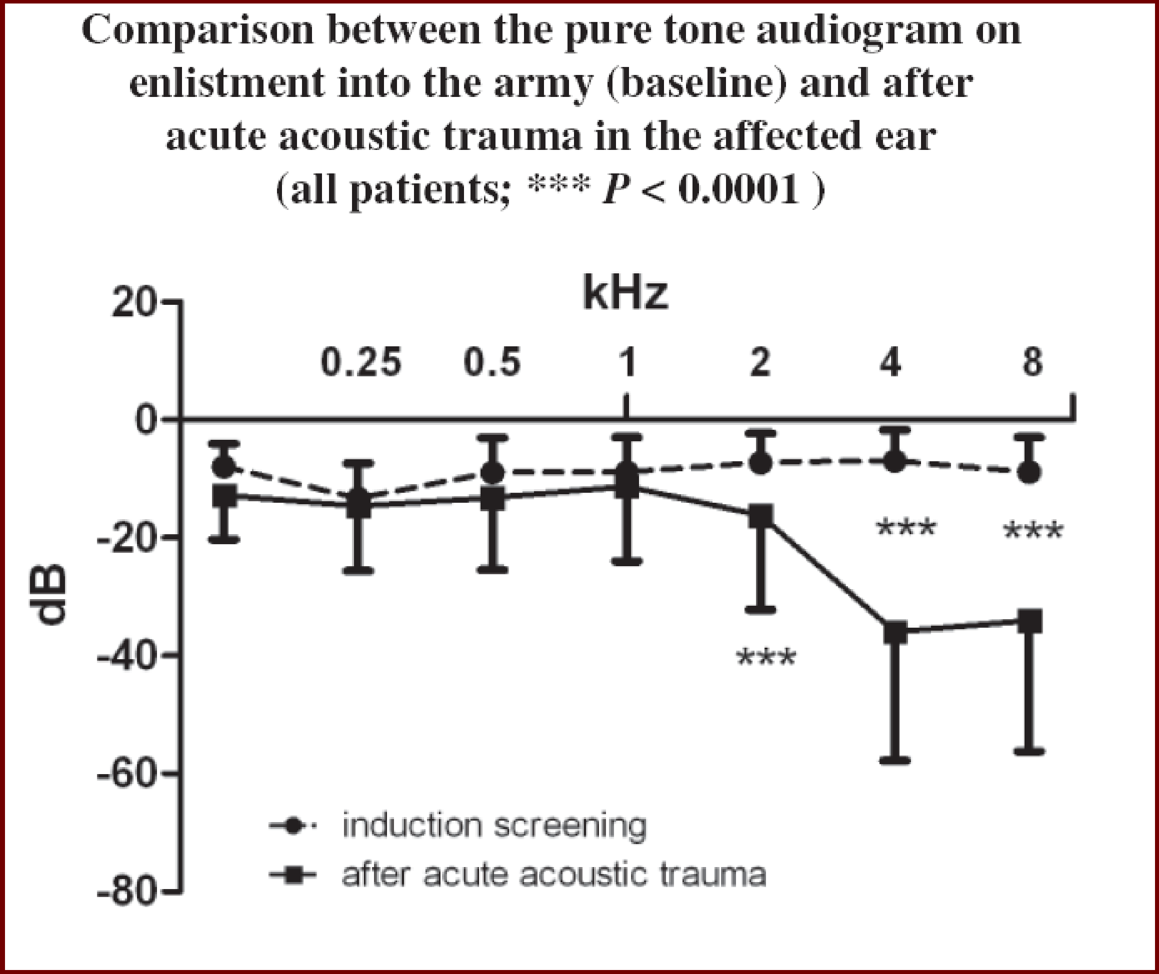
- Animal litterature ++
- 1996 Study on rats
- 2000 Study 2 on rats
- Why not done ?
  - Clinical human RCTs lacking
  - Optimal environment HBO and ICU lacking

Acoustic Trauma

- Frequent, both in military and in civilian youth
- Impulse noise vs longer exposure
- Emergency treatment with HBO & corticosteroids = promising
- RCTs lacking
  - Comparison to hearing before trauma ?
  - Early (>36hr) treatment necessary

Acoustic Trauma

- Lafere et al. *DHM 2010*

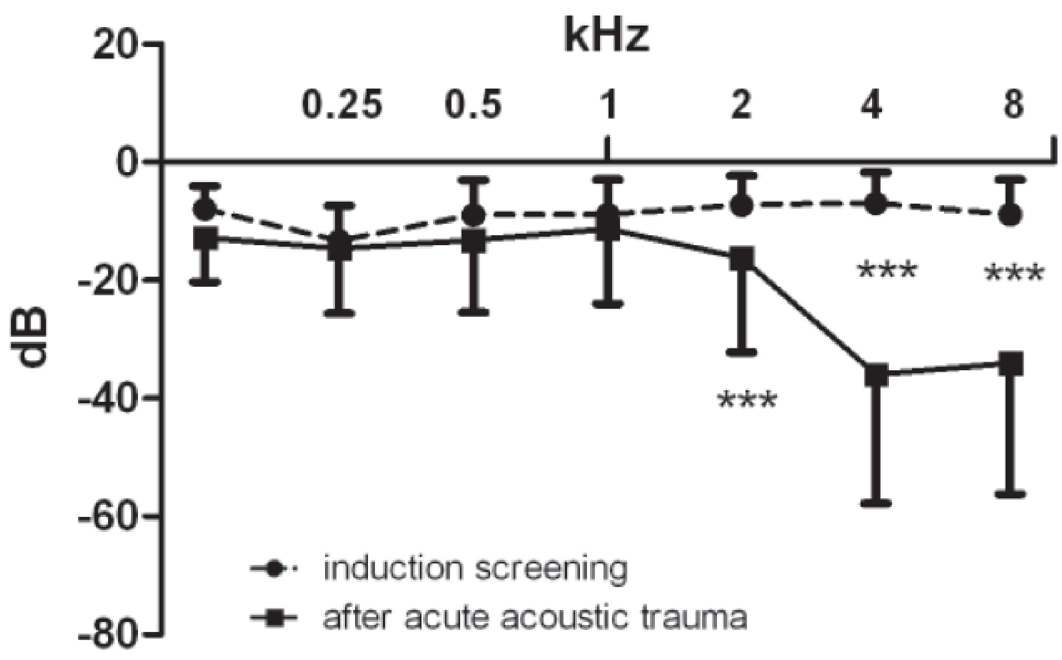


68 Belgian soldiers with acute impulse noise (gunshot) acoustic trauma

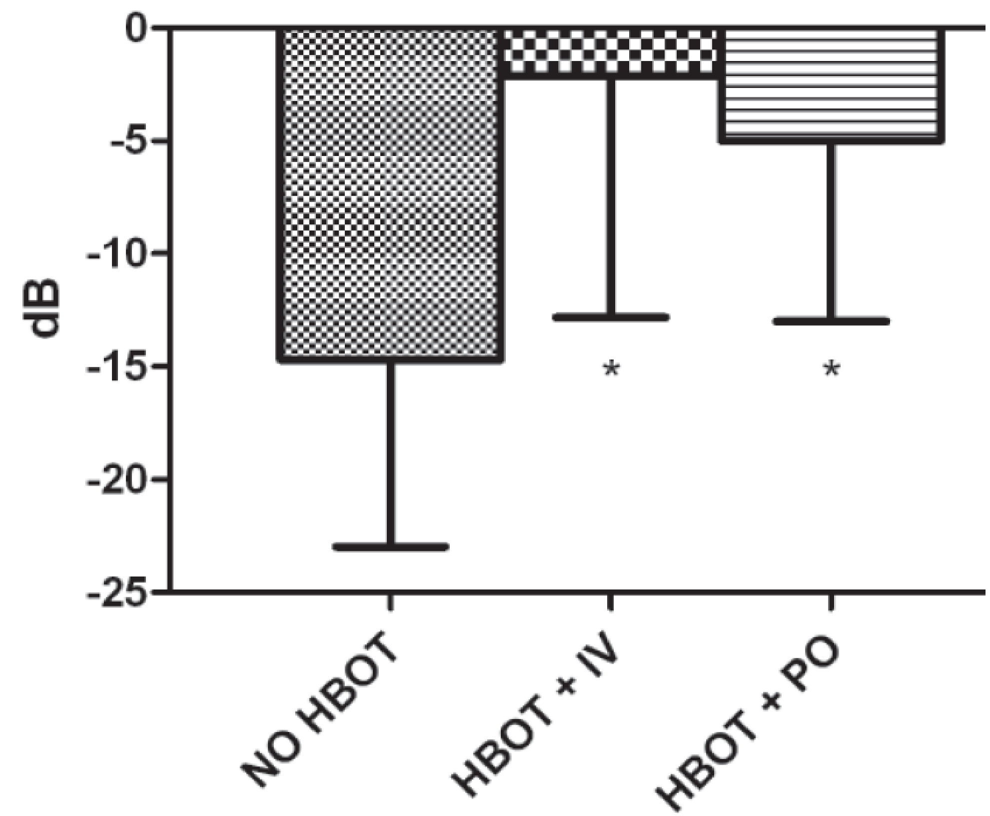
Acoustic Trauma

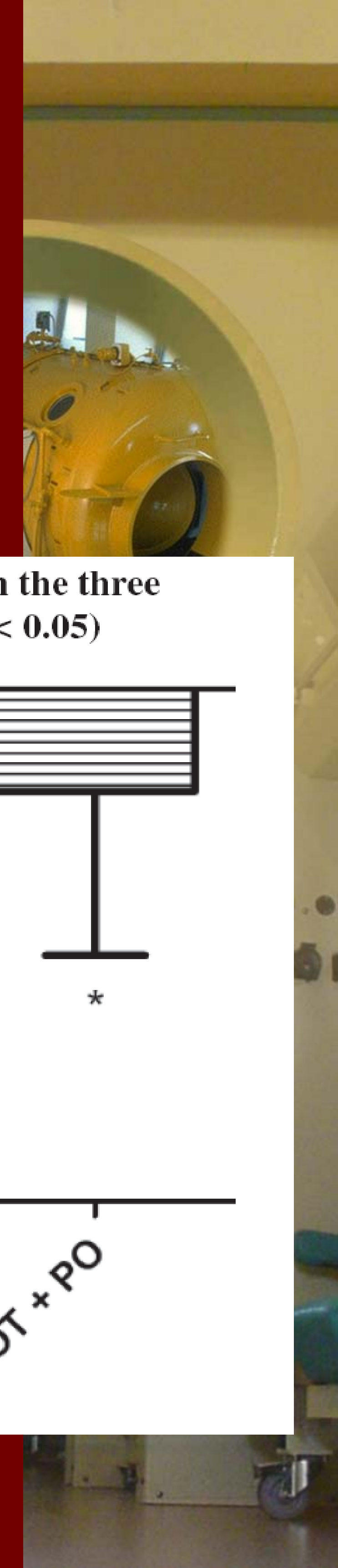
- Lafere et al. *DHM 2010*

Comparison between the pure tone audiogram on enlistment into the army (baseline) and after acute acoustic trauma in the affected ear (all patients; *** $P < 0.0001$)



The average residual hearing loss in the three treatment groups (see text; * $P < 0.05$)





Dangers of HBO therapy

- Transportation
- Compression
- Stay at Depth
- Decompression

Dangers of HBO therapy

- Haemodynamically unstable patients should not be moved !
- Barotrauma of the ears
  - Common (10-20%)
  - Preventable
  - Rarely serious
- Hyperoxic seizures
  - Seldom (1 in 1500-5000 treatments)
  - Unpredictable (but...)
  - No sequelae

Dangers of HBO therapy

- Uncontrolled use
  - Diseases with large impact of QoL
  - For which there is no cure
  - For which evaluation of effects is mainly subjective
  - Gives HBO "a bad name"
- Examples...
  - Multiple Sclerosis
  - Chronic Fatigue
  - Autism
  - Cerebral Palsy
- Never say never...But: proof must be given

HYPERBARIC FOR AUTISM - Windows Internet Explorer provided by CCCIS-P&S-WSV

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Not currently using Hyperbaric to treat your child? Click Here For Info

Hi. I'm Doctor Harold Grams. I use the the Defeat Autism Now! philosophy and protocols in my care of autistic children.

I've been successfully treating autism with hyperbaric oxygen for over 7 years.

Are you going to a doctor's office now for hyperbaric treatment? And are you looking for a way to control your costs and see the fastest possible improvements in your child's autism?

Please call me now to discuss how to get started with hyperbaric treatments in your home--as soon as possible.

I've helped people all over the U.S. and in over 10 countries worldwide to effectively use hyperbaric oxygen to significantly reduce symptoms and defeat their children's autism

Tired of the time, cost, and hassle of going to your doctor's office for hyperbaric treatments?

Now you can buy, or rent, a hyperbaric chamber and give your child much-needed treatments in the convenience of your home. This is the most affordable way to bring the healing power of hyperbaric oxygen to your child.

With a portable hyperbaric chamber in your home your child will get double or triple the number of treatments you might be able to schedule at your doctor's office. More treatment sessions means more likelihood your child's symptoms will improve faster. Plus you will save $1000s of dollars on treatments--and your valuable time.

Choose the best chamber for your personal size and for your budget.
All our chambers work at 4 psi (pounds per square inch). Since all provide the same treatment...the only question is which size chamber is right for you? Which chamber fits your budget? And is it better to buy or rent?

VITAERIS 33.5 inches tall, 7'9" long, 190 cubic feet

Includes chamber, inner frame, mattress, bolster pillows to stabilize chamber, compressor and all hoses and attachments.

Oxyhealth chambers are the originals--used and trusted by more DAN doctor's worldwide than any other. These are FDA approved, medical grade quality,

The **Vitaeris** is the chamber of c[...] for many families who have active [...] children, larger children, or who a[...] uncomfortable in the smaller othe[...] chambers.

The **Vitaeris** is 33.5" tall. This le[...] adult prop up with a pillow at a comfortable angle...and leaves lo[...] room for a child to play in the "submarine" during treatments.

We have put large, immobile stro[...] patients into this chamber using [...] This chamber comes with 2 compressors. This gives more ai[...] and makes it a bit cooler inside t[...] the smaller chambers. This is mo[...] comfortable for some people.

Rental Savings:$3,405

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Autism Nutrition

Nutritional & biomedical support for children with autism

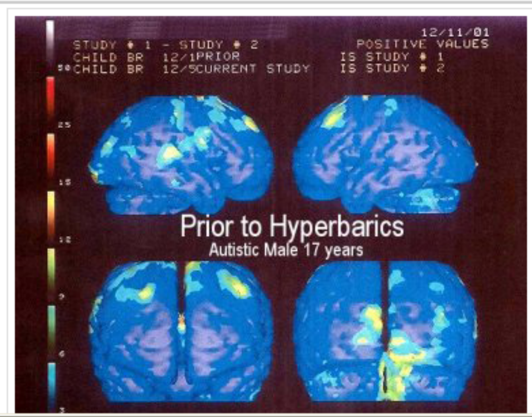
Efficacy of Hyperbaric Oxygen Therapy for Autism

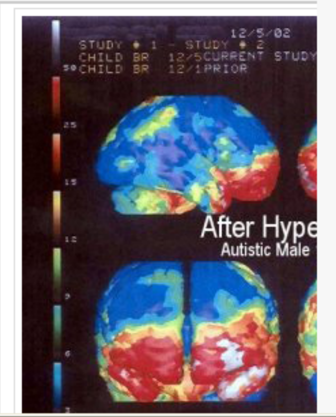
The use of hyperbaric oxygen therapy for the treatment of autism is relatively recent and so there is not a great deal of scientific evidence specifically related to it, but some positive study results are beginning to come in. At the same time, there are many testimonies from families that have used HBOT as an autism treatment for their autistic children and the results have mostly been encouraging.

To gauge the efficacy of HBOT, the brain can be monitored for its perfusion – the extent to which it is supplied by blood – and its activity. At the same time, we can monitor the behavior, response to stimuli (sensory function) and motor skills of the autistic individual, to determine if hyperbaric oxygen therapy has produced any positive results. In addition, hyperbaric oxygen therapy has been used for many years – and proven effective – in the treatment of cerebral palsy, which involves serious damage to brain cells.

Brain SPECT scans

Monitoring of cerebral blood flow can be done with a Brain SPECT (Single Photo Emission Computed Tomography) scan. SPECT scans before and after mild HBOT sessions have shown dramatic improvements in cerebral blood flow that is sustained over time.





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Hyperbaric Oxygen Therapy, Alzheimer's and Dementia

by Rashmi Gulati, MD

Alzheimer's is a progressive brain disorder affecting areas of the brain that control behavior, memory, and cognitive thinking skills. Alzheimer's symptoms include loss of memory, difficulty performing familiar tasks, problems with language, disorientation to time and place, poor or declining judgment, difficulty with abstract thinking, and changes in personality. As the nervous system deteriorates there may be involuntary muscle reflexes.

Some toxic metals like aluminum, arsenic, cadmium, lead, mercury, and nickel are taken into our bodies through the air, food, and water. The toxic effects of these metals can remain in our bodies for years, and have been linked to Alzheimer's disease, aluminum toxicity, and mercury poisoning. per million of aluminum in human blood can cause it to coagulate. This slows d shuts off the flow of blood in smaller vessels. Brain cells will die without blood

Banishing Cellulite with Hyperbaric Oxygen Therapy

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Ranked #13,876 in Healthy Living, #200,934 overall

How to look great on the beach!

Cellulite can be a real problem when you're wanting to look good on the beach. But don't send those high-cut summer shorts and flirty mini skirts to the charity shop just yet. There are therapies which can help with cellulite, and hyperbaric oxygen therapy is one of them.

But what is hyperbaric oxygen therapy and how does it work?

Hyperbaric oxygen therapy is also known as hyperbaric medicine, and involves the use of oxygen at higher pressures than usually experienced with atmospheric pressure.

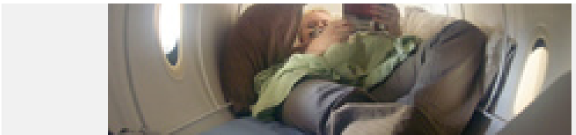
Dr. Maria

Aesthetic and MEDIC

Hyperbaric Oxygen Therapy

Vitaeris320
hyperbaric chamber

It is a safe, powerful, non-evasive alternative treatment that is used for a wide variety of different symptoms and disorders. view treatable conditions



And even…

Interest in HBOT by the equine industry is due to its ascribed beneficial effects on the healing of lower limb wounds, which remain a major health problem to man and horses worldwide. Slow-healing wounds or those that fail to heal can result in prolonged hospitalisation, numerous surgical interventions and time-consuming wound care. Slow healing is particularly inconvenient and challenging for high-performance human and equine athletes.

And even…