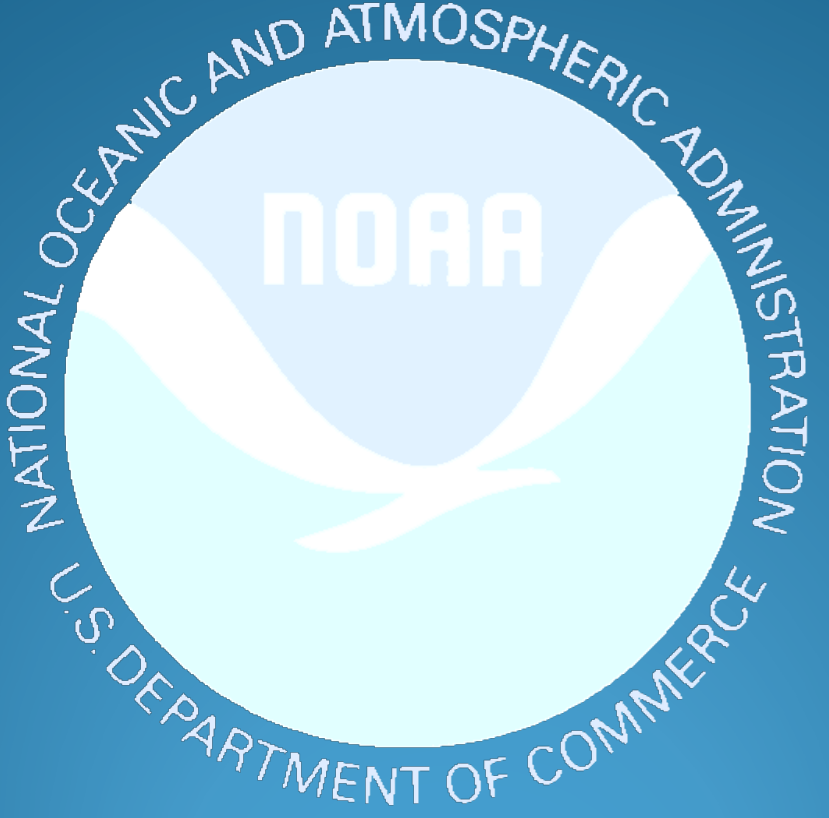
Nitrogen Narcosis



WHAT IS IT?

- A reversible alteration in consciousness that occurs while at depth (usually noticeable around 30 meters or 100 ft)
- Caused by the anesthetic effect of certain gases at high pressure


50 feet =

NITROGEN NARCOSIS

Depths Beyond 100 Feet!

- Individual Variability
- Day-to-Day Variability

Signs and Symptoms of N_2 Narcosis

- Impaired performance mental/manual work
- Dizziness, euphoria, intoxication
- Overconfidence
- Uncontrolled laughter
- Overly talkative
- Memory loss/post-dive amnesia
- Perceptual narrowing
- Impaired sensory function
- Loss of consciousness > 300 ft

Deep Scuba Dives Breathing Air

YEAR	DIVER	DEPTH
1943 1948	Dumas Dumas	203 feet 307 feet
1967 1968	Watts Watson	390 feet 437 feet
1989	Gilliam	452 feet

Dr. Dan Manion surfaces after his 491 foot dive in 1994 to beat Gilliam's record.

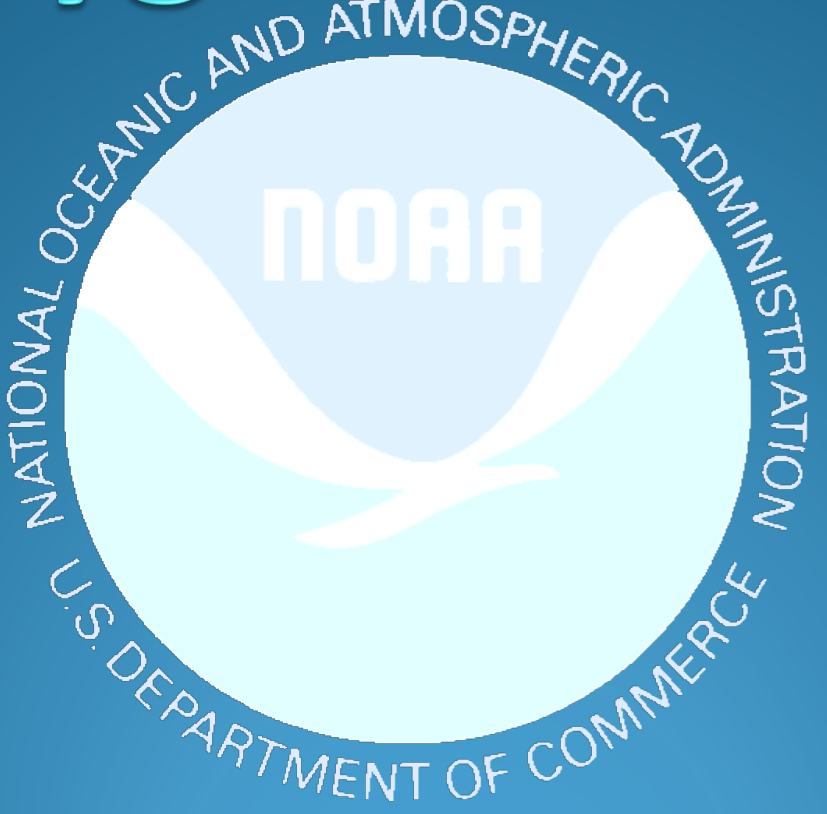
Prevention of Nitrogen Narcosis

- Restrict diving depth to less than 100 fsw
- If affected, return immediately to surface
- Plan dive beforehand
  - Max time to be on bottom
  - Any decompression required
  - Minimum air required for ascent
  - Emergency action in event of accident
- Breathe helium/oxygen mixture

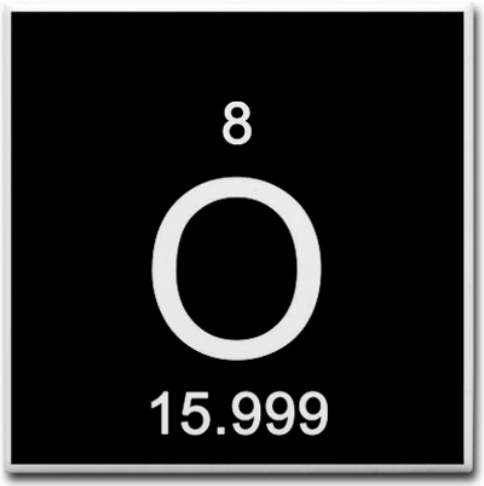
How to Beat Narcosis (Francis 2006)

- Be sober, no hangover and drug free
- Be rested and confident
- Use a high quality regulator
- Avoid task loading
- Be over trained
- Approach limits gradually
- Use a slate to plan dive
- Schedule gauge checks and buddy checks
- Be positive, well motivated and prudent

Oxygen Toxicity



Oxygen



- Characteristics:
  - Colorless
  - Odorless
  - Tasteless
- Disadvantage:
  - Toxic when excessive amounts are breathed under pressure

Oxygen is the only gas metabolized by the human body

Too much or too little oxygen is dangerous!

Oxygen Toxicity

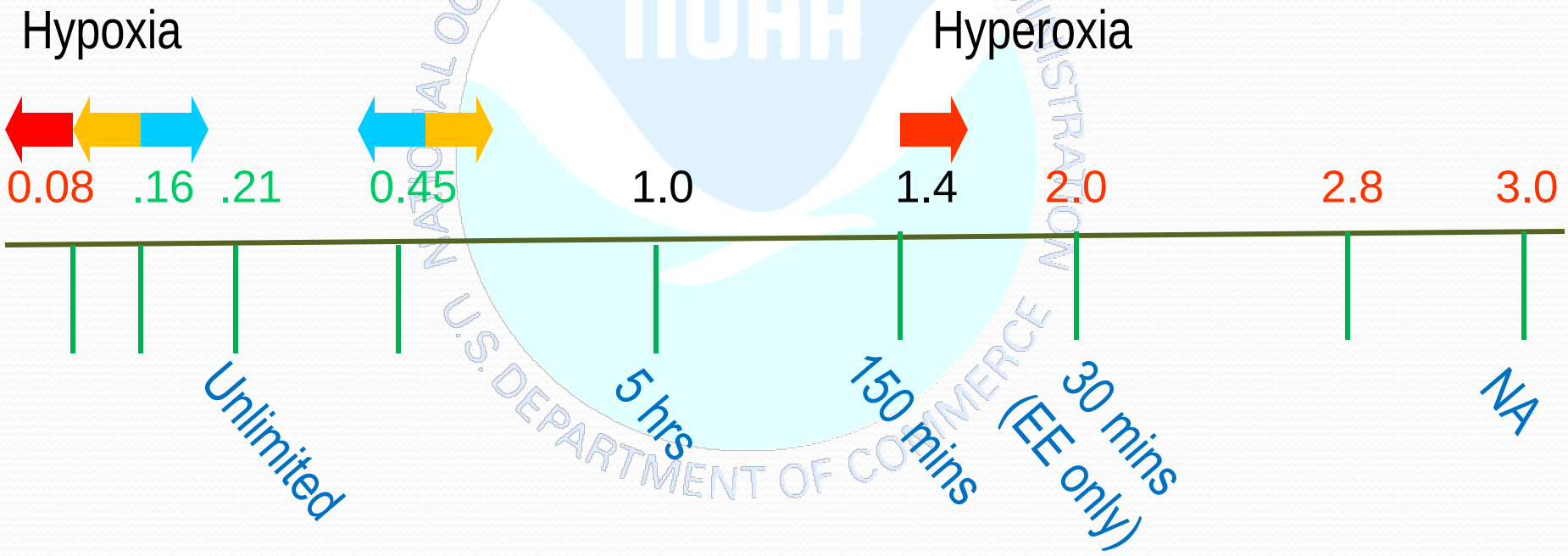
- Oxygen toxicity is generally not a problem for routine air diving operations
  - A diver must dive deeper than 186 fsw before exceeding the 1.4 PO_2 limit
- However, a diver breathing a Nitrox mixture will reach the 1.4 PO_2 limit much shallower than a diver breathing air!

1.4 PO_2			
AIR	NN32	NN36	100% O_2
186 fsw	113 fsw	95 fsw	13 fsw

NOAA PO_2 & Exposure Limits

ATA	CNS SINGLE EXPOSURE (MINS)	PULMONARY 24 HOUR EXPOSURE (MINS)
1.6	45	150
1.5	120	180
1.4	150	180
1.3	180	210
1.2	210	240
1.1	240	270
1.0	300	300
0.9	360	360
0.8	450	450
0.7	570	570
0.6	720	720

Oxygen Limits Continuum



Hyperoxia

- Contributing Factors:
  - Primary
    - FiO_2
    - Depth
    - Duration
    - Physical exertion
  - Secondary
    - CO_2 retention
    - Cold stress
    - Heat stress
    - Individual physiology

- CNS Toxicity:
  - V-vision
  - E-ears
  - N-nausea
  - T-twitching
  - I-irritability
  - D-dizziness
  - C-convulsions

CNS toxicity varies from person to person and from moment to moment

Unit Pulmonary Toxic Dose (UPTD)

1 UPTD = Pulmonary toxicity due to breathing 100% O_2 at a pressure of 1 atm for 1 min

Unit Pulmonary Toxic Dose (UPTD)

1 UPTD = 100% O_2 for 1 min at 1 ATA

USN 5 UPTD 336

USN 6 UPTD 646

USN 6A UPTD 693

UPTD 615 - vital capacity - 2%

UPTD 1425 - vital capacity - 10%

Lung Pathology Phase I

Exudative Phase

- Interstitial and alveolar edema
- Intra-alveolar hemorrhage
- Fibrinous exudate
- Hyaline membranes
- Capillary endothelial cell
- Swelling/destruction
- Type I alveolar epithelial cells destruction

Lung Pathology Phase 2

Subcutaneous Proliferative Phase

- Interstitial fibrosis
- Fibroblastic proliferation
- Hyperplasia Type II alveolar epithelial cells

Signs and Symptoms of Oxygen Toxicity

V.E.N.T.I.D.C.

- Visual Symptoms
- Ear Symptoms
- Nausea and Vomiting
- Twitching and Tingling
- Irritability
- Dizziness
- Convulsions

Signs and Symptoms of Oxygen Toxicity

Irritability:
Any change in the diver's mental status; including confusion, agitation and anxiety.

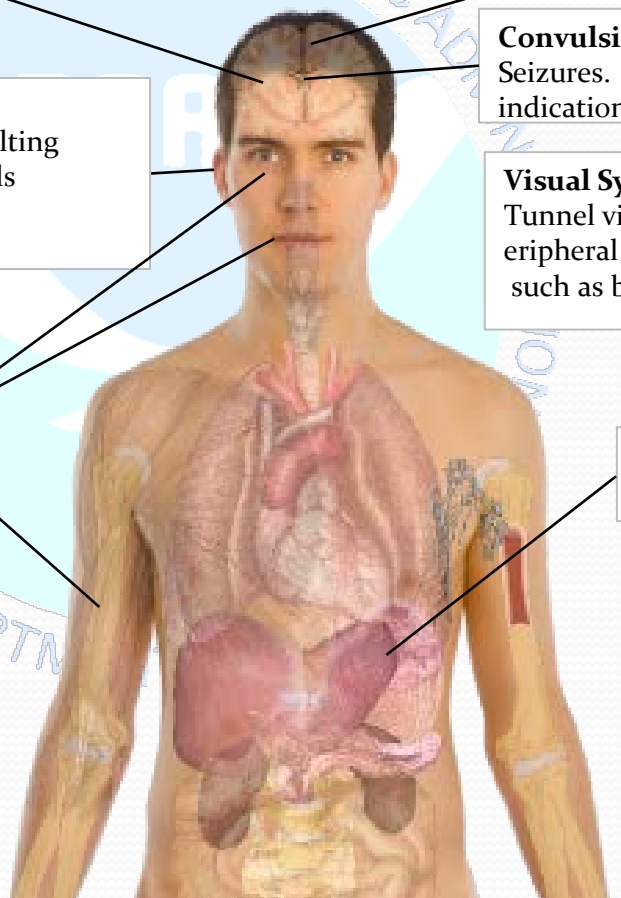
Dizziness:
Clumsiness, incoordination and unusual fatigue.

Convulsions:
Seizures. Maybe no pre-convulsions indications.

Ear Symptoms:
Tinnitus is any sound perceived by the ears but not resulting from an external stimulus. The sound may resemble bells ringing, roaring, or a machinery-like pulsing sound.

Visual Symptoms:
Tunnel vision, a decrease in the diver's p eripheral vision, and other symptoms, such as blurred vision, may occur.

Twitching and Tingling:
Any of the small facial muscles, lips, or muscles of the extremities may be affected. These are the most frequent and clearest symptoms.



Nausea and Vomiting:
These symptoms may be intermittent.

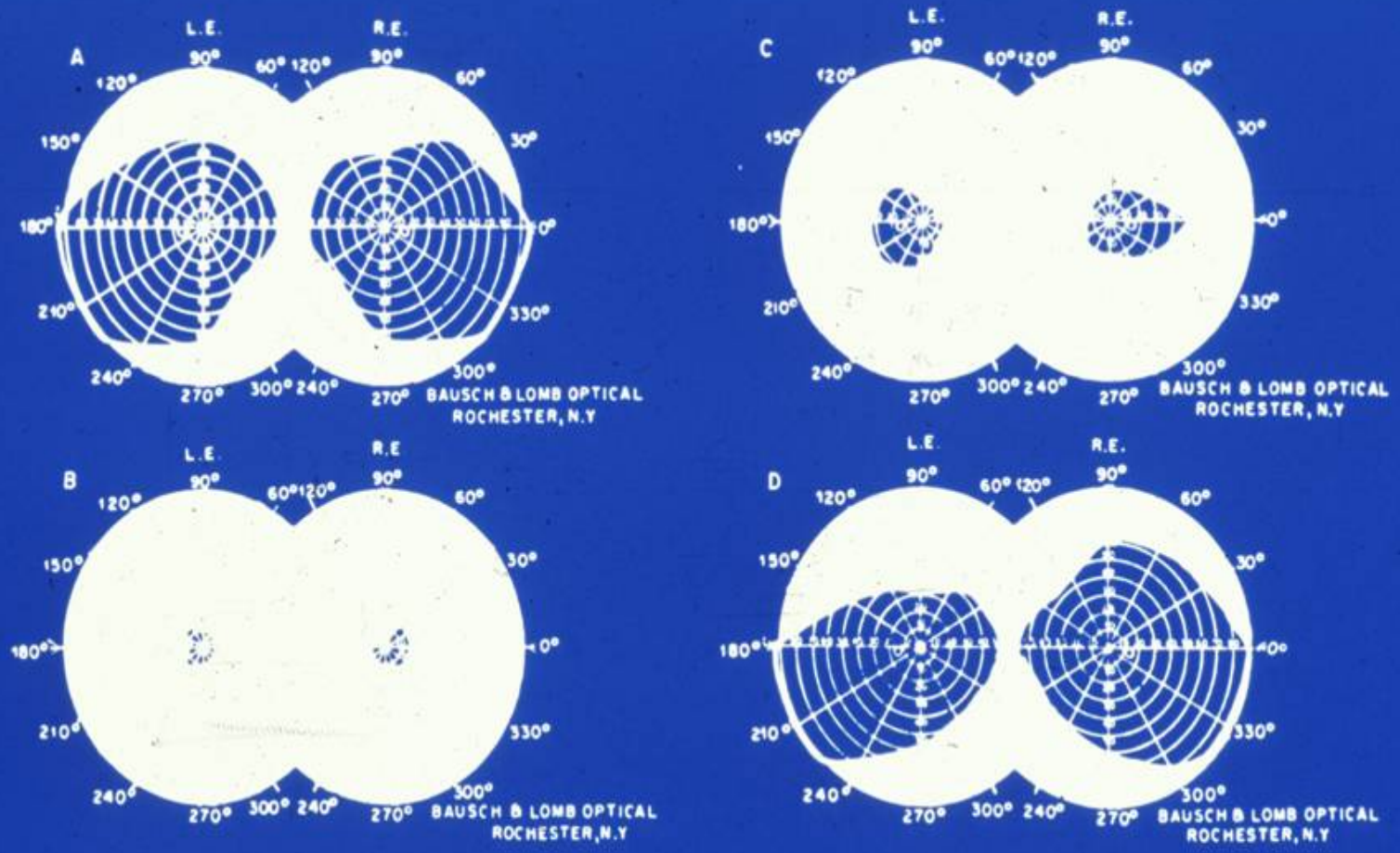


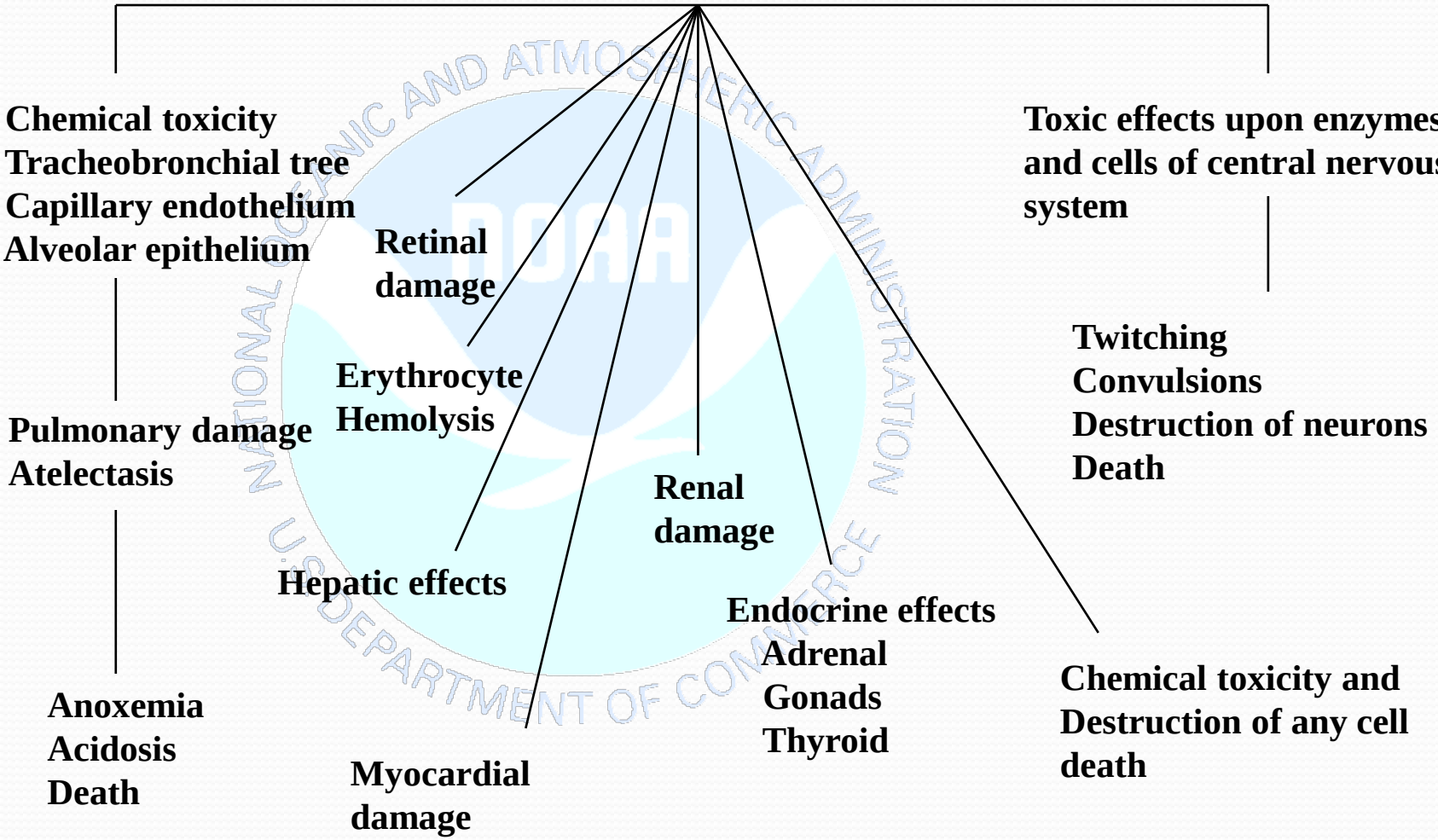
FIG. 9.14. Perimetric measurements of visual fields in the same subject before and after 3.5 h of oxygen breathing at 3 ATA. Normal pre-exposure visual fields shown in A. Visual fields shown in B, C and D, respectively, were obtained 5, 25 and 50 min post-exposure. (From Behnke *et al.* 1935)

Nitric Oxide and Oxygen Convulsions

- Increase in NO overrides O_2 vasoconstriction
- Brain tissue pO_2 increases markedly
- Convulsion follows

EFFECTS OF OXYGEN TOXICITY

High Inspired Oxygen Pressure



Factors Which Protect Against Oxygen Toxicity

- Intermittent exposure
- Pre-exposure to CO_2
- Tris buffer (tris [Hydroxymethyl] Aminomethane)
- Barbiturates
- Hyperventilation
- Adrenalectomy
- Factors decreasing the metabolic rate

Factors Which Increase Oxygen Toxicity

- XS CO_2 in mixture breathed
- Increased temperature
- Work or exercise
- Respiratory impairment
- Factors increasing the metabolic rate
- Adrenalin

Questions?