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DCS

DESCENDING

- **The Total Pressure of The Respired Gas** during Diving increases in Direct Proportion to "**Diving Depth**".

- At each successive depth, **The Gradient** increases for **The Net Flow of Nitrogen** across the Alveolar Membrane into the blood and eventually into **All Tissue Fluids** for Equilibration.

HENRY'S LAW

- At a given TEMPRATURE,
- Greater The Partial Pressure of a Gas,
- Greater the amount of that gas that will be dissolved in solution.

HENRY'S LAW

:Example:

- The Appearance of CO_2 Bubbles, When Removing The Cap from a Carbonated Beverage Bottle.

- With the cap in place, the gas remains dissolved under pressure. Removing the cap suddenly reduces pressure above the fluid, causing bubbles to form.

HENRY'S LAW

ASCENDING

- With **Rapid Ascent,**
- The External Pressure against The Diver's Body decreases dramatically.
- Excess dissolved nitrogen in the body tissues begins to separate from the dissolved state
- Eventually forms bubbles in the tissues

DECOMPRESSION SICKNESS

- Occurs When Dissolved Nitrogen moves "Out of Solution" and Forms **Bubbles** in Body Tissues and Fluids.

- Results from Ascending to The Surface **Too Rapidly** following a **Deep, Prolonged Dive**, often made possible with Double and Triple air tanks.

Decompression Sickness

- **Also Known as**:

✓Caisson Disease

✓Dysbarism

✓Compressed Air Sickness

✓Bends

✓Divers Paralysis

TYPES

- **DCS Type I**:

  - Poorly Localized Joint Pain, Rash, Itching, Lymphatic Swelling, and sometimes included Extreme Fatigue

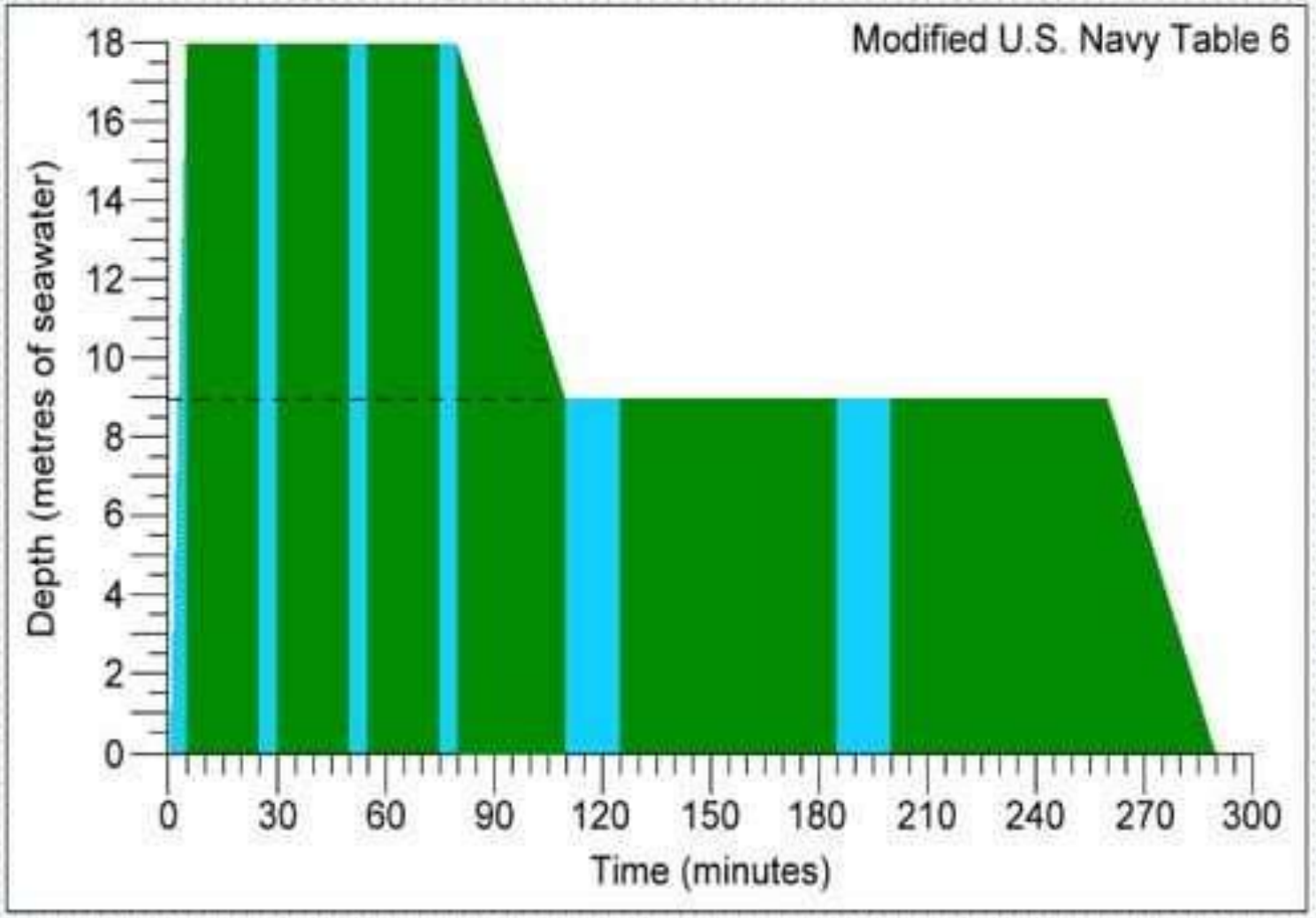
  - **Treatment**: 100% Oxygen, Supportive Care, U.S. Navy Table 6 Algorithm

DCS TYPE II

- Numbness, Dizziness, Weakness, Gait-Abnormality, Hypoesthesia, Respiratory Symptoms, Hypovolemic Shock, Cardiopulmonary Problems, and Central or Peripheral Nervous System Involvement.

- **Treatment:** 100% Oxygen, Supportive Care, U.S. Navy Table 6 Algorithm

U.S NAVY TABLE 6 ALGORITHM



DCS TYPE III

- Includes Arterial Gas Embolism
- Also called **Decompression Illness (DCI)**

DECOMPRESSION SICKNESS

- **Nitrogen** reaches Equilibrium slowly in many tissues, particularly **Fatty tissues**, so it leaves the body slowly.

- Hence, **Women** (with a greater average percentage body fat than men) and **Obese men** face greater risk for DCS.

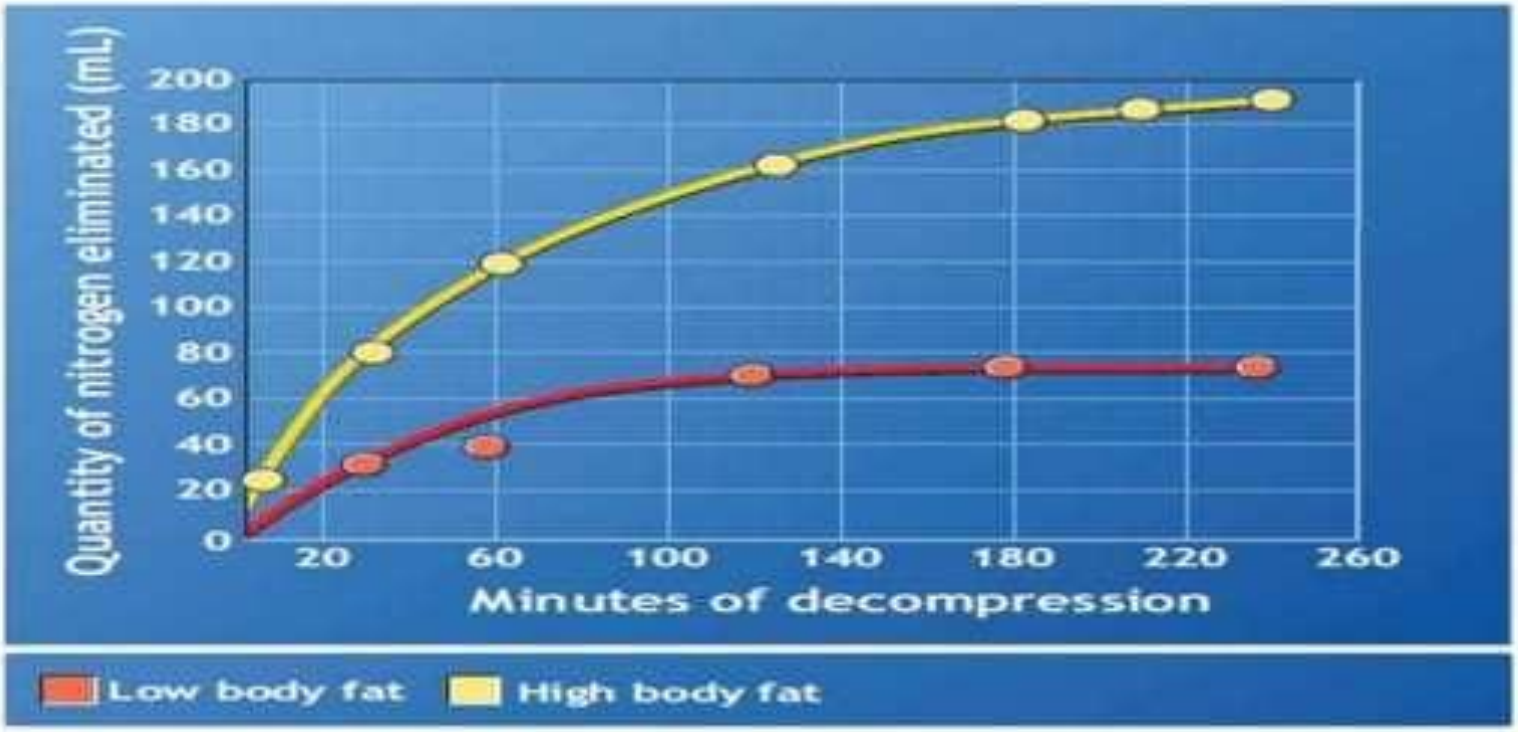


Figure 26.7 • Nitrogen elimination from body tissues of a relatively lean dog and one higher in body fat during decompression in a chamber. (Courtesy of Dr. A. R. Behnke.)

Above Figure **Compares** Nitrogen Elimination after a **"Simulated Dive"** by 2 Dogs that differed in fat content.

The relatively fat dog (*yellow line*) eliminated considerably more nitrogen over the 4-hour decompression than the leaner dog.

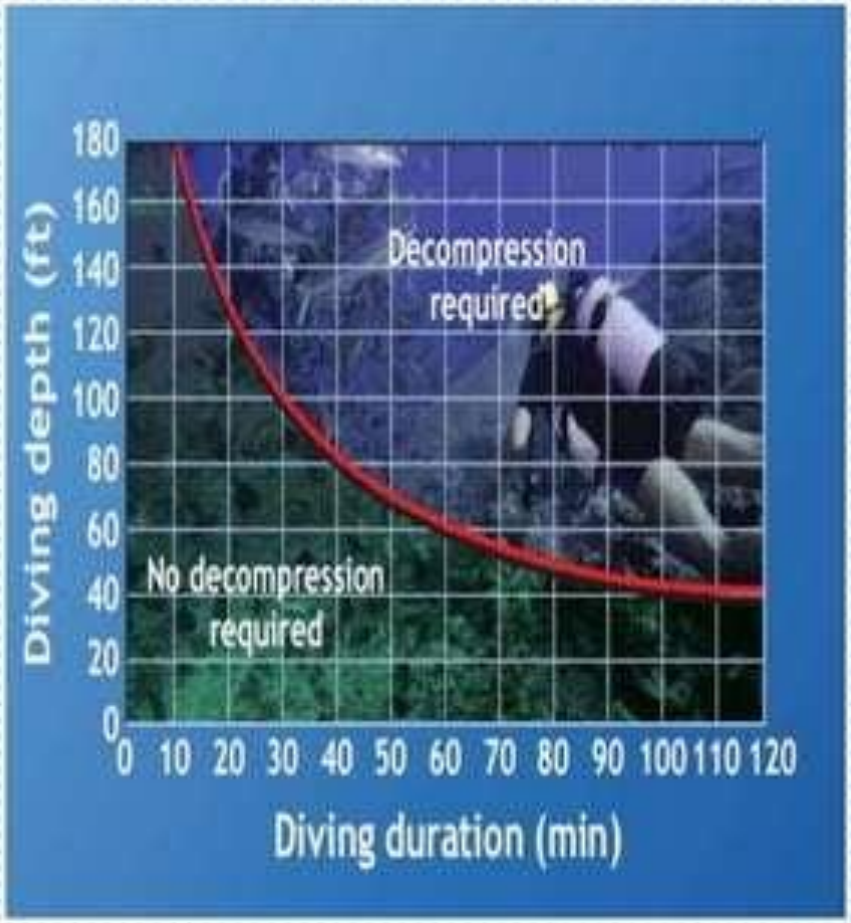
DIVING TIME & DEPTH LIMITS TO AVOID DCS

- Diving at a depth of 30 m (98 ft) for up to 30 min
- About 18 minutes is the limit at 40 m (131 ft)
- An Hour at 20 m (65 ft)

ZERO DECOMPRESSION LIMITS

- Any Single Dive that falls on the **Left Side** of the curve, Requires **No Decompression** provided the Rate of Ascent does not Exceed **60 ft per Minute**

- Dives on The **Right Side** of the Line, Require The "**Decompression-Period",** as Specified in Standard Decompression Tables.



RECREATIONAL DIVE PLANNER™

DIVING SCIENCE & TECHNOLOGY, CORP.

START

DEPTH (feet) ▶ 35 40 50 60 70 80 90 100 110 120 130 140

PRESSURE GROUP

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

48 NO DECOMPRESSION LIMITS

SAFETY STOP REQUIRED

REPETITIVE

TABLE 1
NO DECOMPRESSION LIMITS AND GROUP DESIGNATION TABLE

TABLE 2
SURFACE INTERVAL CREDIT TABLE

START OF SURFACE INTERVAL

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Z Y X W V U T S R Q P O N M L K J I H G F E D C B A

CONTINUE ON OTHER SIDE

PRESSURE GROUP AT END OF SURFACE INTERVAL

DEPTH (feet)	Z	Y	X	W	V	U	T	S	R	Q	P	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
35	205	188	168	152	139	127	117	108	100	92	85	78	73	67	62	57	52	48	44	40	35	32	29	25	19	10
		17	37	53	66	78	88	97	105	113	120	126	132	138	143	148	153	157	161	165	169	173	176	180	186	195
40	140	129	120	111	104	97	91	85	79	74	69	64	60	55	51	48	44	40	37	34	31	27	25	22	16	9
		11	29	39	46	53	59	64	71	76	80	85	89	93	96	100	105	106	109	113	115	118	124	131		
50			80	75	71	67	63	60	57	53	50	47	44	41	38	36	33	31	28	26	24	21	19	17	13	7
				5	8	13	17	23	23	27	30	33	36	39	42	44	47	49	52	54	56	59	61	63	67	73
60				55	54	52	49	47	44	42	39	37	35	33	31	29	27	25	23	21	19	17	16	14	11	6
					1	3	5	8	11	13	16	18	20	23	24	26	28	30	32	34	36	38	41	44	49	
70							40	38	36	34	33	31	29	27	26	24	22	21	19	18	16	15	13	12	9	5
							2	4	6	7	8	11	13	14	16	18	19	21	22	24	25	27	28	31	35	
80									30	29	28	26	25	23	22	21	19	19	17	15	14	13	11	10	8	4
											2	4	6	7	9	9	11	12	13	16	16	17	19	20	22	26
90										25	24	23	22	21	19	18	17	16	15	13	12	11	10	9	7	4
												2	3	4	5	7	8	9	10	12	13	14	15	18	18	21
100												20	19	18	17	16	15	14	13	12	11	10	9	8	6	3
														2	3	4	5	6	7	8	8	10	11	12	14	17
110														16	15	14	14	13	12	11	10	9	8	7	6	3
																2	3	5	6	8	8	9	10	11	13	
120																13	12	12	11	10	9	8	7	6	5	3
																			2	3	4	5	6	7	8	10
130																			10	9	8	8	7	6	5	3
																								4	5	7

TABLE 3 • REPETITIVE DIVE TIMETABLE

RETURN TO TABLE ONE

The Recreational Dive Planner is designed specifically for planning recreational (no decompression) dives on air only. Do not attempt to use it for planning decompression dives.

Safety Stops — A safety stop for 3 minutes at 15ft is required any time the diver comes up to or within 2 pressure groups of a no decompression limit and for any dive to a depth of 100ft or deeper.

Emergency Decompression — If a no decompression limit is exceeded by no more than 5 minutes, an 8 minute decompression stop at 15ft is mandatory. Upon surfacing, the diver must remain out of the water for at least 6 hours prior to making another dive. If a no decompression limit is exceeded by more than 5 minutes, a 15ft decompression stop of no less than 15 minutes is urged (air supply permitting). Upon surfacing, the diver must remain out of the water for at least 24 hours prior to making another dive.

Flying After Diving Recommendations

For Dives Within the No Decompression Limits

- Single Dives: A minimum pre-flight surface interval of 12 hours is suggested.
- Repetitive Dives and/or Multi-day Dives: A minimum pre-flight surface interval of 18 hours is suggested.

For Dives Requiring Decompression Stops

- A minimum pre-flight surface interval greater than 18 hours is suggested.

Diving at Altitude — Diving at altitude (1000ft or higher) requires the use of special procedures.

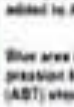
Special Rules for Multiple Dives

If you are planning 3 or more dives in a day: Beginning with the first dive, if your ending pressure group after any dive is M or L, the minimum surface interval between all subsequent dives is 1 hour. If your ending pressure group after any dive is Y or Z, the minimum surface interval between all subsequent dives is 2 hours.

Note: Since little is presently known about the physiological effects of multiple dives over multiple days, divers are wise to make fewer dives and limit their exposure toward the end of a multi-day dive series.

General Rules

- Ascend from all dives at a rate not to exceed 60ft per minute.
- When planning a dive in cold water or under conditions that might be strenuous, plan the dive assuming the depth is 10ft deeper than actual.
- Plan repetitive dives so each successive dive is to a shallower depth. Limit repetitive dives to 100ft or shallower.
- Never exceed the limits of this planner and, wherever possible, avoid diving to the limits of the planner. 140ft is for emergency purposes only; do not dive to this depth.



White area indicates *Residual Nitrogen Time (RNT)* in minutes and is to be added to Actual Bottom Time (ABT).

Blue area indicates adjusted no decompression limits. *Actual Bottom Time* (ABT) should not exceed this number.

Residual Nitrogen Time (RNT)
+ Actual Bottom Time (ABT)
= Total Bottom Time (TBT)

CAUTION: This product for use only by certified divers or individuals under the supervision of a certified scuba instructor. Misuse of this product may result in serious injury or death. If you are unsure as to how to properly use this product, consult a certified scuba instructor.

ZERO DECOMPRESSION LIMITS

- If a Diver exceeds **The Depth Duration Recommendations** for "**Compressed-Air Diving**", Ascend should be at a **Prescribed, Relatively Slow Rate**, Designed "Not to Require Stops".

- Enables **All Excess Dissolved Nitrogen** to diffuse **From the tissues** into the **blood** and **Escape** through the **Lungs** without Forming Bubbles.

EXERCISE & DIVING

- Exercise before diving or during Decompression, **Does Not Increase The Number of Bubbles** or magnify the Risk of "Decompression Sickness".

- A Period of **Mild Continuous Exercise (30% VO_2max)**, During a 3-minute "Decompression Period" may reduce Post-Dive Formation of Gas Bubbles.

STAGE DECOMPRESSION

- Requires The Diver to make One or More Stops on Ascent to The Surface.

- The Time required for "**The Slowest Tissue Compartment**" to lose **Sufficient Nitrogen** to allow Ascent to The Next Depth Determines The Duration of Such **Pauses**.

- Termed "**Stage-Decompression Stops**"

Surface Stage Decompression

- Involves **Transfer** of The Diver from **The Water** (after several **in-water stops**) to a **Decompression Chamber** at The Surface.

- The Judicious use of a **Hyperoxic Breathing Mixture** facilitates **Recompression**.

Consequences of Inadequate Decompression

- The Primary Bubbles form in the **Venous** and **Arterial** Vascular Bed.

- Other Bubbles Form in **Central Nervous Tissue**, which causes Lesions in The Brain and Spinal cord and Damage Intervertebral Disks.

- Symptoms of Decompression Sickness usually appear within **4 to 6 hours** Following a Dive.

- Severe Violation of Decompression Procedures (e.g., diver runs out of air and ascends too rapidly) initiates Symptoms Immediately.

- These Symptoms Progress to **Paralysis** within Minutes.

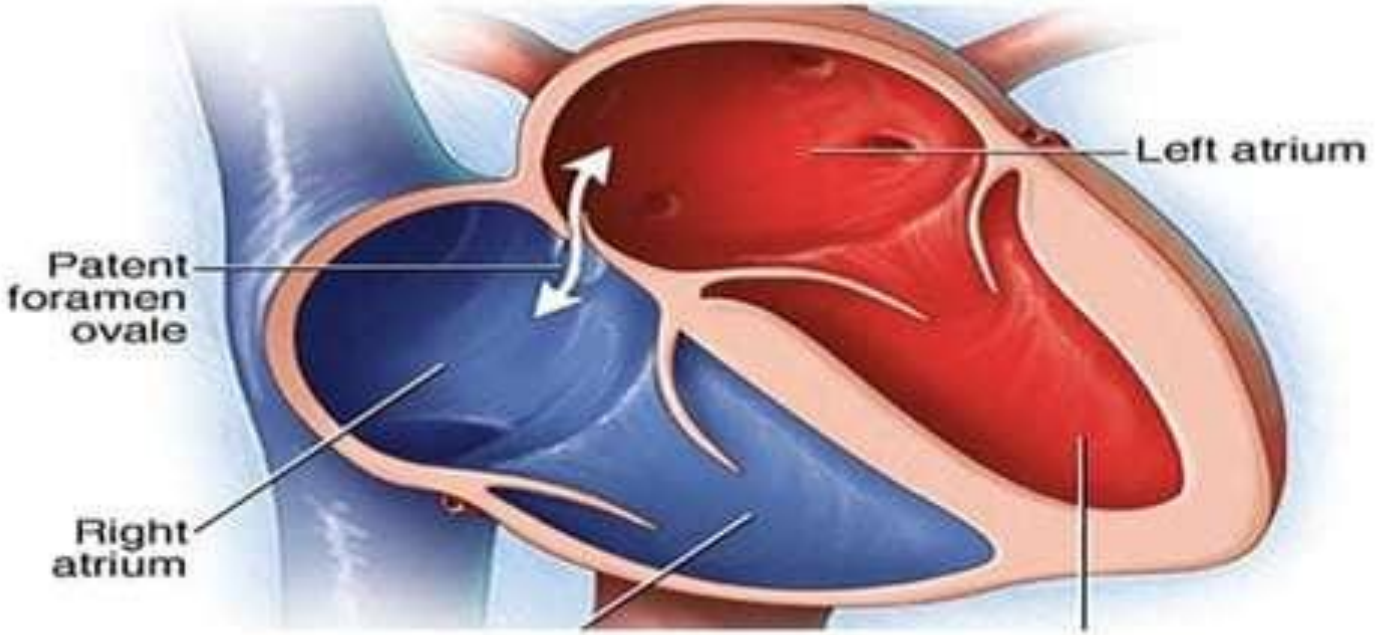
- **Indications of Inadequate Decompression include**:
  - Dizziness
  - Itchy skin
  - **Aching Pain** in The Legs and Arms, particularly in Tight Tissues such as Ligaments and Tendons

- **The Degree of Injury** depends on The Size of The Bubbles and Where they form.

- **Bubbles in the lungs** cause choking and Asphyxia;
- **Bubbles in the brain and Coronary Arteries** block **Blood Flow** and Deprive these Vital Tissues of Oxygen and Nutrients, to produce Cellular Damage and Death.

- **CNS Bends** occurs with some frequency; Failure to provide Immediate Treatment leads to **Permanent Neural Damage**.

Higher Prevalence with a Patent Foramen Ovale



- Divers with Lesions Localized in The **High Cervical Spinal Cord** and **brain areas** show a higher prevalence of **Patent Foramen Ovale (PFO)** of the Myocardium than Divers who experience decompression sickness that localizes in **The Lower Spinal Cord**.

Patent Foramen Ovale (PFO)

- Consists of an Interatrial Septum Channel that forms a **Functional Valve** between The Right and Left Atria.
- Can Cause **Localized DCS**, as Nitrogen bubbles that the pulmonary vasculature normally filters pass through the PFO into the arterial circulation.
- The bubbles then migrate preferentially into **The Carotid and/or Vertebral Arteries**.

PREVENTION

- Avoiding diving if you are **Obese**, **Pregnant**, has **Heart or Lung problems**, or has had a **recent Joint or Limb Injury**.
- Avoiding **Excessive Alcohol Consumption** for 24 hours before diving
- Avoiding **Flying for 24 hours** after Deep Sea Diving
- Avoiding **Repeated Dives** within a 12-hour period

TREATMENT

- Involves "Lengthy Recompression" in a **Hyperbaric Chamber**.
- Elevates External Pressure to Force **Nitrogen Gas** back into Solution.
- Gradual Decompression then follows to Provide Time for **The Expanding Gas** to leave the body as the diver returns to the Surface.
- Immediate Recompression offers the best chance for success; any delay decreases the prognosis for complete recovery.

A Collapsible, Lightweight, Transportable Chamber

Thanks