

ANALYSIS OF DECOMPRESSION SICKNESS CASE TREATED AT THE SA NAVY DIVING SCHOOL,
1962-1976

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The SA Naval Diving School was established on the 1st of July 1957. A 10 man decompression chamber was installed and it became operational in 1958. From this date towards the end of 1960 it has been used solely for training and testing of equipment.

The first therapeutic decompression was done on the 5th January 1962. While this was still in progress a second diver with the "bends" was brought in. He had to be compressed in the one man compression chamber for the interim period, and was later transferred to the main chamber for his therapeutic decompression. Since this flying start a total of 70 therapeutic decompressions has been done up to the present.

INDICATIONS FOR THERAPEUTIC DECOMPRESSION

Any diver suffering from decompression sickness, pulmonary barotrauma with air embolism or any obscure symptoms of sickness which cannot be clearly attributed to other causes must undergo therapeutic decompression. Recompression does not cause any damage and can prevent serious consequences.

DECOMPRESSION SICKNESS

When a person is subjected to an increased pressure, the raised partial pressure of the nitrogen will cause an influx of nitrogen, via the lungs, into the body tissues. With a decrease in pressure the reverse will happen and nitrogen will flow from the tissues to the lungs until an equilibrium is reached.

When this pressure decrease is above a critical level, the escaping nitrogen can not be passed to the lungs fast enough for elimination and micro-bubbles of nitrogen may form. They may coalesce to form bubbles which may cause obstruction in the smaller blood vessels. The symptoms caused by these bubbles is known as decompression sickness.

TYPE I DECOMPRESSION SICKNESS

This includes all the cases where pain is the only symptom. It is normally situated in or around a joint. Skin and lymphatic manifestations are also included in this group.

TYPE II DECOMPRESSION SICKNESS

This includes all the more serious symptoms such as neurological, vestibular and respiratory symptoms.

PULMONARY BAROTRAUMA

Due to overexpansion of the lungs, ruptures may occur. Air may be forced through these small openings into the circulation and again cause obstructions of the vessels. This is a very sinister problem and requires immediate recompression.

BREAKDOWN OF CASES INTO TYPE OF ACCIDENT

Type I	44
Type II	12
Pulmonary barotrauma with air embolism	11
Incomplete records	3
Total	70

EVENTS LEADING UP TO ACCIDENT

	TYPE I	TYPE II	AIR EMBOLISM
1. No decompression schedule	26	7	
2. Simulated dives in a compression chamber	4	3	1
3. Caisson Workers	6	1	
4. Equipment failure followed by free ascent			5
5. Inaccurate depth or bends on an apparently safe table	6		
6. Breathhold or controlled breathing			4
7. Flying after diving	1	1	
8. Attendant during therapeutic decompression	1		
9. Nitrogen narcosis			1

BREAKDOWN OF SYMPTOMS AND SIGNS IN AIR EMBOLISM

A. Presenting Symptoms

1. Pain in chest	4	approx 37%
2. Unconscious	2	± 18%
3. Apnoea	1	± 9%
4. Blindness	1	± 9%
5. Headache	1	± 9%
6. Pain in elbow	1	± 9%
7. Pain in lumbar area	1	± 9%

B. Most common signs and symptoms in air embolism

1. Pain:			
Chest	7		
Lumbar area	2		
Elbow	1		
Thigh	1	11	± 33%
2. Paralysis + paresis:			
Arm	1		
Right sides hemiparesis	1		
Lower extremities	2		
Facial hemiparesis	1	5	± 14%
3. Disorientation	3		± 9%
4. Headache	3		± 9%
5. Apnoea	2		± 6%
6. Convulsions	2		± 6%
7. Dizzy (vistribular)	2		± 6%
8. Sensory fallout lower extremities	2		± 6%
9. Urine retention	2		± 6%
10. Coughing up blood	1		± 2%
11. Blind	1		± 2%
12. Foam in mouth	1		± 2%

TYPE I DECOMPRESSION SICKNESS

Most Common Sites of Pain

1. Shoulder	17	± 34%
2. Knee	13	± 30%
3. Elbow	5	± 12%
4. Hip	4	± 10%
5. Ankle	3	± 7%
6. Wrist	2	± 5%
Upper extremities	24	54.5%
Lower extremities	20	45.5%

TYPE II DECOMPRESSION SICKNESS

A. Most Common Serious Symptoms and Signs

1.	Dizzy	6	± 33%
2.	Lumbar backache	5	± 31%
3.	Headache	2	± 11%
4.	Clonus of ankle	1	± 5%
5.	Pain in chest	1	± 5%
6.	Paresis from waist down	1	± 5%
7.	Paresis R leg	1	± 5%
8.	Sensory fallout R leg	1	± 5%

B. Most Common Sites of Pain

1.	Knee	5
2.	Ankle	2
3.	Shoulder	2
4.	Hip	1
5.	Paralysis both lower legs	1
	Upper extremities	2
	Lower extremities	8

THERAPEUTIC DECOMPRESSION TABLES USED

The type of therapeutic decompression table used will depend on three major factors:

1. the type of diving accident;
2. the response of the diver to the therapeutic decompression; and
3. the availability of oxygen in the decompression chamber.

THERAPEUTIC TABLES USED

1.	Long Air table 50 metres for 38 hours 55 minutes	17	}	
2.	Air table 50 metres for 19 hours 43 minutes	15	}	
3.	Air table 50 metres for 9 hours 43 minutes	12	}	
4.	Air table 30 metres for 6 hours 52 minutes	11	}	79%
5.	Oxygen table 18 metres for 2 hours 15 minutes	7)	
6.	Oxygen table 18 metres for 4 hours 45 minutes	8)	21%
	TOTAL	70		

Relapses after therapeutic decompression where recompression was needed:

1. One caisson worker after treatment on air table for 9 hours 43 minutes.
2. After treatment in Durban - table unknown.
3. Crayfish diver on air table for 9 hours 43 minutes
4. Air embolism case on O₂ for 4 hours 45 minutes.
5. One death in the chamber due to air embolism on air table 19 hours 43 minutes.

NON-DECOMPRESSION SICKNESS CASE TREATMENT IN CHAMBER

1.	Reverse barotrauma due to curry	2
2.	Hyperventilation	1
3.	Influenza	1
4.	Reverse barotrauma sinuses	1
5.	Inner ear infection	1

DISCUSSION

General

The information was obtained from the medical and SA Naval Diving School records. Symptoms and signs as reported have been analysed to compile this paper.

Incomplete and vague recording that was encountered, could be ascribed to the following:

1. Therapeutic recompression to a depth of 50 metres has been used in 63% of the cases. At this depth nitrogen narcosis will affect the examining medical officer to such an extent that a thorough examination becomes very unlikely.
2. No laid down proforma of the medical examination of decompression accidents has been used to ensure a complete examination. This would also be of immense value for future research into these cases. See Appendix A.

PULMONARY BAROTRAUMA WITH AIR EMBOLISM

The very high incidence of pulmonary barotrauma with air embolism (PBT) in this series (16%) stresses the importance of preventing this sinister condition. It is always preventable. The most important single factor was panic in inexperienced divers.

DECOMPRESSION SICKNESS

The most common single factor here was total disregard of laid down decompression tables. This was very much so in the days of the crayfish diver and before the Regulations on diving has been instituted through the Factories, Machinery and Building Work Act, through the Department of Labour.

it is interesting to note that the occurrence of pain in the upper extremities has been more frequent than in the lower extremities.

This confirms the findings of other workers in this field. Also the higher incidence of pain in the lower extremities in airlock workers follows other findings.

APPENDIX

BLAST THAT FISH

Alf Leggatt, who was awarded the NBE for his services to fishing, asked the army to blow a perch out of his pond because it had eaten 2000 goldfish there. The army obliged and exploded two charges. But the perch stayed put. Nicknamed "Jaws" to commemorate his appetite, he remained an unwelcome victor. His reign only closed when the Southern Electricity Board sent two men to shock him. They used an electrified fishnet, 20 minutes and 240 volts to complete the assignment. As Alf said when his enemy floated stunned to the surface, "I knew I'd get him in the end - I wouldn't let a thing like this beat me. But I must admit I've developed a grudging respect for him". So he put Jaws, all of 31 cms long, into a separate pond in front of his house. Jaws quickly recovered and swam strongly round the pond.

"He looks hungry," said Alf.

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DECOMPRESSION ACCIDENT REPORT FORM

Date: Unit:

1. No Rank: Name:

2. PRINCIPAL SYMPTOM or MAIN INJURY

3. Type of dive 4. Depth:

5. Time of accident: 6. Time of surfacing:

7. Bottom time: 8. Ascent time:

9. Type of diving equipment

10. Decompression shortened.... 11. By how much?

12. Explosive ascent? 13. Therapeutic table in use:

14. Combined dive? 15. Diver Qualification:

16. FIRST SIGNS:

	COMMENTS	YES	NO
17. PAIN - Localization			
18. SKIN OR CUTANEOUS Manifestations			
19. CANIAL NERVES			
- Deafness			
- Vertigo, Nausea, Vomiting			
- Visual problems			
- Pupil size			
- Rhomberg's sign			
20. INTRACRANIAL			
- Headache			
- Level of consciousness			
- Fully conscious			
- Confused but rousable			
- Responding only to pain			
- Deeply unconscious			
- Fatigue			
- Personality disorders			
21. PERIPHERAL NERVOUS SYSTEM			
- Paresis			
- Paralysis			
- Sensory Fall out			
- Pins & Needles			
- Urinary retention			
- Reflexes			
22. RESPIRATION			
- Normal			
- Noisy			
- Shallow, weak			
- Painful			
- Assisted ventilation			
- Worsening with decompression			

- 23. CIRCULATORY
 - Pulse
 - Bloodpressure
 - Shock
 - Cyanosis
- 24. INJURY
 - Type:
 - Cut
 - Fracture
 - Position
 -
 -
 -
 - Bleeding:
 - Slight
 - Moderate
 - Severe
- 25. Medical Treatment given
(attach details)
- 26. Status after therapeutic
decompression
- 27. Residual signs or symptoms
(attach details)
- 28. Diving Supervisors account
of incident.
- 29. Divers own account of incident.
- 30. Disposal of Diver.

COMMENTS	YES	NO

NOTHING'S FOR FREE

Mr Ball, British based managing director of Shell Oil Exploration, has said that his firm is now spending \$1500 a minute of their North Sea Oil operations.

A VERY LUCKY DIVER

Keith Momery, a 23 year old skin-diver, became unconscious and sank while diving off Penzance, U.K., recently. His life was saved through the action of Beaky, a dolphin well known to local divers, who swam down and not only brought him to the surface but kept him afloat till rescuers arrived. Not everyone who dives alone can expect such providential succour.

DIVING HISTORY OF AIR EMBOLISM CASES

- a. Prospective diver undergoing compression to 10 metres water depth in compression chamber. Over the last 1.5 metres whilst surfacing, started shouting, developed convulsions, dilated pupils. Diagnosis of hysteria made by attending Medical Officer. Given Sparine 65 mgm and Valium 5 mgm IVI. Then surgical emphysema felt in neck.

Treatment - Therapeutic decompression to 165 feet on Table 5B was attempted at 140 feet 5 inches. Emphysema returned. Patient recompressed to 165 feet on 5E. Then:

Headache

Confusion - ? Sparine effect

Pain chest with deep inspiration

Absent knee and ankle reflexes.

Cleared up completely on above. Later re-applied and became a diver.

- b. Lost face mask and mouth piece, ditched weight belt emergency ascent. Unconscious and not breathing on surface. Mouth to mouth resuscitation, then sent back underwater for a 10 minute stop, depth unknown. Arrived at Diving School disorientated, upper abdomen and chest pain.

Treatment - Main chamber occupied and put into one man chamber - later transferred into 8 man chamber. Table I and II - complete recovery.

- c. Compressor stopped - emergency ascent. Pain in chest, pains both thighs. No CNS signs. Treatment - Table 1.

- d. Man-made equipment, garden hose kinked in upright position, cut off air supply. Pulled off face mask, arrived unconscious at surface. Came to after initial resuscitation. White froth mouth, paralysis R side of face, dilated R pupil absent reflexes.

Treatment - recompressed 165 feet, Dextran 40 IVI, Plasma IVI, aramine for opnoea and Sodium Gardinal for convulsions. Died in chamber.

- e. Dived in Standard Suit. Few minutes down, could not get enough air, passed out. On surface: pain in chest, paresis L arm; bleeding nose. Responded to treatment.

- f. Swimming on his back doing shipsbottom search. Whilst underwater developed pain in chest. On surfacing pain in lower back. On O₂ for 4 hours 45 minutes - chest and back pain relieved. Diagnosis: pulmonary barotrauma with air embolism.

- g. Dived at 185 feet, developed nitrogen narcosis. Panicked and pulled off face mask. Did an emergency ascent.

On ascent: paresis R side, aphasia.

- h. Dived to 12 metres for 20 minutes. Did a controlled ascent. Ran out of air and rebreathed from set then continued controlled ascent. Air bubbled from mouth on reaching surface.

On surface: After 2 minutes pain in lumba area. Seen and diagnosed as lumba strain by inexperienced Medical Officer.

4 hours after dive: severe lumbar backache. Paresis ++ lower extremities - could not straighten leg due to pain. Urinary retention.

Treated at 18 metres on long O₂ table (4 hours 45 minutes). Pain in back gone

after 6 minutes. Passed urine completely after 3 hours 5 minutes. No sequela after treatment.

- i. Bought a SCUBA set. Practised controlled ascents for 30 minutes. Depth 40 feet. Symptoms: Pain L shoulder after dive. Very severe next day on arrival at Diving School. Treated on Short Oxygen table 2 hours 15 minutes. Pain gone after 6 minutes.
- k. Snorkel diving. Buddy breathed from a scuba diver. Chest felt uncomfortable and shot to surface.

On surface: Immediate chest pain. Nausea, frontal headache, severe tiredness, with now prominent nausea. Seen 4 days later by a doctor who diagnosed muscle injury. Tanderil given.

5 days later coughing up blood and severe chest pain. Chest x-ray clear. Diagnosis of sinus barotrauma made. Two days later: worsening of frontal headache and chest pain. Still vestibular symptoms. Diagnosis of pulmonary barotrauma made by a diving Medical Officer. Treatment O₂ at 18 metres. Improvement after 10 minutes, completely pain free after 15 minutes. Surfaced after 2 hours 15 minutes. No sequela.

- l. Dived at 70 feet for 17 minutes. Swam up trying to keep pace with an expanding bubble.

On surface: Got out of water feeling fine. After 3 minutes became dizzy and disorientated and blind. Put onto 100% O₂ immediately, taken to Diving School. On arrival vision 100%. Nausea, headache and breathing pain R chest. Started on O₂ at 18 metres. Still nausea, headache and vomiting after 3.5 hours. Dextrostix: 40 mg% blood-sugar. 10cc of 50% Dextrose IVI with immediate relief of symptoms. Surfaced after 4 hours 45 minutes with NO symptoms and signs. Chest X-ray NAD and a glucose tolerance test arranged.

5 hours after decompression: diver unconscious, roused with difficulty, disorientated. Paralysis from waist down. Sensory fall-out from waist down. Taken down to 60 feet and another shot of Dextrose given IVI. Diver conscious, only paresis of lower extremities. After discussion with Surg Cdr Pearson RN: Table 65 (air 165 feet). On arrival - headache better but again complete paralysis lower extremities.

Medical Treatment:

- 1. Dextran 40, 500 ml IVI over half hour, repeated 6 hourly.
- 2. Decadron 100 mgm IVI 6 hourly.
- 3. Heparin 5000 μ subcut 8 hourly.
- 4. Lasix 20 mgm IVI.
- 5. Maxolon 2cc IVI stat.

Had to be catheterized after 5 hours for urinary retention.

Condition steadily improved until at 30 feet. Then complete paralysis both legs again. Patient put onto a modified O₂ table with complete relief. On surfacing after 46 hours, severe atoxic walk which cleared over next couple of weeks.

Three months after accident - NO neurological residual and declared fit for diving again. Patient however has lost his nerve (perhaps not surprisingly!).