

Fitness to Scuba Dive ©

Critical Issues for GPs & Patients

NZMA GP CME Meeting:
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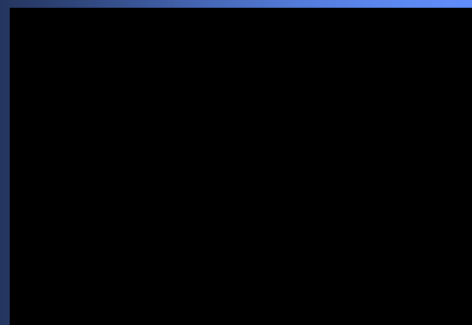
Supporting Better Medicine www.ipn.com.au

Objectives

Basic understanding of Diving Physiology & Hazards with reference to assessment health risks for Sport Scuba Dive Trainees



Fitness to Dive



Compressed Air Diving

- SCUBA
- Technical Diving
- SSBA / Hookah
- Commercial Diving
- Scientific Diving



Submarines Breath Hold Diving

Diving Physiology

- Boyles law $P \sim 1/V$ @ constant T or $P_1 V_1 = P_2 V_2$
- Henrys Law amount gas dissolved $\propto$ pressure gas over the liquid
- Charles law increasing T increases gas V @ constant P
- Daltons law $P_T = P_1 + P_2 + P_3 + P_4$
- Pascals Principle linear relationship between P & D underwater

Daltons law

- Air 78 % N₂ + 21 % O₂ + traces CO₂, CO, Arg, He, Ne, Kr, Xe
- Nitrox N₂ + O₂
- Heliox He + O₂
- Trigas He + O₂ + N₂
- Hydrox H₂ + O₂

Daltons Law

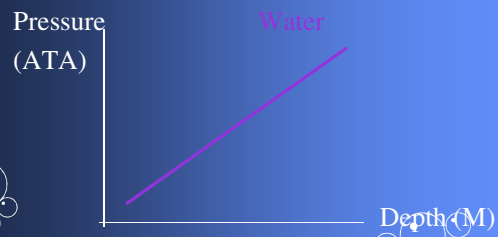
- Oxygen Toxicity
- Nitrogen narcosis 'nares'

Surface = 1 ATA = 0.8 N₂ + 0.2 O₂
(pp O₂ = 1 ATA x 20% = 20%)

40 m = 5 ATA = 4.0 N₂ + 1.0 O₂
(pp O₂ = 5 ATA x 0.20% = 100%)

Pascals principle

- 1ATA = 10 m sea water / 33 ft sea water / 34 feet fresh water / 1 bar / 760mmHg



Buoyancy

- Archimedes Principle

Temperature

- Thermal Comfort Zone

Light & Colour

Sound

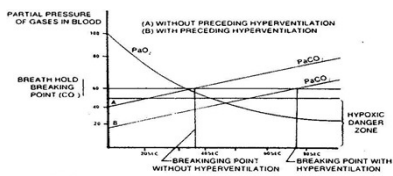


The Big Blue



Break Point

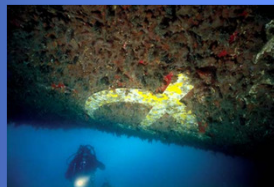
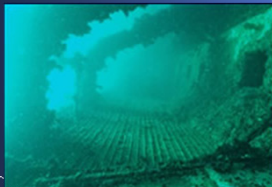
Figure 11. Breath-hold diving, and levels of arterial oxygen and carbon dioxide.



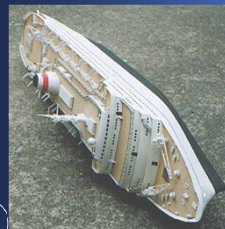
Mikhail Lermontov Disaster 16 Feb 1986



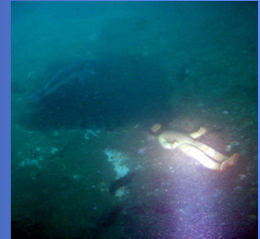
Mikhail Lermontov 1996



Mikhail Lermontov Disaster



- The vessel lying in Port Gore in about 37 meters of water although this varies with the tide
- 10 degree slope
- The Port bridge wing is only about 12 meters below the surface.
- Bottom visibility varies greatly from 4-20m,



Standards Diving Medical Fitness

- **Commercial AS/NZ 2299** Dept of Labour
- **Standards Australia - Recreational Diving Medical** 31.03.2000

www.standards.com.au

www.saiglobal.com

- **SPUMS Sport Diving Medical** May 1999

www.spums.org.au

Code of Practice for Diving on Construction Work 1987

Dive Medicine Courses

- United States Navy Diving Medical Officer Course.
- Royal Adelaide Hospital Basic Course in Diving Medicine or the Advanced Course in Diving and Hyperbaric Medicine;
- Royal Australian Navy Submarine and Underwater Medicine Unit Basic Course, Advanced Course or Medical Officer's Course;
- Diving Medical Centre Medical Examiner Course;
- Fremantle Hospital Medical Assessment of Divers Course;
- Royal New Zealand Navy Basic Course;
- Christchurch Hospital Basic Course;
- Institute of Naval Medicine (UK) Medical Examiner Course

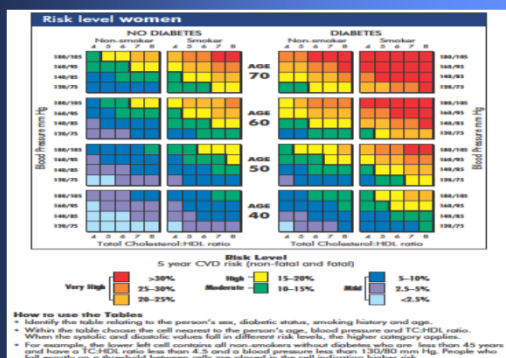
Standards Australia www.standards.com.au

- Search using Australian Ref No 4005.1
- Search results - \$38.70 per 50 copies
- AS 4005.1-2000 training & certification of recreational divers - minimum entry -level SCUBA diving (H/C or PDF)
- **AS 4005.1 Supp 1-2000** Medical form for prospective recreational SCUBA divers
- **AS 4005.1 Supp 2 -2000** Statement of health for recreational diving

Sport Dive Medical

- History, Examination and Risk Assessment
- Urinalysis
- Spirometry
- Audiogram ? Tympanogram
- ? Chest x-ray

NHF tables CV Risk Profile



Risk Matrix Scuba Diving

		LIKELIHOOD				
		Historical:	Unlikely in the industry	Has occurred once or twice in the industry	Has occurred many times in the industry, but not in the Company	Has occurred frequently in the Company
		Frequency: Continuous Operation	Once every 10,000 to 100,000 years at location	Once every 1,000 to 10,000 years at location	Once every 100 to 1,000 years at location	Once every 10 to 100 years at location
		Probability: Single activity	1 in 100,000 to 1,000,000	1 in 10,000 to 100,000	1 in 1,000 to 10,000	1 in 100 to 1,000
			0	1	2	3
CONSEQUENCE		People	Environment	Value	Reputation	
		>20 Fatalities (or Permanent Total Disabilities)	Regional scale (>100 km²) Long term (permanent) impact	A+10000	International concern. Major ventures terminated. Company at stake.	A+ Catastrophic
		2-20 Fatalities (or Permanent Total Disabilities)	Large scale (10-100 km²) Long term (discrete) impact	A10000	Persistent national concern. Long term 'brand' impact. Major ventures/asset operations severely restricted.	A Massive
		1-3 Fatalities (or Permanent Total Disabilities)	Medium scale (1-10 km²) Medium term (years) impact	A1000	Medium term national concern. Minor ventures or minor asset operations restricted or curtailed.	B Major
		Major hypoxia/loss of consciousness (Prolonged Work Case or Lost Work Case or Fatality)	Medium scale (1-10 km²) Short term (months) impact	A100	National bad mention. Short term regional concern. Close scrutiny of Asset level operations/proposal.	C Moderate
		Minor hypoxia/loss of consciousness (Prolonged Work Case or Lost Work Case or Fatality)	Small scale (<1 km²) Short term (weeks) impact	A10	Short term local concern. Some impact on asset level non-production activities.	D Minor
		High hypoxia/loss of consciousness (Prolonged Work Case or Fatality)	Localised (immediate area) Temporary impact (days)	A1	Local mention only. Quickly forgotten. Prudent to operate unaffected.	E Slight

Medical Assessment Fitness to Dive

- Absolute & Relative Contraindications

Decision Making Fitness to Scuba Dive

1. Will the Medical Condition:

Get worse

Improve

Stay the same

Don't know = get advice

2. What are the Risks for

Barotrauma

Drowning

Bends/ CAGE

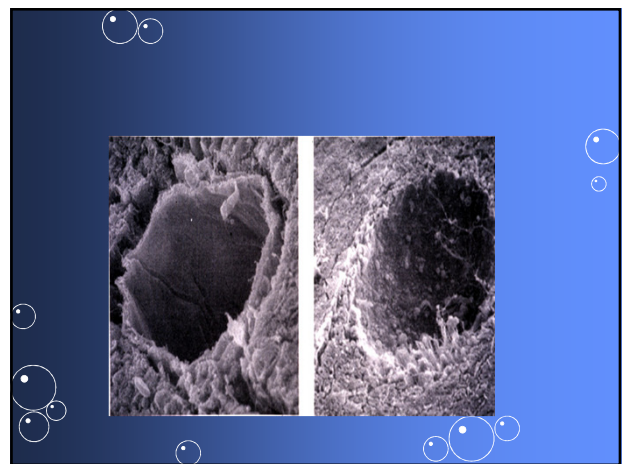
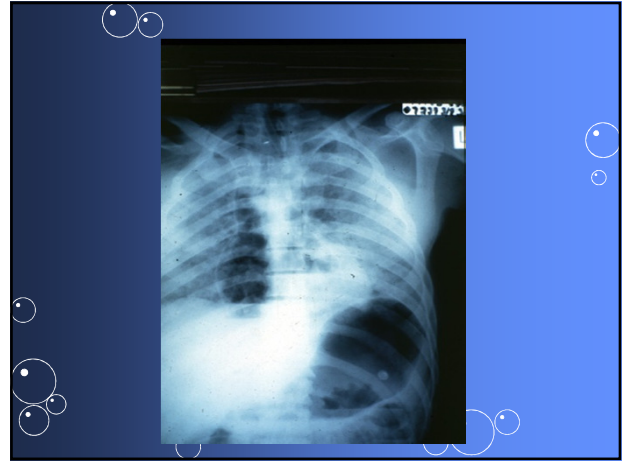
Asthma

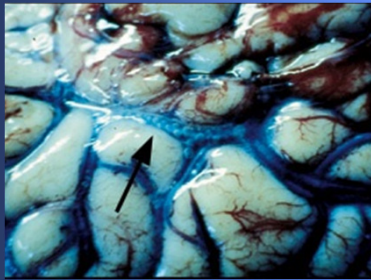
- 1) 20 year old female nurse with history of childhood hayfever and asthma. Asymptomatic, no meds, normal spirometry.
- 2) 40 year old female GP with asthma 25 years, on budesonide (800ug/day). No symptoms at present and last used salbutamol inhaler 6 months ago. Spirometry normal.

MJA 1999 711:595-598 Simpson & Roomes

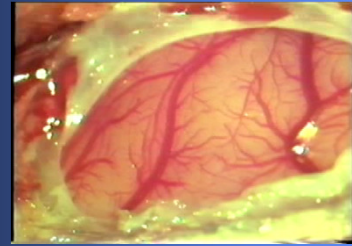
Asthma

- Air trapping - CAGE
- Not possible to medicate underwater
- SCUBA air dry and may aggravate asthma
- Salt water aspiration may trigger
- Decompression treatment may aggravate asthma and complicate acute management
- Risk for pneumothorax





CAGE



Requirements for Barotrauma

A space that is :-

- Gas filled
- Rigid / stiff walls
- Enclosed
- Vascular penetration
- Ambient pressure change

Medical Assessment Fitness to Dive

- Absolute & Relative Contraindications
- Risks for Barotrauma
- Risks for Drowning
- Risks for Decompression

Risks for Barotrauma

- Psychiatric conditions
- Intellectual difficulties
- Inability to autoinflate ears or sinuses
- Previous middle ear, sinus or lung surgery
- Previous lung disease e.g. pneumothorax
- Lung cysts
- FEV1/FVC <75%

Risks for Barotrauma

- Flow volume loops
- Paradoxical embolism from R to L shunt
- Laryngocoele
- Post gastrectomy
- Hiatus hernia
- Nissen fundoplication
- Abdominal or Thoracic hernia

Risks for Drowning

Any condition that may cause transient loss of consciousness:-

- Cardiac - long QT syndrome; IHD; pacemakers; warfarin; valvular heart disease
- Drug abuse - THC; EtOH; Methadone
- ENT - inner ear surgery; tracheostomy etc
- Haematological - Sickle Cell disease etc
- Metabolic - thyrotoxicosis; IDDM etc
- Neurological - epilepsy; TIA; head injury etc

Risks for Drowning

- Psychiatric conditions
- Intellectual difficulties

Risks for Decompression

- Age
- Sex
- Obesity
- Smoking
- Drugs - legal/illicit
- Cardiac -PFO; R →L shunt
- Neurologic - AVM
- Pregnancy - no foetal decompression tables

Bends

- Bubble dynamics
- Off gassing
- Evolution
- Premorbid conditions
- Non diving vs diving related pathology
- Types 1,2 & 3



Barotrauma

- Cerebral Arterial Gas Embolism **CAGE**
- Middle Ear Barotrauma
- Inner Ear Barotrauma
- Sinus Barotrauma - pneumocephalus
- Tooth Barotrauma - aerodontalgia
- Chest Barotrauma – pneumothorax / emphysema
- Gastrointestinal Barotrauma - pneumoperitoneum
- Diaphragmatic Rupture following Nissen Fundoplication for GORD

Br J Sports Med 1998 32:75-76 Hayden et al

Chest Trauma

- 54 yr old caucasian professional male
- March 2003 fall from mountain bike sustaining # left ribs 2-8, # left clavicle, L ACJ disruption & haemopneumothorax
- Initially triaged but represented 2/7 later requiring IC tube & drainage
- SCUBA 1996 ; 70 dives ; maxm 33 m
- FEV1 3.50 FVC 4.23 82 % Ht 1.76 m
- CXR 08.09.2003 old healing # 2-8 left. A little linear parenchymal scarring at left lung base.

Chest Trauma

- Contiguous CT scan in inspiration and expiration recommended
- **CT chest high resolution 16.01.2004** – very minor pleural & parenchymal scarring anteriorly at left base within the lingula and involving the adjacent oblique fissure (manifest by several parenchymal bands and minor thickening of the inferior oblique fissure). No air trapping.
- 10.03.2004 – two easy dives 15-16 m cray fish hunting. No problems.
- Risks explained.

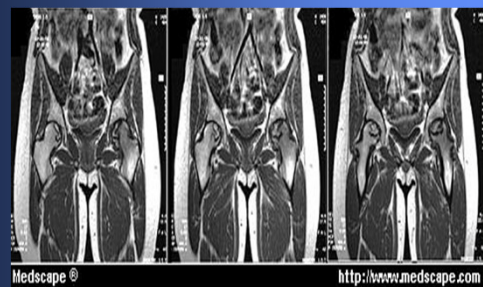
Pulmonary Edema of Diving

- Immersion related; etiology unknown
- Cough, SOB, haemoptysis on bottom or during ascent
- Intermittent
- Spontaneous resolution over 24 hours
- Precipitating factors – preload & afterload e.g. heavy exercise; -ve pressure breathing; prediving fluid overload

Cutis Marmorata



Dysbaric Osteoradionecrosis



Preliminary management



Links

- **DAN** www.diversalertnetwork.org
- **SPUMS** www.spums.org.au
- **UHMS** www.uhms.org
- **HTNA** www.htna.com.au
- Not recommended - www.uksdmc.co.uk

Case 1

- 11 year old boy presents with his mother for a dive medical as the family are going on a holiday to Fiji and both parents are keen scuba divers.
- History of grommet surgery both ears when he was 5 otherwise OK

Case 2

- 16 year old school girl is doing a diving course in Year 11.
- Possibly interested in a career as a Marine Biologist
- History of asthma until age 12 then free of symptoms

Case 3

- 55 year old UK executive on holiday with family wants to do SCUBA diving on Hamilton Island
- CAVG surgery eight months ago x 4 grafts

Case 3

- Ignores your advice that he is not suitable for sport scuba diving following a strongly positive post CAVG surgery stress exercise test
- Finds a GP who signs him off as “*fit for shallow diving only*” (not > 60 feet/20 metres)
- Found unconscious floating in water off Hamilton island. CPR unsuccessful.
- Coroners Court requests a copy of your medical records

Case 4

- Epileptic well controlled on carbamazepine for 20 years with no history of seizure for 19 years
- Drives a commercial truck

Case 5

- 19 year old male with recent head injury following cycle accident 6 months ago. Admitted to hospital for observation for 3 days. GCS 12 on admission.
- Six weeks recovery and still has intermittent headaches

Case 6

- 21 year old female with recent head injury following MVA 12 months ago. Admitted to hospital for observation for 2 days.
- GCS 13 on admission. CT Head scan showed diffuse frontal lobe petechial haemorrhages.
- Remarkably quick recovery & back at work as an administrator after 14 days

Case 7

- 22 year old female with history of multiple relapses for bipolar disorder
- Lithium medication

Case 8

- 24 year old male with Paranoid Schizophrenia on olanzapine

Case 9

- 25 year old paraplegic male T12
- Paraplegia a result of fall at work two years ago and burst # T12/L1
- Wheelchair bound
- Para-olympian Basketball player

Case 10

- 45 year old male
- BP 150/100
- Cholesterol 6.30 ; HDL 0.79 ; Chol/HDL ratio 8
- BMI 32
- Non smoker
- Brother age 35 heart attack

- Dr X issues a conditional medical certificate stating:

“ To Whom it May Concern: This is to certify that I have examined this man today. He has untreated hypertension and is awaiting cardiologist assessment atHospital which is scheduled for I feel he is fit to do the basic PADI course in a pool but should defer sea diving until clearance by his Cardiologist has been obtained.”

- There is no indication that the reviewing Cardiologist was contacted to request an opinion on Diving Medical fitness.
- The PADI medical statement signed by Dr X (and later the usual GP) says in the preamble:

“To scuba dive safely you must not be extremely overweight or out of condition. Diving can be strenuous under certain conditions. Your respiratory and circulatory systems must be in good health.”

PADI warning statement

“ A person with heart trouble, a current cold or congestion, epilepsy, asthma, a severe medical problem, or who is under the influence of alcohol or drugs should not dive. If taking medication, consult your Doctor and the instructor before participation in this program.”

Cardiologist Letter

- Dr P (registrar to Dr M consultant Cardiologist)
- Echocardiogram normal.
- Started Mr X on treatment (accupril) for his high blood pressure.
- Screening stress exercise test was not undertaken, as Mr X had no symptoms of heart disease. No mention of SCUBA diving in the correspondence

