

**THE RELATIVE IMPORTANCE OF DIFFERENT PARTS OF THE DIVING MEDICAL IN IDENTIFYING FITNESS TO DIVE AND THE DETECTION OF ASTHMA.**

John Parker

**Introduction**

This is a report of one medical practitioner's review of two hundred consecutive sports diving medical failures in order to attempt to assess the relative importance of the diving medical in identifying fitness to dive and in detecting asthma.

**Methods**

The diving medical has been fully described in another paper.<sup>1</sup>

Each failure was reviewed in order to identify at what stage of the diving medical the reason for failure was first anticipated. The diving medical was divided into four stages:-

- Stage 1  
Reading the completed questionnaire before seeing the diver.
- Stage 2  
Interviewing the diver about the questionnaire.
- Stage 3  
Physical examination.
- Stage 4  
Investigations.

The frequency which each question in the questionnaire anticipated, or failed to anticipate a reason for failure was recorded.

All divers who failed their diving medical because of asthma were reviewed to identify at what stage of the medical the asthma was identified.

**Results**

The 200 diving medical failures were compiled from 2,051 consecutive initial sports diving medical examinations. Two hundred and twenty one reasons for failing the diving medical were recorded. The actual causes for failure and the frequency of each cause of failure has been documented in a previous paper.<sup>1</sup>

The stages at which failure was first anticipated are shown in Table 1.

**TABLE 1**

**STAGES AT WHICH THE 221 FAILURES WERE FIRST ANTICIPATED**

107	(48%)	failed at stage	1
33	1(5%)	failed at stage	2
61	(28%)	failed at stage	3
20	(9%)	failed at stage	4

**The questionnaire (Stages 1 and 2)**

The questions which accurately predicted a reason for failure were obvious and predictable (Table 2).

**TABLE 2**

**QUESTIONS WHICH ACCURATELY PREDICTED A REASON FOR FAILURE**

Asthma	68
Discharging ear or infection of ear	9
Pneumothorax	8
Deafness or tinnitus	8
Present disability	3
Heart disease	2
Chest injury or infection	2
High blood pressure	2
Fits or Epilepsy	1
Operation on ear	1
Diabetes	1
Hernia	1
Pregnancy	1
<b>Total</b>	<b>107</b>

The questions which needed discussion before a reason for failure became evident included the more general enquiries (Table 3).

Other questions which led on to useful discussion and enquiry but rarely led on to a failure included:- hayfever (severity?), sinusitis (severity?), wearing of glasses/contact lenses (what they intended to do underwater?), claustrophobia (how serious?), motion sickness (proposed prophylaxis?) and previous diving experience (previous problems? ability to equalize?).

Some conditions relevant to scuba diving were not well screened. These included abnormalities of the sinuses and haematological disorders.

TABLE 3

**QUESTIONS NEEDING DISCUSSION BEFORE A REASON FOR FAILURE BECAME EVIDENT**

Asthma	11
Present disability	5
Other chest complaints	3
Previous operations	3
Bronchitis or pneumonia	2
Chronic cough	1
Sinusitis	1
Medication	1
Migraine	1
Hepatitis	1
Back injury	1
Paralysis or muscles weakness	1
Previous hospital admission	1
Other illnesses	1
<b>Total</b>	<b>33</b>

Other questions seemed of little relevance or asked specifically for problems which although possibly relevant to professional diving or conditions of employment were not of relevance to the sports diver, or could easily be covered by the system enquiry. These were swollen joints, sleepwalking, indigestion, vomiting blood or rectal bleeding, malaria or other tropical diseases, venereal diseases, haemorrhoids, insurance rejection, previous pension, family history of suicide or mental illness.

It was surprising that many obvious questions were **not** answered correctly by the diver (Table 4.). When later the condition was detected and admitted, varying reasons for omission were given. These included "I didn't think it mattered", "I forgot" or "I didn't see it".

**Specific questions of interest**

**MEDICATION**

Two hundred and ninety six divers were on medication. Only 2 divers failed solely because of it. A wide range of medication was encountered (Table 5).

**SMOKING HABITS**

Six hundred and twenty four (30%) of the divers were cigarette smokers. Ninety (4.4%) smoked 20 or more cigarettes per day. No-one failed directly because of their smoking habits. Predictably 10 of the 12 divers who failed due to a lower respiratory tract infection were smokers. Seven of the 10 divers who failed with unexplained poor lung function were also smokers.

TABLE 4

**QUESTIONS NOT CORRECTLY ANSWERED**

Medication	24
Asthma	11
Present disability	
cold	8
hayfever	1
Ear discharge	3
Chest surgery	1
Pneumothorax	1
Diabetes	1

TABLE 5

**MEDICATIONS TAKEN BY DIVERS**

Contraceptive pill	145
Sympathomimetic inhalers	55
Antibiotics	27
Antimalarials	26
Antihistamines	11
Non-steroidal anti-inflammatories	8
Beclomethasone nasal spray	8
Beclomethasone inhaler	8
Decongestant nasal drops	4
Pseudoephedrine	4
Cimetidine	2
Frusemide	2
Prednisolone	2
Salazopyrin	2
Thyroxin	2
Acyclovir	1
Aspirin	1
Bleomycin	*1
Danazole	1
Diethylpropion	1
Evening Primrose Oil	1
Iron	1
Loperamide	1
Nystatin	1
Oestrogen	1
Prazosin	1
Sodium valproate	1
Warfarin	*1

\*Failed for medication alone

**The examination (Stage 3)**

Sixty one (28%) of the 221 reasons for failure were first identified at this stage (Table 6).

**TABLE 6**

**REASONS FOR FAILURE FIRST IDENTIFIED BY THE EXAMINATION**

Non-patent eustachian tubes	13
Lower respiratory tract infection	11
Upper respiratory tract infection	8
Impacted wax in external ear canal	6
carred tympanic membrane	3
Middle ear effusion	3
Cardiac arrythmias	3
Otitis media	3
Severe dental caries	2
Asthma	1
Active hayfever	1
Anaemia	1
Hypertension	1
Perforated tympanic membrane	1
Pneumothorax (from scar)	1
Previous chest surgery (from scar)	1
Obesity	1
Herpes simplex of face	1
Total	61

**The investigations (Stage 4)**

Twenty (9%) of the reasons for failure were identified at this stage. Respiratory function tests identified 18, histamine provocation tests and urinalysis identified one each.

**RESPIRATORY FUNCTION TESTS**

Of the 18 divers who had abnormal lung function tests, 7 were shown to have reversible airways disease (by an increase in FEV<sub>1</sub> of 15% or greater after 5 mg of nebulised salbutamol)<sup>2</sup>, whilst 11 divers were failed provisionally pending full assessment by a respiratory physician.

**URINALYSIS**

Twenty divers showed proteinuria, all of whom had a normal urine upon subsequent testing. Eight divers showed glycosuria of which only one was shown to have a high blood sugar level. (It was eventually discovered that this diver was a known diabetic trying to obtain a diving medical certificate under false pretences).

**CHEST X-RAY**

In 2051 cases under review 231 (11%) had chest X-rays of which only 3 showed an abnormality, one with a bulla and two with pleural adhesions.

**AUDIOGRAM**

Forty four (2%) divers had an air conduction audiogram performed. Seven divers were failed due to severe hearing impairment.

**PREGNANCY TEST**

This was done on six female divers with no positive results.

**ELECTROCARDIOGRAM**

All divers over the age of 45 years, 20 (1%) divers in all, were given a resting electrocardiogram. Only one abnormality was found, an atrial fibrillation which had already been detected during the examination.

**The stages at which asthmatics are detected**

Eighty divers were failed because of asthma. Of these 68 were identified by the questionnaire alone (stage 1), 11 were identified during the interview (stage 2), 1 was identified during the examination (stage 3) and 8 were identified by investigations (stage 4). Seven divers failed the routine respiratory function tests and one failed a histamine provocation test.

Thirty divers gave a history of asthma in early childhood but no attacks since the age of 12 years. On further questioning 10 of these were found to have occasional asthmatic symptoms or to admit to occasional use of bronchodilator inhalers. (One diver claimed that he had not any asthma for 16 years but still carried an inhaler). One diver had mild wheezing on examination whilst three more had abnormal respiratory function tests.

Of the remaining 16 divers 5 were given a histamine provocation test (they were only recently made available) of which one failed. Thus of the 30 divers who gave a history of childhood asthma only 15 (50%) were considered fit to dive (Table 7).

**TABLE 7**

**HISTORY OF "CHILDHOOD ASTHMA"**

Considered normal	15
Still had symptoms	10
Abnormal spirometry	3
Positive provocation test	1
Bronchospasm on examination	1

## Discussion

The sports diving medical should be aimed at assessing safety and fitness to undertake sports diving. The present generally accepted Australian sports diving medical examination has been evolved from the Australian Navy and commercial diving bodies. With new legislation concerning sports diving and diving medicine being introduced into Queensland and possibly all of Australia, now is a suitable time to review both the diving medical standards and the format of the diving medical.

No review of the relative importance of the different stages of the sports diving medical nor its efficacy has ever been undertaken. By reviewing the different stages of the diving medical it may be evaluated and suggestions made for improvement.

## The questionnaire

The questionnaire is an important and effective part of the diving medical. To be fully effective it needs to be easily understood and reasonably brief, each question being a specific discriminator of potential problems in scuba diving. A question should be classed in one of the following categories: an enquiry for a specific contraindication or diving relevant problem (e.g. asthma), a general system enquiry (e.g. any stomach or bowel disease?), a general enquiry on past or present health (e.g. have you ever been in hospital? and an enquiry on past diving/hyperbaric experience.

Most of the questions asking for specific symptoms (e.g. indigestion) were poorly answered and rarely led to any useful information. System enquiry could be covered by fewer but more general questions.

Discussion around the medication being taken often led on to past health problems not admitted in the questionnaire because it was considered trivial by the diver. Some divers who denied having asthma freely admitted using bronchodilator inhalers. The use of inhalers would be a useful additional question to be included in the questionnaire.

It is also useful to know for how long they have been smoking and to calculate the "pack-years", where one pack-year is smoking 20 cigarettes per day for one year. Hence 40 cigarettes per day for five years equals 10 pack-years. In this manner the smoking habit can be quantitated.

Past occupations are sometimes of relevance to scuba diving and should be requested in the questionnaire.

The findings in this paper suggest that the present questionnaire can be improved by asking more direct questions for problems shown to be poorly perceived by many

divers, omitting questions on specific conditions not very relevant to sports diving, making a system enquiry in more general terms and adding questions to cover conditions not presently adequately screened.

Even though asthma and medications are asked for directly on the questionnaire it is recommended that they be sought after verbally during the interview.

Using the findings from this review a modified questionnaire has been compiled to try and incorporate these suggestions (Table 8).

## The examination

The examination was shown to be very important especially in finding problems with the respiratory tract and ears. The number of divers with aural and respiratory tract problems of which they are unaware or choose to ignore is large. More direct questions need to be incorporated into the questionnaire to identify these conditions at an earlier stage of the medical examination.

Screening for colour vision, although very interesting, has no relevance to sports diving and need not be part of the medical.

## The investigations

The investigations have also been shown to be an essential part of the medical.

## RESPIRATORY FUNCTION TESTING

Simple respiratory function testing has always been accepted as an essential part of the diving medical to try and to identify asymptomatic yet significant lung disease. Any respiratory function test must be simple to perform, easily reproducible and meaningful in its interpretation. It must be able to identify both obstructive and restrictive lung disease.

One of the problems with any spirometric assessment is the large range of normal variation. Colebatch (personal communication) compared the individual variation between the common spirometric indices in the 1950's and found the FEV<sub>1</sub>/FVC ratio to have the smallest variation.

If a statistical limit of normality of two standard deviations from the mean is applied, the lower limit of normality for the FEV<sub>1</sub>/FVC ratio would approximate 90% of the predicted values. As the divers being examined in the 1950's were mainly male naval divers between the ages of 18 and 35 the value of 75% became the accepted value of the lower limit of normal. These age groups are starred and in bold type in Table 9.

**TABLE 8**

**PROPOSED QUESTIONNAIRE FOR SPORT DIVING MEDICALS**

Name	Sex	DOB	Age
Address		Nationality	
Occupation	Previous Occupations		
Dive School			
How would you rate your fitness?	Excellent	Good	Fair (ring one)

<b>Please answer Yes or No</b>	<b>Yes</b>	<b>No</b>
Do you have any disability or illness?		
Do you have a cold?		
Do you have a cough (smoker's or otherwise)?		
Are you suffering from hayfever?		
Is your hearing normal?		
So you suffer from motion sickness?		
Do you take any pills, tablets, medication, or any drug of any type?		
Do you use an inhaler?		
Do you smoke?		
How many cigarettes a day?		
For how long (years) have you smoked?		

**Have you ever suffered or do you now suffer from any of the following?**

	<b>Yes</b>	<b>No</b>
Asthma		
Pneumonia or bronchitis		
Pleurisy		
T.B. or consumption		
Burst lung or pleurisy		
Any operation on the chest or lung		
Any other chest complaint		
Hayfever or blocked nose		
Sinusitis, sinus pain or problems		
Perforated ear drum		
Discharge from ear		
Recurrent ear infection		
Operation on ears		
Dizziness or vertigo		
Deafness or difficulty in hearing		
Do you suffer ear pain in aircraft		
Do you wear glasses or contact lenses		
Any eye problems		
Heart attack or angina		
Rheumatic fever		



TABLE 9

PREDICTED FEV<sub>1</sub>/FVC RATIOS OF DIFFERENT AGE GROUPS AND SEXES

<b>Females</b>								
<b>Age</b>	<b>12</b>	<b>15</b>	<b>18</b>	<b>25</b>	<b>30</b>	<b>40</b>	<b>50</b>	<b>60</b>
Predicted ratio	94	94	88	88	87	86	85	85
90% Prediction	84	84	79	79	78	77	76	75
<b>Males</b>								
<b>Age</b>	<b>12</b>	<b>15</b>	<b>18</b>	<b>25</b>	<b>30</b>	<b>40</b>	<b>50</b>	<b>60</b>
Predicted ratio	92	92	85	85	84	83	81	79
90% Prediction	82	82	<b>*76</b>	<b>*76</b>	<b>*75</b>	75	73	71

At present the FEV<sub>1</sub>/FVC ratio of greater than 75% is still most used as the standard of satisfactory lung function.<sup>3</sup>

However, the FEV<sub>1</sub>/FVC ratio has some disadvantages.

Lung function changes with age. Present diving instructor organisations accept any diver over the age of 11 years and have no upper age limits. The predicted respiratory function normals of a 12 year old girl are very different from those of a 60 year old man (Table 9).

It is easy to cheat. If the diver does not exhale completely, artificially reducing the FVC, the ratio will be easily raised.

The commonest source of error in spirometry is the failure to record a full FVC. The FEV<sub>1</sub> however, shows no decrement therefore artificially increasing the ratio.<sup>4</sup>

If the diver, especially if tall, has large lungs then there may be an abnormally low ratio due to dysynapsis of the airways. Because the main expiratory resistance in the normal lung is in the large upper airways, especially the trachea, a diver with large lungs but a slightly small trachea, is unable to exhale as fast as expected, no matter the state of the smaller airways or the respiratory force applied. However such a diver is in no danger of pulmonary barotrauma through small airway closure.<sup>5,6</sup>

Being a ratio it will only identify obstructive airway disease for in severe restrictive airway disease both FEV<sub>1</sub> and FVC are reduced.

The FEV<sub>1</sub>/FVC ratio is not a good predictor of pulmonary barotrauma.<sup>7</sup> To counter these disadvantages the FEV<sub>1</sub> and FVC were also noted as percentages of predicted normals. (With the newer computerised spirometers all the predicted normals are printed out with the results). If a statistical limit of normal to two standard deviations from

the mean is applied, then the lower limit of acceptable lung function would approximate 80% of predicted normal of FEV<sub>1</sub> and FVC.

Of the 11 divers who failed their respiratory function tests with no apparent pathology and were referred to a respiratory physician, some will have normal lungs and simply be in the lower range of normal values. Unfortunately because of the transient nature of the divers having diving medicals in this area no follow up is possible as the majority of these people cancel their dive course and continue their travels.

## CHEST X-RAYS

A chest X-ray was taken if there was a personal history of lung disease, serious lung infection or recurrent lung infections, a family history of tuberculosis, a suspicious occupational history, a history of smoking for ten pack-years or more, a past history of mechanical ventilation of the lungs, any abnormality found on clinical examination of the respiratory system or poor lung function test results.

The need for a routine chest X-ray in sports diving medicals has been debated for years. The argument for taking a chest X-ray in any diver without one of the above indications is to exclude asymptomatic pulmonary cysts, bullae, asymptomatic silicosis and sarcoidosis. The incidence of asymptomatic pulmonary silicosis and sarcoidosis is about 5 per 100,000 of the population.<sup>8,9</sup> A literature search for the incidence of asymptomatic pulmonary cysts was unfruitful. A telephone survey of 20 radiologists concluded it was a very rare finding. Guesses (by radiologists) at the incidence of asymptomatic pulmonary cysts in this age group of population centred around 1 in 10,000. If asymptomatic pulmonary sarcoidosis and silicosis have an incidence of 1 in 20,000 then 3 out of every 20,000 chest X-rays can be expected to show a contraindication to scuba diving. At a cost of \$55 per chest X-ray (AMA rate), which is not claimable under Medicare, the cost of each positive finding would be \$366,666.

It is up to both the diving medical bodies and the diving industry to decide whether routine chest X-rays should be mandatory for all sports diving medicals.

Meanwhile it would seem reasonable practice to offer every potential diver a chest X-ray with an explanation of its advantages and allow the diver to make the choice. (See note in Table 8).

#### ELECTROCARDIOGRAM

Edmonds and Walker<sup>10</sup> showed that cardiac deaths "peaked" in the 45-50 year old age group. A routine resting cardiogram for divers 45 years or older would therefore seem to be a reasonable precaution. Although no unexpected results were found in this series only 25 divers were in the age group at risk.

#### AUDIOGRAM

Although aural barotrauma is by far the most common diving related injury, the incidence of significant hearing loss following such injury is uncertain. It is surprising how many divers with completely occluded external ear canals have no idea that their hearing is diminished until the canal has been cleared. (One hundred and thirty six divers (6.6%) needed their ears to be cleared). Asking the diver whether his hearing is normal is therefore an unreliable method. However, standards set down in AS2299 for professional divers state that anyone with a 35Hz or 50db or more on higher frequencies must be screened by an ENT specialist. It is presently unclear whether these standards should be applied to sports diving and whether routine air conduction audiograms should be performed routinely.

#### PREGNANCY TESTS

It is generally accepted that women be advised not to scuba dive whilst pregnant.<sup>11</sup> Pregnancy was therefore considered a reason to provisionally fail the initial sports diving medical. All female divers should be asked whether a pregnancy was possible. If affirmative than a pregnancy test should be shown to be negative before the diver is passed.

#### Detecting asthma in diving medicals

It would appear that the dive shops screened out many of the asthmatics before the diving medical. The incidence of asthma in the adult population is about 10%.<sup>12</sup> One would therefore expect about 200 asthmatics in this series yet only 83 marked it on their questionnaire. It has become routine to ask every potential diver at the interview if they are asthmatic and many admit that they have a "bit of a wheeze sometimes" or "just a touch of it". Others denied they had asthma but freely admitted using bronchodilator

inhalers.

The importance of good routine respiratory function tests is reinforced by the fact that 7 divers were only shown to be asthmatic by the tests.

Fifty per cent of divers who gave a history of "childhood" asthma were found to still have symptoms, signs or abnormal lung function tests. It is recommended that all divers with such a history be given a histamine provocation test even if they are apparently symptom and sign free. Any doctor performing diving medicals without ready access to a respiratory laboratory is encouraged to set up the equipment and procedure to perform provocation tests.

#### Conclusions

All stages of the diving medical have been shown to be essential.

I recommend modifications to the AS 2299 diving medical questionnaire.

The FEV<sub>1</sub>, FVC and FEV<sub>1</sub>/FVC ratio as percentages of the predicted normal should be calculated and used in the interpretation of respiratory function.

A chest X-ray may not be indicated by all divers as part of their medical.

Twenty three per cent of asthmatics identified during the medical are not identified by the present AS 2299 questionnaire.

Fifty per cent of divers who give a history of "childhood" asthma were found unfit to dive.

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## SPUMS NOTICES

### MINUTES OF THE SPUMS EXECUTIVE MEETING (TELECONFERENCE), April 4th 1991 at 1000 EST

#### Apologies

Dr J. Robinson

#### Present

Drs D Gorman (President), G Barry (Treasurer), J Knight (Editor), .Slark (Past President), D Davies (Education Officer), C Acott, D Wallner and J Williamson.

#### 1 Minutes of the previous meeting

The Minutes, having been circulated, were taken as a true and accurate copy of the previous meeting. Proposed by Dr Davies, seconded by Dr Slark.

#### 2 Business arising from the Minutes

##### 2.1 AGM 1991 MALDIVES

Terry Cummins' presentation at the AGM was raised. It is apparent that some people feel that SPUMS may be aligning itself with PADI rather than all diver instructor organisations. Dr Gorman pointed out that in this context Terry Cummins is representing the National Scuba Qualification Committee and not PADI.

##### 2.2 AGM 1992 PORT DOUGLAS

Dr Williamson reported that the academic program was advancing for this meeting and that a new program was in the hands of the Secretary and Dr Barry. All speakers invited to participate from AIMS have agreed to participate. This undertaking has been given by Michel Pichon.

The dates for this meeting are to be finalised as speakers need to make long term plans. The academic component of the meeting has a very full program and in addition the ANZHMG wishes to make a presentation at the meeting and hold a meeting of that sub-committee.

Dr Barry indicated that with the savings achieved by switching from the Science Centre Foundation to our new secretariat we should be well able to offer each invited speaker (approximately 25 speakers) two nights accommodation and meals. The Committee decided that we will provide two nights accommodation plus meals and that if we get a large attendance at the meeting then we could be in a position to provide a contribution towards speakers' travelling costs as well, bearing in mind most speakers live locally.

Dr Gorman indicated that conversation with Geoff Skinner had indicated that numbers expressing interest in the 1992 meeting far exceed any previous meeting held by SPUMS.