

fact that it is usually the most common barotrauma she decided that she did not want to dive.

### Tricyclic antidepressants

#### Meehan

A 29 year old male Australian electrician was on prothiaden, which is a tricyclic antidepressant, 150 mg at night, to control excessive sweating. He was very conscious of his sweating and did not want to stop the prothiaden but did want to scuba dive. Any comments about scuba diving while taking antidepressants?

#### Gorman

Andy Veale told me about a lady, on monamine oxidase inhibitors, who was on a live-aboard dive charter, ate some cheese and became decerebrate!

#### Bove

Many people take tricyclic antidepressants for a variety of reasons and there is no particular interaction with the diving environment. More important is the underlying process that requires the use of the drug. I have never heard of them being used for excess sweating, but I do not think it would be a problem with diving. The tricyclics sometimes produce premature ventricular contractions. Occasionally I see a patient with extra beats that are not understood, they are induced by the tricyclics. The cure is to get them off the tricyclics or lower the dose.

#### Davies

I think he was on prothiaden not to stop his sweating, but to stop him worrying about his sweating.

### References

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### FITNESS AND THE OLDER DIVER

Sue Paton

with audience participation

### Key Words

Air embolus, cardiac conditions, diving medicals, investigations, medical standards, pulmonary barotrauma.

### Introduction

Paton

During this session we want to formulate some guidelines for assessing fitness to dive in the older diver.

We should also define the age of the “older” diver, but let us begin by assuming they would be fifty plus.

### The diver

Consider the case of a 59 year old retired factory manager seen by you for the first time for a diving medical for recreational scuba certification. Two years ago in Fiji he did a resort dive and is still occasionally snorkelling and surfing. He used to play competitive squash but now his main exercise is walking. He has no allergies, is a non-smoker and takes no medicines. He has had excellent health in the past.

### The medical

On examination there is no abnormality except that he weighs 91 kg. At a height of 174 cm, this gives him a body mass index of 31. His ideal weight would be less than 70 kg. His blood pressure is 140/90 sitting and his resting pulse is 80. He has no difficulty in performing a sharpened Romberg for 70 seconds.

He has an entirely normal resting ECG, performed immediately after a limited step test, up and down for five minutes on a step of 30 cm. His pulse rate is 100 one minute after the step test, at the start of the ECG, and back to his resting pulse rate of 80 at the end, a minute later.

Hold up you hand if you would have failed him?  
(No hands went up)

### Exercise ECG

Unidentified speaker

Any form of exercise resulting in a pulse rate of 80-100 is not exercise. There is a resting ECG and an exercise ECG, what is the point of the in-between ECG? He is overweight. He has worked an executive type job. He has not been active in recent times. I think he should have a stress test.

Paton

According to the current Australian Standard for recreational dive medicals (AS4005.1-1992) there is no requirement at any age for even a resting ECG let alone a stress ECG. Are our guidelines satisfactory?

Bove

As a physician for a 59 year old who has not seen a doctor in a long time, one has other obligations besides just making sure he is fit to dive. I think you need to do rectal and prostate examinations, because two of his high risks are colon cancer and prostate cancer, despite the fact that he came into your office for a diving medical.

Paton

In Australia one would recommend that these tests be done by his own general practitioner, as these have no immediate bearing on his fitness to dive.

Knight

The Standard is a consensus document. We had a lot of difficulty getting the diving instructor organisations to agree to a medical at all. If doctors are going to investigate everybody, so that it appears that doctors are making a fortune from the medical, we will lose the support that we have got to keep the medical in the Standard.

This man did not complain of shortness of breath on exertion and in the Standard the only mention of ECG or exercise ECGs is in reference to there being doubt about the candidate’s cardiac fitness for exercise. One needs some evidence of inability to exercise before being in doubt about the ability to exercise. If being overweight and over 50 was evidence of inability to exercise many people in this room would require an exercise ECG. We have already said that he meets the Standard. That is all that is legally needed for a diving medical in the states of Australia that require a diving medical to be performed to this standard.

I would do a British Army Step Test,<sup>1</sup> stepping, at a rate of 30 times a minute, onto a height of 17 inches (43 cm) for five minutes, then 30 second pulse counts (P1, P2, P3) are taken at 1, 2 and 3 minutes after exercise. To pass the sum of P1, P2 and P3 must total 190 or less (the lower the better). I have done this on every diver I have examined. If they pass I can safely assume that they will tolerate 5 minutes of moderate exercise. If someone developed angina during the test, which never happened in the 20 years I was doing diving medicals, I would have given the patient glyceryl trinitrate sublingually, told him he was not fit to dive and arranged referral. For those who fail the test I recommend a training program before they start their course, during this, if they are going to get symptoms, they get symptoms not sudden death in the water.

The diving doctor should offer advice about how to cope with the common problems of diving, such as ears and mention the need for physical fitness. After that it is up to the patient to get any treatment required from his regular doctor.

Veale

I think the concept of fitness to dive is a nonsense which tends to be thought of as black or white, pass or fail. There are only relative degrees of unfitness and therefore AS4005.1 is a mistake. Our job is to attempt to stratify the risk to the patient so that he or she can make an informed decision. In order do that for this individual, a number of additional investigations are required over and above those in the Standard .

Bove

I think a regular exercise stress test is quite adequate for a man like this with a normal ECG, without hypertrophy or bundle branch block. One can then interpret the stress ECG in a 59 year old as being indicative of ischaemia if it is positive and if it is negative, though it may not rule out coronary disease completely, it will rule out currently critical lesions that would get him into trouble when exercising. If it were strongly positive I would refer him to a cardiologist and let them decide what they wanted to do but I would not let him dive.

Barham

I think one has a duty of care to the patient to explain the risk of diving to the individual and in this case the main problem is going to be one of cardiovascular fitness. I think one should suggest an exercise ECG but if the patient declined and was aware of the risks, I would pass him.

Davis

Unfortunately exercise stress tests are conducted running on a treadmill or pedalling on a bicycle. Some people have no leg strength but they have got upper body strength. They could swim for 10 miles but could not run or cycle 100 m to save their lives.

Paton

Is it not appropriate to test a person's fitness using the intended form of exercise, therefore swimming in the case of diving? Des Gorman talked about fitting the test to the actual task.<sup>2</sup>

Unidentified speaker

I think we are missing the fundamental principle of the exercise stress test. When doing an exercise stress test for cardiac ischaemia, one is looking for an adequate heart rate response. Someone with weak legs will still achieve a diagnostic heart rate response at a lower work load, so one can still make an assessment for the presence or absence of ischaemia. If people have to do a mandatory swim test that is probably a more appropriate work load with which to test them.

Unidentified speaker

It is important to remember that one's  $VO_2$  max on a treadmill or a bicycle ergometer is higher than  $VO_2$  max when swimming. So a stress test on the surface in controlled circumstances is perfectly valid and more sensitive than doing a test in water. It is certainly safer if a myocardial infarct were to occur.

Paton

Hands up those who would pass him now. (Three hands went up)

That is a complete change from your earlier attitude. It seems that people have become aware of the risks of cardiac disease in older and overweight people

## Chest X rays

Paton

Is there any reason for doing a chest X-ray?

Unidentified Speaker

Chest X-ray to assess cardiac size is a waste of time. Some people who have large cardiac silhouettes on X-ray have normal hearts on echocardiography and vice versa. And there can be significant left ventricular hypertrophy despite a normal chest X-ray.

Bove

I would not do a chest X-ray unless there was a history of pulmonary problems such as pneumothorax, recurrent pneumonia or a gunshot wound to the chest. The chest X-ray is too crude to use to assess cardiac size. If there was something not detectable by physical examination which had a high probability of complicating diving, then a chest X-ray would be necessary for all divers. Chest X-rays are not much help because most of the conditions that would complicate diving, without the clue of a positive history, are rare.

Veale

The first chest X-ray I ever did on a diver showed a pulmonary cyst. It totally coloured my practice of medicine for years and I have never found another.

## Other Tests

Paton

Are there any other tests that you would like to do on this individual?

Knight

I would want to see how long he took to swim 200 metres. If he can cope with the swim he will be able to cope with the workload of learning to dive. That is a much more useful test than further medical investigations. In Australia every diving candidate must perform a timed distance swim supervised by a diving instructor. If they achieve this within the required time, they have proved that they can tolerate the physical workload in the course. If they take too long, they should be told that they are not fit enough to manage the course.

Greg Leslie

You could just walk people up steps to make their assessment.

Unidentified speaker

I think it is very relevant that potential divers should be subjected to a test with reference to diving, like swimming. I noticed with some alarm that in December 1994 PADI removed the time factor in the swim test for instructors. This was the main physical test that a

prospective instructor had to do apart from the routine medical.

Richardson

They still have to swim 800 metres in 17 minutes to become a dive master. When they go to instructor qualification they have to complete the distance but the time is not relevant. The 800 metre snorkel swim is to measure stamina but that is done before they go to their instructor development process. Their physical stamina is measured in many different ways as they progress. There is no under performance allowed, some folk use adapted techniques depending on their physical disability but they still have to meet the criteria for timed exercises. Most candidates for the instructor examination have met the criteria recently in their dive master tests as it is common to progress quickly from one to the next. Therefore we already have a record of the fact that they have met that time criterion.

### **Holiday tomorrow**

Paton

Ideally to assess this individual's fitness and safety to dive he should have a stress ECG and his cholesterol measured.

These, however, are beyond the absolute requirement of AS4005.1. If due to the additional cost or time constraints, the individual is reluctant to proceed with your recommendation for these further assessments, is it reasonable to then counsel him about his possible cardiovascular risk, allow him to make an informed decision regarding this risk, and then, if he still wishes, pass him with a strong warning? Take into consideration an additional problem which arises in large metropolitan centres. If someone rejects your advice he can go around the corner, perhaps not in this situation, but in other situations, having learnt from your medical how to present to the next doctor.

Unidentified speaker

We should not sit on the fence. One's duty to the patient is to tell him that he should not dive without an exercise ECG.

John Parker

We see this scenario in North Queensland. Someone who wants to start a diving course tomorrow comes for a diving medical and the pressure is on to say yes or no. I have totally changed my views recently and it is not my problem any more, it is their problem. I do not think we should be intimidated. One has got to keep one's professional standards. One has got to go through the right processes and considerations. One really has to say, "No, you should not dive until these other things are sorted out."

Paton

I agree with what you say. But if you say, "I believe that at 59, overweight with borderline blood pressure, you are potentially at significant cardiovascular risk. You should have these tests done before I can say, from all discernible factors, you are genuinely medically safe to dive." And then he says, "I have already done a resort dive, I was fine. I want to do this. I am the one taking the risk." How does one respond?

Parker

One can sort that out by full discussion. These people have come to me for a medical opinion, so I am not deciding whether they should dive or not. They have come to me to decide if they are medically fit to dive.

### **Physical Fitness**

Coetsee

Are you not confusing physical fitness and abnormalities? Is the diving medical not to detect medical abnormalities and is physical fitness an abnormality? A person can pass a fitness test and a month later be totally unfit again. I think this is a very big problem with divers. They do their course to become fit, they dive properly, they enjoy their dives on that course and then they go home. Six months later they want to dive straight away without getting fit again. Should they then be tested again? I think the physical fitness aspect belongs to the instructors and diving clubs. It would be ideal if SPUMS could introduce some form of physical fitness standard with which people should comply before they dive.

Bove

I do not think that we are arguing about physical fitness, we are arguing about his probability of having significant coronary artery disease which might lead to a tragedy while diving.

Paton

Should we not institute a program of regular check ups for the older diver who is at risk from ischaemic heart disease, advancing years, putting on weight and becoming less aerobically fit?

Unidentified speaker

I wonder how many people in the audience have a body mass index over about 28 and age over about 50 and how many of them have had an exercise stress test.

Leslie

I have a body mass index over 28 and have not had an exercise stress test but I can still run 16 km and swim 3 km.

Paton

In New South Wales there is no requirement for any

training for doctors doing diving medicals. Any doctor should be able to work out a reasonable assessment of someone's cardiovascular fitness but perhaps physicians who are not trained in diving medicine are unaware of the need for sudden exertion when diving. Should the Standard have any firm guidelines to make stress ECGs mandatory after a certain age, as they are for the occupational diver?

Veale

We are in danger of going over the top here. The dive industry is already alienated from doctors. Intending divers, and certainly existing divers, have become deceitful, they conceal things. To have cut offs is totally artificial. Is 39.5 functionally any different from 40.5? We know that a cholesterol of 5.9 is better than one of 6.1 but does it justify vast amounts of screening? The cost per case detected has to be considered. I think that the absolutely critical thing here is that we have divers on our side. Fundamentally, divers are honest and should be just like any other patient. Diving is a action that patients undertake, just like driving a car, so that their family needs to have an awareness of their diving. I do not think that we can take over total responsibility for the diver, I do not think it is practicable. I think it is too expensive and will alienate the dive industry.

## Reality

Unidentified speaker

Could the cardiologists tell us what the chances are of a fat 59 year old, in the normal course of his life, having a fatal accident while he is swimming? Most fat 59 year olds survive to be fat 60 year olds.

Bove

The probability of having significant coronary disease at age 59 is certainly increased and relates to the number of risk factors for the individual. With one risk factor the probability may be 1.2 times the non-risk population. With all the risk factors, hypertension, diabetes, smoking, obesity and hyperlipidaemia, the risk of coronary disease is 5 to 6 times the normal population. The best way to assess a 59 year old is look at their risk factors and tell the individual that because of these he may be between 1.2 and 6 times more likely to have coronary disease than somebody without risk factors. Whether this relates to the risk of sudden death or not, is a different thing because we cannot tell from risk factors whether an individual will have a sudden death while in the water. I would also say that if the same person came to you and said, "Can I play tennis?" you would have to go through the same discussion. One is concerned with sudden death from coronary disease.

Unidentified speaker

I would like to ask our dive organiser what would

you do if this man arrived here to do a diving course which did not require a medical?

Unidentified Instructor

I think people are losing the point. We are talking about sport diving. As instructors we qualify divers but we also recommend limitations. Not every diver would be suitable for every dive. I think the man who does one "Discover Scuba" dive in 6 m of water on a sand bottom, is probably at no more physical risk than if he plays tennis. We certify a lot of people, but our job is not just to certify them, it is also to give them the recommendations about where and what their limitations should be. I think they are looking to your profession for the same advice. If a diver's physical health and fitness may preclude them from diving safely, recommend further action rather than simply telling them not to dive. If someone is going to have a cardiac arrest underwater he might just as easily have it on the tennis court or somewhere else. Perhaps the 6 m swim around dive is going to relax him a lot more than if he gets dragged behind a ski boat. It is all relevant because we are talking about sport diving. I wonder how any people here would be diving if we said that you have to have a medical before you can come diving with us. We have had enough trouble to get liability forms from you. (Applause)

Bove

As a physician I have no coercive powers. All I can do is provide advice to the individual about what is and is not safe. I can tell a late stage diabetic with retinal detachments in one eye and one leg missing and gastroparesis that I think it would be very risky to go diving but I cannot say "You are not allowed to dive". All I can do is provide what I think is reasonable advice based on my assessment whether it is safe to dive or not. If it is not safe to dive what are the alternatives? Can something be fixed after which it will be safe to dive? I would never let somebody dive after a spontaneous pneumothorax, even after they had a pleurectomy. I think it is just too dangerous. That same person can go to another doctor, lie about the spontaneous pneumothorax and get certified and go diving until he gets a pneumothorax. It is different in the military where the military system excludes people who fail the medical from diving. It should be well documented in your records that you have advised the individual that it was not safe or that certain things needed to be done, and in extreme cases have a patient sign the note on the chart stating that he read and understood your advice.

Veale

I think we have created a problem for ourselves by creating a black and white standard. A pass or fail standard. There is no fitness to dive, there is no safe diving. There are relative degrees of everything. This is an informed consent issue. Surely we can talk to patients about their relative risk. The purpose of tests is to help clarify the risks for us, so that we can better present them to the patient, but it still is and should be an informed consent issue.

Tony Slark

We seem to be overwhelmed by the need to assess somebody's fitness to use apparatus underwater. Where there are potential medical disorders that we can assess by age, blood pressure and so on, or there are obvious reasons why somebody is apparently physically unfit, we should advise them to buy a snorkel, fins and a mask with which to enjoy the water sensibly and get fitter and familiar with the marine environment before they advance to using scuba apparatus.

### The decision

Paton

In fact, this man had already been snorkelling with his wife on all their holidays, and while she had no intention to take up diving, he was quite vehement about his desire to dive. Having discussed his risks with him at great length so that he truly understood the risks, I passed him, writing all the warnings on the certificate with my strong recommendation that he must pass the 200 metre swim test in 15 m, to dive only in tropical waters, which was his stated intent, and not to dive in Sydney in winter, in surf or swell, and left him to make his own informed decision.

### The seventh dive

He took the decision to dive and undertook a course in Sydney in summer. He was part of a group of 7, everyone else in the group was younger and probably fitter than him. On the last day of his course he did his 6th dive, (including the resort dive he had done), to 18 m for 23 minutes. On the next dive, which was his final certification dive, he experienced difficulty, as on his previous dives, with buoyancy control, probably because he was wearing 13.5 kg (30 lb) on his weight belt. He had problems descending and ascended briefly before continuing the dive, but then the rest of the dive was uneventful. Towards the end of the dive, one of the other students was low on air, so the group ascended with the instructor, all holding hands, supposedly a very controlled ascent. When they got to the surface they began swimming to shore. After 20 m he complained to his instructor that he was feeling tired. His instructor began to tow him, initially linked arm in arm and then on his back, towing him by his tank valve for another 60 m. The instructor then noticed that he had become unresponsive to conversation although his eyes were open. The instructor found he was pulseless and not breathing and began in-water expired air resuscitation while help was summoned. He was carried the last 20 m to the beach where the paramedics continued the resuscitation attempt. At the nearby hospital he was pronounced dead 1 hour and 52 minutes after he had surfaced from the dive. The Sydney Police Diving Squad examined all the scuba diving equipment and found it in working order.

### The diagnosis

Paton

An infarct is one possible cause of death. What other causes should be considered?

Unidentified speaker

Any illness that effects a diver must be assumed to be diving related until proven otherwise. He had just come to the surface so my diagnosis would be air embolism. Only a post mortem would tell.

Paton

At post mortem there was blood around the nose and the mouth, the ear drums were intact and there was no subcutaneous emphysema. His heart weighed 420 grams. His left ventricle was mildly dilated to 45 mm in diameter. His intraventricular septum and lateral wall were 12 mm in thickness. He had normal valves. Atrial and ventricular septa were intact and there was no scarring. The four major coronary vessels had up to 30% stenosis by atherosclerosis. His upper airways contained blood stained fluid. There were oral bacteria and food particles around the bronchi, prominent pulmonary oedema and intra-alveolar haemorrhage. He had a fatty liver, erosions and congestions of the cardio-oesophageal junction, with two 5 mm long tears in the gastric mucosa and 100 ml of heavily bloodstained fluid in the stomach. His kidneys were normal size with focal segmental scarring and hypertensive vessel changes. Chest X-ray revealed gas in the right ventricle, the arch of the aorta, neck vessels and the pulmonary veins. Opening the scalp under water revealed air in some of the scalp vessels. There was also air in the vessels of the brain and gas in the left ventricle on aspiration. He had small apical bullae but no pneumothorax. The pathologist could not tell exactly where the gas came from.

Bove

Most air emboli have neurological symptoms and unconsciousness but rarely a cardiac arrest. Tom Neuman and I are writing a paper on cardiac arrest in the presence of air embolus. In every case that we have collected there has been a total replacement of the central circulation with air.

Paton

Why did he embolise?

Unidentified speaker

He had a very unsafe profile. We have been told that he had difficulty with buoyancy, that he had 13.5 kg (30 lb) of lead and that he had difficulty descending. I cannot believe that a group of divers all holding hands can control their buoyancy. Each diver needs a free hand to adjust his or her buoyancy compensator. When holding hands it is inevitable that they will make an uncontrolled and possible rapid ascent. It is likely that he held his breath for a moment too long.

## Veale

Alveolar over distension or lung over distension rather than the pressure changes are the likely cause of pulmonary barotrauma. This man may have been a bit panicky, he was certainly breathing at close to TLC (total lung capacity) in order to compensate for his 13.5 kg (30 lb) of lead, so operating in the absolute upper range of his volume compliance curve. That with an uncontrolled ascent and breath hold would have easily caused the air embolus.

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### DIVING MEDICAL CENTRE SCUBA DIVING MEDICAL EXAMINER COURSES

Courses for doctors on diving medicine, sufficient to meet the Queensland Government requirements for recreational scuba diver assessment (AS4005.1). will be held by the Diving Medical Centre in 1997 at:

Bond University,  
Gold Coast, Queensland.  
28th-30th March 1997 (Easter Holidays)

Royal North Shore Hospital,  
Sydney, New South Wales,  
7th-9th June 1997 (Queen's Birthday Long Weekend)

Previous courses have been endorsed by the RACGP (QA&CE) for 3 Cat A CME Points per hour (total 69)

Information and application forms for courses can be obtained from

Dr Bob Thomas  
Diving Medical Centre  
132 Yallambee Road  
Jindalee, Queensland 4047  
Telephone (07) 3376 105  
Fax (07) 3376 1056