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The above is an edited version of the transcript of the recording of Dr Meehan's paper presented in Madang.

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LUNG FUNCTION TESTING TO DETECT ASTHMA IN RECREATIONAL DIVERS

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Key Words

Asthma, exercise, histamine, hypertonic saline, lung function testing, methacholine.

Introduction

Current Australian recommendations suggest that those with active asthma should not dive, nor should those with previous symptoms of asthma and current bronchial hyper-reactivity.[1,2] These recommendations are not universal and a number of countries suggest that individuals with well-controlled asthma may dive. Recently the British Sub-Aqua Club (BSAC) and other organisations have introduced guidelines which allow those with mild and well-controlled asthma to dive, with the intention of monitoring this policy in terms of safety.[3] Undoubtedly, some divers from these countries will be visiting Australasia and will be diving. In addition, many Australian recreational divers have asthma.[4] This paper will briefly discuss some of the issues surrounding asthma and diving, and will summarise the methods of diagnosing current asthma. The issues that give rise to concern have been described in previous issues of this journal and elsewhere are several-fold and can be summarised in terms of:[5-8]

1 the hypothetical increased risk of barotrauma;
2 the risk of salt-water aspiration or nebulisation and subsequent bronchospasm;
3 exercise-induced asthma;
4 poorly controlled asthma leading to difficulties either while submerged, or while swimming at the surface.

The risk of pulmonary barotrauma is considered to be increased in asthma as there is the potential for small airways to be either constricted by smooth muscle over-activity or by mucous plugs. This could occur while at increased barometric pressure and so fail to allow this portion of the lung to equilibrate on ascent, leading to overpressure and pulmonary rupture, with subsequent pneumothorax or pneumomediastinum. The available data in man are very much lacking, despite this making sound physiological sense. Colebatch et al. showed that in those submariners who developed pneumothoraces on ascent, the problem was associated with abnormal elastic properties of the lung, rather than an obstructive pattern in their lung function, although those with frank airway obstruction had been screened out of this group.[9] James Francis reported at the 2001 SPUMS Scientific Meeting, that the data from the Royal Navy would suggest that a restrictive pattern was associated with pneumothoraces, rather than any evidence of obstruction.[10] Also reported at the same meeting were data from our own research in those with a heavy smoking history who underwent hyperbaric oxygen therapy. While the degree of airway obstruction was mild, there was clear evidence of air-trapping at baseline which did not increase after hyperbaric therapy, and the residual volume did not change. The likelihood of air-trapping in association with airway obstruction and hyperbaric conditions remains to be proved.

Salt water aspiration is probably not uncommon in any diving population and regulators may allow a mist of sea-water to be nebulised into the airway. This hypertonic solution could cause airway narrowing in a susceptible individual, particularly those with unstable asthma. It would therefore seem logical that those with a significant response to a challenge of hypertonic saline should at least be aware of the increased risks of diving, if not advised not to dive at all. Again, the data suggesting that this is the correct advice are minimal.

Exercise-induced asthma is associated with airway cooling and drying. Cold dry air is a bronchoprovocant for some asthmatic individuals, and can be associated with exercise-induced asthma. The logical advice again is that if there is evidence of bronchoconstriction during or after strenuous exercise, then diving should be avoided, particularly as the compressed air will be cold and have a low humidity, thus making bronchoconstriction likely. In addition, if a vigorous swim against a strong current is required to return to the surface or to the boat is required, this too may provoke exercise-induced asthma.

An additional, but largely unsubstantiated risk which is oft quoted is that the use of bronchodilators could lead to increased systemic gas emboli.[11] These experiments were performed in dogs which were given aminophylline, and the normal filtering of bubbles by the lung as blood passed through the pulmonary circulation was considered to be reduced. These results have not been demonstrated in man. Thus, in theory, the use of bronchodilators in asthma could be disadvantageous if shown to increase the passage of bubbles into the systemic circulation.

Despite all of these quite cogent reasons why asthma and diving would appear to be a fatal mixture, the data surrounding diving deaths and asthma do not implicate this disease in any large excess of misadventures, despite the fact that in several surveys the prevalence of asthma would appear to be same in divers as in the general population.[3-5,12] Asthmatic subjects are not banned from swimming in the ocean, where one would expect them to inhale hypertonic saline, nor from the swimming pool where they inhale small, but potentially irritating quantities of chlorine gas, and, they are in fact often encouraged to take up this form of exercise. Thus, diving may or may not be a problem for those with asthma, but the current guidelines in Australia make it important to identify those with active disease or airway hyper-responsiveness and to encourage them not to dive.

Diagnosis of Asthma

Various bodies have attempted to define asthma over many years, and with each successive effort the description becomes more convoluted and complex. Objective clinical definitions are easier to use, and generally suggest:

1 a decrease below the predicted value of the forced expiratory volume in the first second (FEV_1) or peak expiratory flow (PEF) with a >20% increase after bronchodilator (200 micrograms salbutamol via a spacer device);
2 20% spontaneous variation in the FEV_1 or PEF during the day, usually the lower value being in the early morning;
3 airway hyper-responsiveness.

A diagnosis of airway hyper-responsiveness is associated with asthma, but can also occur in other syndromes, e.g. after noxious gas inhalation, after viral respiratory tract infection, and in a very small number of people who are otherwise normal. The majority with hyper-responsiveness have asthma. It is important to recognise that the three methods of diagnosing asthma will often be normal if the subject takes regular inhaled glucocorticosteroids, or an adrenergic $beta_2$ agonist prior to the tests.

Which challenge test?

Challenge tests use the principle of the dose response curve to make an arbitrary division between those with and those without hyper-responsiveness. There do not appear to be discrete populations at each end of the dose response range which makes the process of defining hyper-responsiveness arbitrary. Each point is a dose or concentration which is twice that of the last dose or concentration (a "doubling dilution"). A common method is to interpolate between these points to generate the curves as depicted in Figure 1 and then to take a predetermined point, e.g. a 15 or 20% fall in FEV_1, and to calculate the

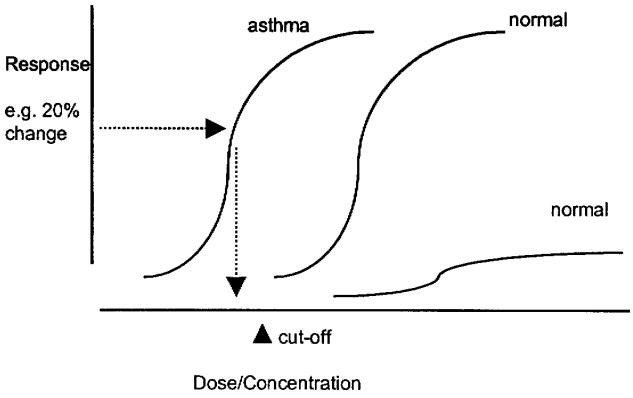

Figure 1. Concentration response curve for airway challenge tests. When an increasing concentration of a bronchoconstrictor is inhaled, there is a progressive fall in FEV_1. The provocative concentration causing a 20% fall in FEV_1 is interpolated from the data (PC_{20} or PD_{20}). Using population data, an arbitrary cut-off point where a 20% fall in FEV_1 occurs can distinguish between hyper-responsive or asthmatic subjects (left) and normal subjects (to the right of the cut-off point).

provocative dose or concentration (PD_{20} or PC_{20}) of drug or stimulus required to cause this response. Cut-off points have been derived from population data to divide the results into normal or hyper-responsive. Hyper-responsiveness appears to be related to airway inflammation, and secondary to this inflammation, mediators are released which may make the airway smooth muscle more excitable or '"twitchy" and thus more likely to constrict when presented with a stimulus.

In European countries and in North America, the most popular tests for hyper-responsiveness are the methacholine and histamine challenges. Each has a direct action upon the airway smooth muscle by activating the muscarinic or histamine receptors respectively to cause bronchoconstriction. Broadly speaking, these tests are similar, although few large-scale comparative studies have been performed in the same individuals. When compared with other challenge tests, these two tests have a higher sensitivity and may therefore have less specificity. In Australia, both methacholine and histamine require a licence from the Therapeutic Goods Administration (Therapeutic Goods Act, Section 19, Subsection 5), and are expensive. Hypertonic saline is recognised to be less sensitive than either of the above methods, but has gained in popularity by virtue of not requiring a licence and by being inexpensive. The mode of action of this test is thought to be by increasing airway osmolarity and hence activation of mast cells, but some subjects will also react to isotonic saline. All three of these tests have a repeatability which is approximately two doubling dilutions. The results for methacholine and for histamine are usually expressed as the provocative concentration/dose to cause a 20% fall in FEV_1, while

hypertonic saline tests are usually considered positive if a 15% fall is achieved.[13]

Exercise testing is often performed in adults in respiratory laboratories, but tends to fulfil the function of trying to distinguish between cardiac and pulmonary causes of breathlessness in older adults. It is designed also to detect exercise-induced asthma, but the details of maximal oxygen uptake (VO_2max) and ECG monitoring are not usually appropriate for young, fit adults. Recommended exercise varies from"6-8 mins of strenuous exercise" to very prescriptive guidelines. Guidelines include target heart rate (210-age), or refer to a predicted power output based on age, sex, weight and height, or a predicted VO_{2max}. The European Respiratory Society and the American Thoracic Society each make suggestions as to how these tests should be carried out for the detection of exercise-induced asthma.[13,14] In brief, these organisations recommend either a treadmill or bicycle ergometer to produce exercise at near-maximal targets for 4-6 minutes. Targets are suggested to be 80-90% of predicted target heart rate (210-age), or 40-60% of maximal minute ventilation (estimated as FEV_1 x 35). The end point for the bicycle ergometer test can be measured in terms of power, when target rate in watts = (53.76 x FEV_1)-11.07. Exercise-induced asthma is precipitated by cold, dry air, and it is important that the subject uses a nose-clip and inhales air which is less than 25° C, and less than 50% humidity. Medical compressed air is suitable for this purpose, but air-conditioned premises will often satisfy these requirements. The end-point is taken as being a 10% fall in FEV_1, although some epidemiological studies use 15%. A fall of 10% is considered significant as most normal subjects bronchodilate on exercise and therefore a fall is thought to represent a greater decrement than is measured by simple FEV_1. The reproducibility appears to be about 12-25% if the test is repeated within one month.[15] BSAC suggests a step test, but this method is not favoured by most respiratory societies.[3]

Comparative Studies

Few studies have considered large numbers of individuals and compared any two tests of bronchial hyper-reactivity, but many small studies exist comparing the response of a small number of asthmatic responses to one challenge test versus another challenge test. In a study of 108 random subjects, 25 had a positive response to methacholine versus 11 for histamine, and of an additonal 95 subjects selected for the symptom of wheeze, the values were 67 and 45 respectively,[16] while others have shown rather poor correlation in smaller studies.[17] Nonetheless, while most research suggests that methacholine is probably more sensitive than histamine as a challenge test, the two tests yield comparable results. In a study of clinically-diagnosed asthmatic subjects, all had achieved a PD_{20} with methacholine, while 84% of these subjects achieved a PD_{20} with hypertonic saline which confirmed an earlier study.[18,19] If wheeze is taken as an indicator of asthma, the sensitivity and specificity of hypertonic saline in the paediatric community was only 47% and 92% respectively, and exercise challenge was 46% and 88%.[20] In a small group of asthmatic subjects, there was little correlation between either hypertonic saline and methacholine or histamine challenges.[17,21] Likewise, a negative result for a methacholine, histamine or hypertonic saline challenge does not preclude exercise-induced asthma.[15,22]

Conclusion

Thus, the challenge tests are not interchangeable, and for the purposes of selecting diving-induced asthma, it would seem appropriate to use an exercise challenge if this is a reported provocant. Hypertonic saline can be used as a general screening tool, as exposure to these exercise or saline is likely to be encountered in diving, and hypertonic saline is less likely to demonstrate a
false positive response, compared to methacholine or histamine. Methacholine or histamine challenges remain the preferred provocants for determining clinical asthma. It should be remembered, however, that an asthmatic subject who is currently taking inhaled bronchodilators or glucocorticosteroids is likely to be unreactive to these challenges and therefore may have a normal response. The use of exercise and hypertonic saline challenges does not require a licence and the equipment for the latter is relatively inexpensive. Few studies have been published in terms of the challenges performed for the purposes of diving medical examinations,[23] and none have reviewed those passed as having normal responsiveness and who have gone on to dive. It remains to be seen whether the rather more stringent restrictions on diving and asthma in Australasia remain unchanged in the face of relatively more permissive attitudes elsewhere.

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DISCUSSION following Meehan and Thomas papers

Mike Bennett, Chairman

I am sitting in the hyperbaric unit with a diving candidate, who gives a history of wheeze and took some Ventolin (salbutamol) 6 or 7 years ago but he thinks he has been OK since then, in front of me. I ring up wanting to do some provocation testing to see whether this person can safely be allowed to do a dive training course. What do you say to me?

Paul Thomas

As a respiratory physician I would say to you that I am happy to organise a provocation test but I do not actually certify divers. That responsibility lies with you.

I think saline is adequate. However I am not very fond of it because it is not very sensitive for the sort of work that I do. My experience with it is that there are some people, who quite clearly have asthma, who do not respond. That may be because some of them have been on treatment. Also one does not really get a very clear response in a large number of patients. In a lot of cases I was not sure whether they had asthma. Probably for divers with a history of wheezing it is probably a quite adequate test. I do not think it is sensible to exclude people because they have a positive methacholine test but no other symptoms.

Debbie Yates, Respiratory physician, Sydney

I probably would use saline simply on the basis that it is not a terribly good test and I think that people with asthma who dive are not at a great risk and therefore if you do a bad test, you will actually let more of them who perhaps should be allowed to dive, dive anyway.

James Francis

Well said. We are starting this discussion from the position that asthma is a risk factor for barotrauma. However there is no good evidence to support that belief.

We have got ourselves into is sort of Catch-22. Many years ago, people thought about the mechanisms of pulmonary barotrauma. They thought airways obstruction was the thing to avoid. They thought that since asthma can obstruct airways it would be best to stop these people diving.

Which is what happened. So no data have been collected on the effect of asthma on diving and the risk of pulmonary barotrauma. Since there is no evidence that asthmatics are fit to dive they are kept out of the water! We know that asthmatic people die in the water. They quite commonly drown, but we do not know about the risk of pulmonary barotrauma in these people. Cathy Meehan's data tell me that all these tests are irrelevant. That is my conclusion.

There was a very good workshop, which David Elliott held before the UHMS meeting in Palm Beach in 1995, in which the entire day was spent discussing asthma and diving. After all the luminaries had given their talks we reached the conclusion that there really is no evidence for asthma being an important risk factor and that what we ought to do is to try to roll back the restrictions that we apply to people diving with reversible airways disease. Perhaps to the point, eventually, where we let them all dive.

The UK approach to asthma and recreational divers, is now to allow well controlled asthmatics to dive and watch carefully to see if they develop pulmonary barotrauma with greater frequency than those who have no apparent manifestations of asthma. These asthmatics are advised to test their peak expiratory flow twice a day and that their peak flow should be within 10% of their best for 48 hours before they go diving. They should not dive if they have required medication for an acute exacerbation in that 48 hours. However this change in the UK is only for sports divers. Asthmatics are still banned from military and commercial diving. If these asthmatics become over represented in the barotrauma statistics it will become apparent that we have gone one step too far and the restrictions will be stiffened again. But at the moment there is no apparent increase in pulmonary barotrauma amongst those asthmatics who are well controlled and are allowed to dive. If this situation persists, the next step will be to assess those who are not quite so well controlled, let them dive and see what happens. I am convinced that this is the correct approach rather than to dream up arbitrary lung function standards that may be completely irrelevant.

Simon Mitchell, Brisbane

Is there any evidence that the diving population in England have more problems with asthmatics than we do in Australia, given that your standards are much more liberal than ours.

James Francis

No. Pulmonary barotrauma in sports divers in the UK is very rare. Even in those who we have allowed to dive with well controlled asthma.

Paul Thomas

That point is borne out by the fact that when one does surveys of Australian divers asthma is just as common as in the ordinary community.[1] A large number of people actually do have asthma and continue to dive with it.

Simon Mitchell

If I interpret Cathy Meehan's data correctly, using Carl's criteria, 46% of them would have been made unfit. The whole group had done 70,000 incident free dives except for 3 cases of DCI, a DCI rate of 0.4 per 10,000 dives. The group of divers who should not have been diving probably did about 35,000 dives. Even if all 3 cases of DCI were in this group the DCI rate would be 0.8 per 10,000 dives.

James Francis

As you have just shown, asthmatics do not appear, on the basis of Cathy's data which included a big group of dives, to be any different from the general population. Actually asthmatics or non-asthmatics is irrelevant because Fred Bove calculated a DCI rate, using reasonable methodology, certainly the best that has been available, in the general diving population of 1 to 2.5 cases per 10,000 dives. So even if all three cases were in the asthmatic group, that is exactly what one would expect in the general population.

Debbie Yates

I think it would be helpful to liaise with the Thoracic Society to develop a unified approach. The Thoracic Society guidelines are less conservative than some of the others. There is a mechanism for publishing joint position papers which would probably have a fairly good effect. It would be one way to set about changing the standards, which I think are probably unreasonable. I say this because in clinical practice, it is much better that people should be on appropriate medication, including inhaled steroids, and dive safely than to hide it, which is what diving asthmatics do.

As there are no good data a prospective study of asthmatics diving, on a multi-centre basis, would not be very expensive and would be worthwhile doing. It would have to be done on a collaborative basis with divers. One might want to use provocation tests in order to properly make a diagnosis of asthma. Such an investigation needs to be done because the data so far are not clear and it does need to have an evidence base to it.

James Francis

That is a good idea but there may be ethical difficulties with a trial like that, given that you have got such very stringent regulations at the moment. Perhaps repeating Cathy's study of current divers lung function with many more divers might get the rules relaxed a bit. Test hundreds or even thousands of divers and the numbers of dives that they have done. If there is a large population of people who would fail provocation tests and they have done many thousands of uneventful dives, that I think is pretty good evidence for amending the current restrictions.

Cathy Meehan

The Australian standard is based on the SPUMS position and the SPUMS position is based on the Australian Thoracic Society position so they are really similar. The

SPUMS dive medical does say that current acute asthma or hyper-responsiveness is an exclusion and then refer on for specialist medical opinion, including provocation testing, which then goes on to the Thoracic Society guidelines.

Debbie Yates

I was suggesting was that SPUMS and the Australian Thoracic Asthma Society could perhaps together produce new guidelines. There is a mechanism for doing that within the Thoracic Society. It would not be difficult to do, and it would probably be extremely helpful and clarify the position. At the moment there seems to be a lot of emphasis on provocation tests which are not very helpful, so it is certainly something which could be very easily facilitated. All that needs to be done is to write to the President of the Thoracic Society and the request will be passed on to our committee. The Australian Standard would then follow on from the SPUMS medical so that could be done and then the Australian Standard would change as well.

Drew Richardson, PADI

Paul Langton's study last year showed that we already teach asthmatics to dive, albeit unknowingly.[2] We certainly do not want to put people in harms way and if the diving medical community feel that prohibiting well controlled asthmatics from diving is an outdated "sacred cow" that now is no longer supportable, then I think we would happily accept such people. There is no inherent barrier to accepting asthmatics. I think it is a medical clearance question which may not be an issue from what we are hearing here.

Cathy Meehan

The SPUMS medical does not state that a person is fit to dive. It says "I can find no conditions which are incompatible with compressed gas, scuba and surface supplied breathing apparatus (SSBA) and or breath-hold diving" and the student accepts the risks of diving which have been explained to him or her, which is informed consent. From being on the Australian Standard Committee for recreational diver training I got the impression that the training agencies felt that a certificate that did not state "this student is fit to dive" puts undue pressure on the dive instructor.

Drew Richardson

We try to keep the dive instructors out of any interpretation of medical standard or patient condition. We do not want them practising medicine. However it is difficult, I appreciate your situation. In 1995 we had a workshop at SPUMS ASM where we came up with some language about, finding no conditions which would render this person incompatible with diving which can mean that there may have been a discussion between the physician and the diving candidate about how to monitor their health situation. James has brought up the change from the UK. The bottom line is from a legal, ethical, approval point of view, we look for the tick at the bottom of the form. If a physician is not willing to do that we would not be comfortable accepting them. So you may be able to advise that patient on how they might monitor their health condition and still feel comfortable ticking approval. However if there is anything that conditions approval for an asthmatic to dive we would advise our instructors to not accept that certificate. There has got to be a medical yes or a no in this type of situation from our point of view.

Simon Mitchell

I have been using the SPUMS medical certificates for years which employ the kind of language that Drew was just describing and I have never had a problem with them being accepted by diving instructors. We have all tried to avoid making a clear cut statement of fit or unfit to dive because we all agree that it is nonsensical to say fit or unfit. But I have certainly used statements like, I can find no conditions that are incompatible with diving.

That middle ground suits our desire not to make a blanket statement of fitness but it also seems to meet the diving instructors requirement for an indication from a physician that this person is able to go diving. I think that's the middle ground that we have struck and it seems to work.

Mike Bennett

This brings up the question of ethics. As I understand it, Cathy, you measured the bronchial responsiveness in a group of commercial divers. I think that you implied that at least some of them would be defined as asthmatic and therefore unfit to fulfil their occupation. Were there any ethical problems raised?

Cathy Meehan

To correct your assumption, the divers were not all occupational divers. They were all volunteers and some were recreational, some were occupational. The agreement with the volunteers before the trial was that the results would be kept confidential because the occupational divers would need to be protected. It was passed by the Ethics Committee.

Mike Bennett

Does anybody have a comment about that?

James Francis

One must have to have a confidentiality clause in a protocol like that otherwise, quite simply, there would be no volunteers.

Mike Bennett

Does anyone have an ethical problem when you are now in possession of new knowledge which would clearly disqualify someone from their occupation?

It is only a problem if you believe that asthma is a danger to divers. James is someone who does not believe it. Is there someone in the room who believes asthma is a risk? Because if there is not then we have no ethical conflict.

Guy Williams

Would it be in the diving community's best interests if SPUMS and the Australian Thoracic Society got together at a not too future date and perhaps had a meeting where this was discussed to come up with a consensus statement?

Robyn Walker

I would not encourage an acute asthmatic, or someone who has highly variable asthma, to dive. But there are circumstances when people who have well controlled asthma, at that particular time, might be fit to go diving.

We have no data on the population of asthmatics who might have gone diving and who have stopped diving because they got into trouble or they did not feel comfortable in the water. Not necessarily had pulmonary barotrauma or decompression illness, but needed assistance from a buddy or to get back to the boat.

I do not believe that all asthmatics should go diving. We need to be careful how we approach a relaxation of the rules banning asthmatics from diving. Although there is not a lot of data to support it, that does not mean that there is no problem. We just need to be careful.

Barbara Trytko

I know that everyone keeps saying the risk to the diver of asthma is theoretical, but if an asthmatic develops bronchoconstriction at 20 m the consequences could be disastrous. The fact that we do not have a huge number of asthmatics who end up with barotrauma or CAGE does not mean that it is not going to happen. It just means that it is uncommon or even rare.

John Knight, Melbourne

The only evidence we have got of deaths associated with asthma in Australia point to the fact that they do not die from pulmonary barotrauma, they die on the surface from being unable to keep their heads out of the water. They get short of breath and drown.

Debbie Yates

I do not think anybody would want to send an uncontrolled asthmatic diving. There are fairly good data that demonstrate that using inhaled corticosteroids does not only alter the methacholine broncho hyper-responsiveness, but also the shape of the dose response curve. So those on inhaled steroids are actually much less likely to undergo catastrophic bronchoconstriction, at least as far as we know because we tend not to do too many dose response curves on these people.

It is really important that we do examine asthmatics properly and we do not just look at the asthmatics who do dive, because there are problems with bias and so on. We need to do a proper cross-sectional study. That is not too difficult to do because, if we liaise with the Thoracic Society, there are a number of epidemiological studies being done. It is very easy to pull out people from the larger studies where we have the data already. I think that would be really useful.

I totally understand that it takes years to go through the process of changing things and caution should always be exercised. But we should have open minds as we know that things have changed in the UK and that is probably the sort of direction we should be going because of the fact that inhaled corticosteroids are actually very useful.

James Francis

For some reason I get the feeling that people think I would let all asthmatics go diving. At no point have I said that and I do not think anybody in the room has said that.

I am a sceptic and I do not believe that asthma is a very serious risk factor for pulmonary barotrauma.

Certainly, if somebody has got an acute attack I think it is very likely they will be at an increased risk of barotrauma. What one then has to think about is the rate of ascent. If there is a very controlled rate of ascent, even though they have narrowed airways, they should get away with it. Their peak flow is going to be down but they should be able to blow out enough air to get safely to the surface. The one situation where they might be at serious risk of barotrauma is having a mucus-plugged airway with gas trapped behind it.

More importantly, somebody with acute asthma should not be paddling in the water, let alone diving.

Cathy Meehan

We have to be very careful about interpreting my presentation, with the 70,000 dives because we have to consider that these divers have naturally selected themselves. The ones that had bad experiences have stopped diving or died. And so we are looking a naturally selected group.

There are triggers in the diving environment and even though these divers did not develop barotrauma other divers have drowned on the surface or not been able to get back to the boat.

James Francis

What we do have is evidence that there is a group of people, who would be diagnosed as asthmatic if they went to a doctor today and got tested appropriately, who have made many thousands of dives uneventfully. That at least should put a question mark in your mind as to whether or not asthma is a disqualifying condition.

Simon Mitchell

Like James, I am not saying that we should let all asthmatics go diving. There is a big difference between my practice and what is said in the Thoracic Society guidelines, no wheeze for 5 years. I let a lot of people who have wheezed within 5 years go diving, but only after the application of a

fairly stringent protocol of assessment and education. And I document it.

I would like to see the Thoracic Society guidelines move to a system of a little bit more like that, in recognition of what James and Cathy have pointed out.

But no one is saying "Let's let all asthmatics go diving". Definitely not. It is really important we understand that.

Robyn Walker

We have to be careful that people reading about asthmatics and diving do not get the impression that diving is for every asthmatic. It is not. It is only for those who are at no greater risk than the general population.

I do not believe any of us rigidly follow the guidelines but we interpret them according to our own experience and the patient's background. Twenty years ago we did not have the data on inhaled steroids which we do have today. And we do need to move on, but I feel the need to caution doctors, who may not do diving medicals very often, that not every asthmatic can dive safely. We need to be very careful in how we document our position.

Drew Richardson

PADI will still be sending divers to you, even when they utilise the RSTC form, as asthma is still screened, so affected divers are going to be ticking it and looking for advice. Perhaps what Simon has just put forward is the best approach to come up with: advice to provide to clinicians around the world who have to review prospective divers who have ticked in the yes column that they have a history of, or presently are suffering from, wheezing or asthma.

Mike Bennett

Points well made. Can we resolve then from this discussion that at some level SPUMS and the Australian Thoracic Society will investigate a joint and possibly modified position?

References

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ARTICLES OF INTEREST REPRINTED FROM OTHER JOURNALS

MECHANISMS OF DECOMPRESSION ILLNESS III

Bill Hamilton

Key Words

Barotrauma, cardiovascular, cerebral arterial gas embolism, decompression illness, equipment, physiology, reprinted.

Organised and chaired by James Francis, this series of popular one day precourses originally created by David Elliott and now being ably continued on this topic by James Francis, examines decompression disorders in a comprehensive way. One objective is to show what is not known as well as what is. Although intensive discussion was encouraged and did indeed occur, Dr Francis makes the point that these are not workshops, and there is no attempt to reach consensus on complex issues. This year's program collected topics not yet covered, mainly limb and skin bends, cardiopulmonary disorders, spinal DCI, and ear barotrauma.

Simon Mitchell of Brisbane summarised the status of the search for the mechanism of pain in joint bends. He offered several hypotheses, including gas formation in the joint itself, gas in the bone marrow cavity, venous sinusoids, or under the periosteum autochthonous bubbles in pain-sensitive tissues like tendons and ligaments; a central location from which pain is referred to the joint; or the relief of inflammatory substances. The latter may explain the resistance of some cases to recompression and the tendency of some pain to migrate; bone medullary gas is consistent with the characteristic of deep and poorly localised pain.

Tom Buttolph of NMRC told about the various forms of skin bends, spanning the familiar itching and rash due to inert gas bubbles and related to skin blood flow, to cutis marmorata, the potentially more serious marbling type of lesion which may be neurogenic and related to neurological decompression sickness. He mentioned also the distinctive white lesions seen in counter diffusion situations. The final common pathway of skin rash and itching may be histamine release.

Alf Brubakk of Trondheim covered cardiopulmonary decompression illness, the most prominent form of which is the always-serious chokes, due to bubbles lodging in the lung vasculature. These bubbles cause endothelial damage. The lungs are also a site of long-term effects of diving such as reduced CO diffusivity; these effects may also be due to oxygen exposure. Some pulmonary artery bubbles (VGE) are present after most decompressions, but lung symptoms, although rare, are statistically related to DCI. In a slide