kg/min. This sort of person was able to cover only 1.14 miles in 12 minutes. The superior group had a consumption of over 48 ml/kg/min and was able to cover 1.66 miles in 12 minutes.

Similar tables exist for swimming. Thus it is relatively easy to design a simple test to assess the aerobic fitness of a person. A good case can be made for a certain minimum fitness level for diving.

The present levels necessary for certification seem somewhat inadequate. Reasons for insisting on a certain minimal level of fitness are fairly obvious. It improves the diver's safety and also enjoyment.

Incidents can and do occur while diving, requiring a reasonable degree of fitness to overcome them satisfactorily. This is certainly most important in the inexperienced diver and this is the person who will usually be undergoing testing for certification. A more experienced diver can often weather the storm with less expenditure of energy. Obvious examples are currents, loss of way, surfacing a fair distance from shore or boat or encounters with unfriendly ocean inhabitants. Or helping a stranded buddy, etc.

A fit person can enjoy a better dive and is certainly more psychologically prepared for any misadventure which may occur.

I would not be so bold as to suggest which level of fitness one should consider for safe diving certification but I feel that with discussion from the audience that some basic ideas may be formulated.

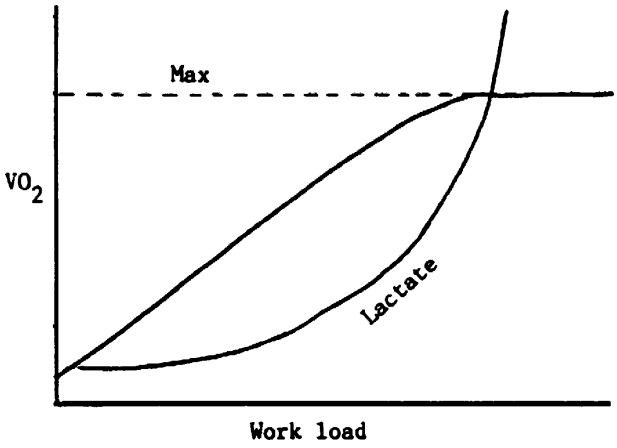
BASIC EXERCISE PHYSIOLOGY

Fred Bove

The state of exercise can best be defined by the whole body oxygen consumption (VO_2). Normal resting VO_2 is about 3.5 ml O_2/kg/min, and during exercise it can rise to 76 ml O_2/kg/min in well trained athletes. If a person is tested with a steadily increasing work load, one finds that VO_2 rises lineally with work load to a maximum (VO_2 max). At VO_2 max, although work load may be increased, no further increment in VO_2 occurs, so anaerobic metabolism in the skeletal muscles becomes dominant, and fatigue develops within minutes.

Figure one demonstrates these relationships. As a person approaches VO_2 maximum, work load becomes greater, dyspnoea is present and a state of generalized discomfort develops. Because of rapid lactate production at or near VO_2 maximum, a metabolic acidosis also develops, and causes further hyperventilation as well as muscle fatigue due to a marked lowering of the local pH in the muscles. Normally, an individual can exercise comfortably up to 50% of VO_2 maximum, and no lactate buildup in blood or

FIGURE 1



muscle will occur. Beyond 50% of maximum, blood lactate will rise to a new steady state, and as VO_2 maximum is approached, the lactate rise is continuous.

If one wished to measure a diver's capacity for exercise, measuring VO2 maximum would provide the most accurate assessment of physical capacity. However, since VO_2 maximum is somewhat difficult to measure, various methods for assessing its value indirectly have been devised. A good alternative to direct measurement is to measure heart rate in a standard protocol. Since for most people, VO_2 and work load are tightly related, VO_2 can be estimated for a standard treadmill work load, and attainment of maximum VO_2 can be assessed by heart rate criteria. For a sport diver to function well in diving, which may include some occasional heavy exercise needed for emergencies, a capability of working at ten times the resting VO2 should be possible. If we want the diver to use ten times basal oxygen for some time, then his maximum should be about fourteen times basal. We refer to these multiples of basal VO_2 as mets. Our sport diver should be able to sustain 10 mets for a brief (four to five minute periods without becoming incapacitated by acute fatigue). His or her maximum should be about fourteen mets. Note that based on body weight, the female sport diver should end up with about the same relative capacity. Male divers will have greater VO_2 values because of greater body weight. If you are concerned about a diver's physical capacity, a treadmill test should demonstrate that the diver can sustain 10 mets of work for 4-5 minutes comfortably, and the heart rate should be about 70% of maximal. If a diver cannot perform at this level, a conditioning programme should be suggested.

It is a simple matter to understand exercise capacity from the above principle. Next, we must discuss variations in VO_2 maximum since work capacity is determined by this value. VO_2 maximum varies with age, sex and state of health. It peaks between 25 and 30, then declines thereafter at a rate dependant on the amount of physical activity. Males generally have higher VO_2 maximum, but much of the difference is due to body size and proportion of adipose

tissue. With the proliferation of excellent women athletes, the differences in VO_2 maximum, when normalized for body weight and lean muscle mass, are not as disparate as once thought. Illness which compromises lung, blood or heart performance limits VO_2 maximum also. Thus a diver with chronic lung or heart disease, anaemia, or abnormal haemoglobin will have a reduced exercise capacity. Finally, the state of physical activity is important. Inactivity reduces VO2 maximum (poor conditioning). The training programmes of athletes are based on this concept.

Many of the problems in divers which require judgement on ability to dive, involve questions on physical capacity. The above guidelines can be used for this purpose, while also taking into account the skills needed to be a successful diver.

Beyond physical capacity lies the problems of sudden incapacitation by illness, inability to learn the necessary diving skills, and the psychological aspects of diver selection. All these aspects must be considered when evaluating a person for diving.

Dr Bove kindly provided this precis of his lecture. Unfortunately, it is but a pale shadow of the brilliance and erudition of his oral presentation.

Question:

In working out maximum oxygen uptake is it better to measure it using a bicycle ergometer or a treadmill?

Dr Fred Bove

Both instruments have been used enough so that we can get a pretty good idea of maximum oxygen uptake from either. The individual who is being studied can affect the treadmill more than the bicycle. If you get a very large or obese person on a treadmill then you have to allow for their weight, because there is some energy consumed in lifting weight as you step on a treadmill.

The advantage of the bicycle is that the subject stays a little more stationary. If you want to do blood studies, it is easier to put an intravenous line in the subject's arm on a bicycle and sample from it, than on a treadmill.

You can get good data from either method. The treadmill is used a lot in cardiovascular clinical studies, where you are just measuring heart rate.

Question:

I was just wondering about the blood pressure reducing effects of exercise. Blood pressure goes down with weight reduction, would that explain the effect of exercise?

Dr Fred Bove

The blood pressure lowering effect is not due to weight loss. If the person loses weight during training you may see more. But you can get the blood pressure lowering factor by exercise without having significant reduction in weight.

Question: Dr Chris Lourey

Some years ago there were some telemetry studies done with athletes exercising on land and in water. On land they showed the two normal pressure responses, a rise in the systolic and a fall in the diastolic. But when they were exercised in water they showed an elevation of the diastolic. In sports divers with occult heart disease or hypertension or a high systolic, a rise in diastolic could be a cardiac stress. Would you like to comment?

Dr Fred Bove

I am not familiar with that study. I think you should tell an individual who wishes to get into a diving programme and who is grossly unfit for diving, requiring treatment for hypertension or weight reduction, or perhaps just is in poor physical condition, to forget about this year's diving course and to get in shape and come back for next year's diving course. I think if you can convince that person to get into condition, you will see an overall improvement in the cardiovascular response to exercise, including a lessened heart rate response, less dyspnoea with stress, and such like. My experience is that if you get a person fit, he can go diving better.

The premise that I would take is that if you get the individual into better shape, you will find that he will make a better diver, that he can handle the exercise load better. Fit people have a better overall cardiac response to diving as well as to exercise on land. I do not know the answer to your question as to whether they have an increased diastolic compared with on land. But generally you will find the diver improves with fitness and can handle diving better if you get him trained.

Question:

How do you train a sport diver to maximise his oxygen consumption?

Dr Fred Bove

I do not think that you need to try to make a sport diver into a world class athlete in order to make him dive well. The great majority of candidates for sport diving are average. That is, they are not well conditioned. If they have to do a long surface swim with equipment on against a current, it will be an overstress situation.

We should train the diver to be able to handle the average situation that he could come up against in sport diving. Not make him into a world class diver or champion swimmer

or runner. So we do not have to try and train the sport diver to run twelve miles a day, or to swim three miles a day.

We would like to generate a moderate programme of exercise which can train that sport diver to be able to handle the stresses that he will experience in diving. We are aiming to make a person fit enough to dive. He does not have to become an expert athlete.

A study was done by NASA. They put trained and sedentary people to bed, which degraded their performance, then gave them all a training programme. The trained persons went back to their previous performance while the sedentary improved on theirs but not up to the level of the trained group. The trained persons had more or less achieved what they could achieve from training. So if you de-train them and then re-train them they will go back to where they were. The maximum oxygen consumption can not be improved ad infinitum in the fully trained person. In other words there is a limit to what you can gain from training. The trained individuals when de-trained and re-trained got back to what they could achieve before. The untrained or average individuals improved beyond their previous condition but not to the same level. This was interpreted as saying that the individuals who were in average condition were not able to improve to the point that the other individuals had reached. In other words there was an inherent difference or inborn difference between the different individuals. It is also possible that the sedentary individuals, if they had had a longer training programme, could have achieved more.

If you give everyone the same training programme, you are going to have individuals who come out with a much higher maximum oxygen consumption because they have got soma inbuilt advantage, which we do not clearly understand. There will be some people who train and end up with a higher maximum oxygen consumption and better aerobics than other persons who are given the same training programme.

What I am saying is that there are inherited differences among individuals, and if you give everyone the same training programme, you are going to have a spectrum of responses.

Question: Bob Halstead

I want to comment from the instructor's point of view. I find that the very fittest people on diving courses tend to be the worst divers at the end of the course. The reason is that they tend to have inappropriate behaviour in the water, deliberately swimming against the current and so on. This would appear to be a psychological attitude that they are fit and can do anything. Whereas the lees fit person behaves in a different fashion.

Dr Fred Bove

Fitness means different things. I see people who say that they are fit. A twenty-five year old who has been working at weight lifting is all solid muscle, and he says that he is fit. That person is really not fit for diving. He needs endurance rather than strong musculature. If somebody says they are fit, and they have arms the size of your thighs, that person is not really fit for diving, that person is trained the wrong way for diving. It is not going to help him at all, in fact it is going to give him trouble. The other extreme is the long distance runner who says "I can do anything because I run fifty miles a day". You are then going to run into the same problem. That person may only weigh 110 lbs and when you put the tank on his back he falls down and can not get up again. His arms are about the size of your little finger. They are the two extremes. I think that the two extremes are not fit for diving. What we are trying to do is to get the average person, who is not trained at all, not physically conditioned at all, to get into some degree of physical condition so that he can handle the normal exercise that is needed for diving. At the same time you have got to get his mind into the right shape too. Physical condition is one thing, train him for that, but also train him to not overestimate his capacities, because they are different. We should train both the body and the mind at the same time, as they are two different things.

TWO CASES OF NECROTISING FASCITIS

Peter McCartney

Mr TW was a 58 year old plant operator at a paper mill who had had no previous ill health other than five years of occasional arthritis.

History

Rigors and 'flu for eight days. Constipation for seven days. Jaundice and dark urine with pain and swelling in both buttocks for five days.
Three days previously admitted to New Norfolk Hospital as ? hepatitis and treated with IM penicillin 1.5 mega units BD.

Admission Findings

Septicaemic (38^{5}) dehydrated, jaundiced, tender hepatomegly, massive induration of both buttocks.

Investigations

WCC 33,000	)
Bilirubin	)
Urea and creatinine	) raised x 3
Al Phos 305	)

Ultra Sound = gall stones, ducts not dilated, therefore cholangitis unlikely to be cause of septicaemea.

Management

IV fluids, central venous pressure line catheterised, antibiotics - Gentamycin and metronidozole.