is no more than that at this stage, would be that the State may be liable to pay compensation to abalone divers suffering avascular necrosis because:-

(a) The Government is aware of the risk to professional divers because of its regulation of the salvage and construction divers and making those divers comply with the Australian standards.

(b) The State Government assumes some responsibility for regulating the industry and providing licences. So it could be argued it is therefore under a duty of care to advise divers of the risks and to insist on proper instruction and training and safe working methods. It could be argued that the Government's failure to do so is negligence, assuming that avascular necrosis is caused by unsafe working methods.

This is similar to the arguments used against the Tobacco Industry by smokers who have contracted cancer.

Problems for Medical Advisers

Lastly, I wish to make some comment on the difficulties for the medical adviser in making the diagnosis of avascular necrosis from the legal point of view.

At the stage of obvious x-ray damage, the option for treatment and prognosis are fairly straight forward.

However, if the diagnosis is uncertain and the evidence can only be seen on, say, bone scans, what are the duties of the medical adviser in advising her or his patient?

If he says "You may have avascular necrosis so do not dive again" then the consequences for the patient may be disastrous. The diver may have to give up a very lucrative profession and suffer financial hardship when in fact his condition may not proceed to serious avascular necrosis.

However, on the other hand, if the medical adviser says "There is a risk that this shadow we can see on the bone scan could be bone necrosis but we can not really say and given there are no other signs you can continue diving" (and there could be a lot of pressure from the patient to continue to dive because of the financial rewards). Then if the patient goes on to develop serious bone necrosis, what is the medical adviser's position?

The test at law is, (though it is under some pressure over the last few years to be changed), "a doctor is not guilty of negligence if he has acted in accordance with a practice accepted as proper by a responsible body of medical men".

So if the medical adviser discloses the uncertainties of the diagnosis and the risks of future damage then he should not be at risk to any claim of negligence.

As medical science advances the problem of diagnosis should become easier for medical advisers.

This paper was presented at the Hyperbaric and Diving Medicine Meeting held at the Royal Hobart Hospital on *November 4th, 5th and 6th 1988. The conference was co-sponsored by SPUMS and the Royal Hobart Hospital.*

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DIVER RETRIEVAL IN TASMANIA

Mike Martyn

Introduction

Tasmania, being an island state, has a large per capita diving population. Diving occurs both commercially and for sport. A hyperbaric facility exists in Hobart and over the years has developed a system for early notification and retrieval of diving medical emergencies. This paper discusses the diving population, the initial contact and notification guide, retrieval options and finally some of the problems.

There are two main groups, commercial divers and sports divers. (See Table 1) Commercial divers can be subdivided into three sub groups. There are some 20 standard work divers. The actual number varies depending on what jobs are around at the time. They have certainly caused some problems with three cases of decompression sickness from the Bowen Bridge building site and more recently the death of a diver from air embolism whilst working on a pipeline at Burnie. There are 125 abalone divers licensed by the Department of Sea Fisheries in Tasmania. One can presume that the majority of these are active although some do sell a part of their licence. The Fisheries also has given out some 300 other commercial diving fish licences, which are specifically for sea urchins and periwinkles. A lot of these are being bought on speculation. There are probably only about 30 to 50 that are actually actively worked. There are also people diving for the aquaculture industry, farming salmon, but most of these are in fact sports divers earning some additional money.

Estimating the number of sports divers is a little more difficult. In 1987 Fisheries sold 3,188 non commercial licences for divers to collect abalone and crayfish. A small percentage will be solely snorkellers. There is also a large number of divers who actually do not possess a licence for a variety of reasons. There are two groups of sport divers. Scuba tank divers of whom most are certified and hookah divers who have generally not undergone certified instruction. Currently there are about 400 people a year certified in scuba diving in Tasmania. It is estimated that there is probably about a 70% to 80% drop out rate. On average there are about 50 tank fills a day in Tasmania. The number of hookah divers is estimated at anywhere between 1,000 and 4,000. The number of hookah units sold or built in Tasmania is around 2,000 to 3,000 in number. So overall, there would be about 2,000 active scuba tank divers and about 1,500 active hookah divers. Active means diving more than the standard three days a year. This equates to nearly 1% of the total Tasmanian population being active divers. A figure of 2.5% of the Australian population having diving certificates is quoted but only a fraction of these would be active divers.

Table 1
TASMANIAN DIVING POPULATION

Commercial Divers	
Work divers	20
Abalone (125)	125
Other Fish (300)	50
Sport Divers (3188)	
Scuba Tank	2,000
Hookah	1,500
Dive Days per Year	
Commercial	10,000
Sports Divers	20,000

Decompression Sickness Rate

These population figures allow for estimates of diving activity and determination of bend rate and mortality. The abalone divers probably dive about 100 days a year accounting for about 10,000 dive days per year. Fisheries estimates for 1983 are 58,000 hours under the water for abalone divers. Assuming an average of five to six hours underwater per day per diver equates well with the estimate of a total of 10,000 days of diving. Other commercial divers would add little to this figure. Assuming five days a year per average sports diver gives some 20,000 dive days total for this group. In Tasmania there has been on average five cases of decompression sickness (DCS) treated each year. There has been only one case of air embolism in the last six years. So about five cases of DCS per 30,000 dives, or five per 3,500 divers per year.

There is obviously an unknown number of DCS cases that are self treated with aspirin, alcohol and other drugs. To date the majority of the DCS has been from the Abalone diver group although over the last two years there has been an increasing number of sports divers visiting the hyperbaric chamber.

Mortality

There has been a fairly constant one death of a diver in the water every two years over the last eight years. That is half per 30,000 days diving or half per 3,500 divers per year. Monaghan's article in the SPUMS Journal[1] estimated the United States diving deaths as one in 95,000 dives or 16 per 100,000 divers. Although small the above Tasmanian figures equate to about one in 60,000 days diving or about 14 per 100,000 divers per year. The mortality in relation to motor vehicles in Australia is 18 deaths per 100,000 motor vehicles per year.

Initial contact and notification

Before 1986 divers often suddenly appeared at the hospital door asking for treatment. This was not an ideal situation. In February 1986 an initial contact and notification guide was worked out with the various retrieval services. This came out as a one page flow chart that was distributed to all medical practitioners, dive operators, hospitals and the abalone divers. Initial contact is through the Tasmanian Ambulance Service via their regional controllers. There are three ambulance regions in Tasmania. They are easily accessible through the '000' emergency toll free telephone number or via radio networks. After recognising the call as a "medical diving emergency" the ambulance controller follows a written protocol. He collects relevant essential information from the caller including location, method of return contact, how many people are involved, their current condition, history of the problem, diving profile, medical history, medical equipment and personnel availability. He gives first aid advice, initiates the retrieval process and contacts the diving medical officer (DMO) who is on 24 hour call via the Royal Hobart Hospital switchboard. The DMO gives further advice on first aid and may contact the dive site. He also advises regarding the appropriate method of retrieval and organises early notification of chamber personnel. This system has streamlined the operation and has generally minimised delays preceding recompression.

Retrieval

Retrieval has improved. The standard retrieval methods of boat, road, helicopter, pressurised plane or portable chamber are available. Boat is usually only used as the initial back to shore transport which occasionally is in

fact direct to Hobart.

The road transport is run by the Tasmanian Ambulance Service in the main regions and by St. John Ambulance volunteers in outlying areas. They are fairly well equipped including the ability to give 100% oxygen using a closed circuit system with carbon dioxide absorption. The main limitation regarding road transport into Hobart is the height of the surrounding hills. To the east Black Charlie's Opening is 336 metres. Coming down the Midlands Highway, Prince's Hill is about 440 metres and from the south, Vince's Saddle is just under 400 metres. Patients who have been brought down by road from Bicheno, where there is an increasing sports diving accident rate, have all said the pain increased in the hills despite being on oxygen.

Helicopter usage is also fairly restricted. There is a single engine Squirrel that is contracted by the Tasmanian Police. It is based in Hobart but may be working anywhere in the state. It is restricted by a single engine to good visibility and to non-night flying. It has certainly been useful in picking up patients from more remote areas in the south where there are no roads or airfields. It has its drawbacks. It is small and cramped and it is difficult to fit a stretcher in and maintain a head down position. However it can provide a speedy retrieval. In one instance an abalone diver with a severe spinal bend was brought from Port Arthur to Hobart fairly quickly.

The fixed wing transport is by small twin engined planes run by Airlines of Tasmania. They are contracted to provide a pressurised and a non-pressurised plane as air ambulance. The pressurised one is a Piper Mojave which is set up to have one stretcher and two seats but can have a second stretcher fitted. Again it is cramped and there are problems with the maintenance of a head down position. The non-pressurised plane is a Chieftain of about the same size. The limitations with fixed wing transport are the condition and location of the various airfields (Table 2). For night use some airfields require local people placing flare pots out to mark the runway. Other airfields such as Swansea and Bruny Island are only suitable at ideal times; i.e. if the pilot can see well, the nettles are not too high, the cows have been herded off and it is not too wet. The distribution of the airfields is quite a limitation. Between Hobart and St. Helens there is an area of popular diving coastline remote from an airfield. In particular Bicheno has been causing some problems with deep sports diving but luckily a coastal road has now been opened up to St. Helens. On the north coast there are Launceston, Wynyard and Smithton but then a large gap on the west coast until Strahan. Abalone diving is popular on the remote west coast and retrieval is difficult. From the north of the state and the Bass Strait Islands retrieval to Melbourne may be more appropriate.

There is no portable chamber in Tasmania and there does not seem to be any great need for one locally as there are only five to six DCS cases a year. Also there is no mating flange on the current Hobart chamber, which means that patients in portable chambers cannot be decanted into the Hobart Chamber. There was an excellent service provided by the National Safety Council of Australia (Victorian Division)(NSCA) from the mainland. This had been used

DIVING MEDICAL EMERGENCIES
IN
TASMANIA

INITIAL CONTACT AND NOTIFICATION GUIDE

IF ACCIDENT OCCURS

GIVE IMMEDIATE FIRST AID AS REQUIRED
(e.g., C.P.R., 100% Oxygen, etc.)

PREVENT FURTHER INJURIES

COLLECT ESSENTIAL INFORMATION

1 Exact location
2 Means of return contact
3 Number of Patients
4 Conscious state
5 Obvious major injury or problem
6 Progressive state of patient(s)
(e.g., stable, getting worse, better)
7 Brief diving history of incident
8 Medical equipment on site (e.g. oxygen)
9 Medical training of people on site

ALSO record details of:

* Full diving history for last 48 hours
* Patient(s) previous medical history
* Time course of events
(problem, treatment and response)

NOTIFY TASMANIAN AMBULANCE SERVICE
(via phone; dial '000' or via radio network)

state: "THIS IS A DIVING MEDICAL EMERGENCY CALL"

FOLLOW INSTRUCTIONS

The Ambulance Service will ask the above essential information, contact the Diving Medical Officer on call at the Royal Hobart Hospital, and organise appropriate transport. The Diving Medical Officer may need to establish direct contact.

Figure 1. The above is a reprint of the leaflet issued to divers on how to handle diving emergencies

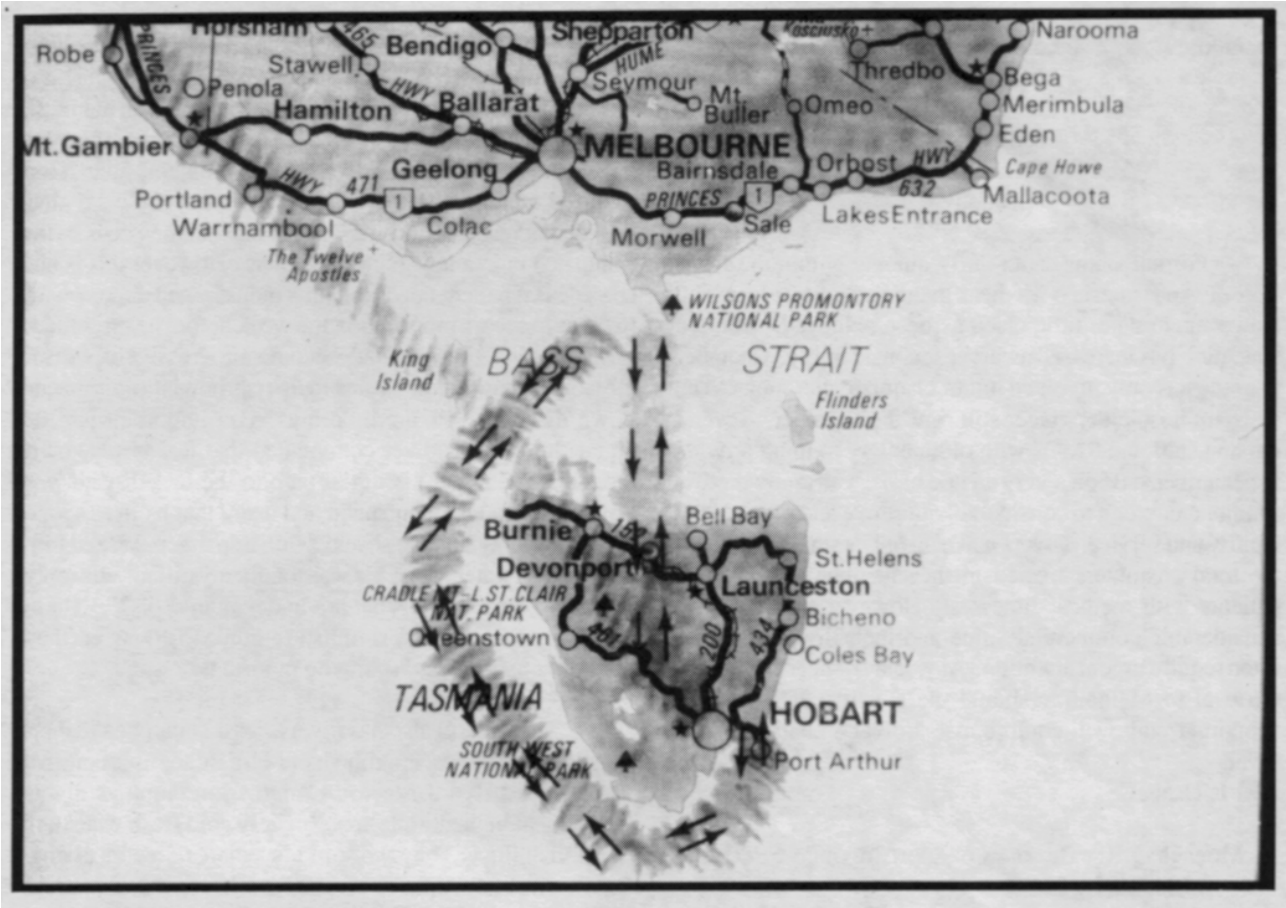

Figure 2. Map of Tasmania showing airfields

on several occasions. They transported the chamber in a King Air and had all the equipment and personnel to maintain and retrieve divers to the mainland. Unfortunately the NSCA has gone into liquidation and will be sorely missed as it provided a very speedy and appropriate service for the severely ill driver.

Table 2

AIRFIELDS AND FLIGHT TIMES IN MINUTES

	Hobart	Melbourne
Hobart		138
St. Helens *	40	114
Launceston	36	104
Wynyard	55	94
Smithton *	65	83
Strahan	43	116
Flinders Island *	74	84
King Island	97	72

* These airports have no fixed landing lights and flares must be used after dark.

Problems

Delays in notification and retrieval are still a problem. Direct notification to the DMO, by-passing the Ambulance Service, can cause delay as then the system is activated in the wrong direction. Considerable delays occur if the patient first presents to a regional hospital, as the diagnosis, paperwork and organisation all take time against a background of feeling safe in hospital. Similarly initial contact with the Diving Emergency Service (DES) in Adelaide has also led to delay. The basic philosophy of DES as a central information body and provider of advice is admirable. However in organised regional areas such as Tasmania there is an inherent delay involved if DES is used as an initial contact in an emergency situation. Knowledge of the local situation and limitations is also important.

The major problems relate to the limitations of the hyperbaric facility. The hyperbaric chamber in Hobart is now 22 years old. It is an old deck decompression unit housed in a garage in the Royal Hobart Hospital grounds. It was run under an ad hoc arrangement until 1985 when a submission was put to the hospital administration. At that stage the following deficient areas were highlighted;

1 Formal status
2 Medical manpower
3 Chamber upgrade
4 Facility manager
5 Chamber staff
6 Education

Formal status came fairly quickly within the Division of Anaesthesia. Medical manpower was organised. However, to date, little else has been achieved. Limited education has increased awareness considerably. Chamber upgrade has only involved minor chamber alterations. The assistant hospital engineer still runs the chamber. Several nursing staff and RMOs with rudimentary training provide the chamber staff on a very ad hoc basis. Currently there is a major campaign to considerably improve and upgrade the facility and service. Divers make up only a small number of the total customers treated in the chamber compared to patients with medical illnesses. However they do have considerable commercial value and their diving illnesses often require urgent attention. Any delay or need for further retrieval to Melbourne should the Hobart facility not be supported may well compromise a diver's chance of survival.

REFERENCES

1 Monaghan R. The risks of sports diving. *SPUMS J.* 1988; 18(2): 53-60.

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RECOMPRESSION CHAMBER REQUIREMENTS FOR TASMANIA

Peter McCartney

Tasmania has a population of under half a million people. The distance from Hobart to Launceston is a little bit more than 320 km.

With regard to our hyperbaric facility needs let us look at the two groups of people who provide our patients.

Firstly the divers. We have a lot of divers in Tasmania. Besides the 125 licensed Abalone divers, there are two groups of divers we know little about. There are 300 licensed Sea Urchin divers. We do not know what level of activity these people are operating at, but I certainly get quite a few for diver medicals.

The other group of divers that has crept up on us are the aquaculture divers. I have not been able to ascertain how many of these people there are. But they have been our most generous suppliers of patients over the last 18 months. We have had 5 aquaculture divers with problems that have required treatment in the chamber. Some people say that they do not really count as divers because all they do is swim round at 3 m in a few giant fish bowls. However this is not so. The last patient I had from this industry had done two 24 m dives to secure moorings in the week before he presented, during which time he had become progressively worse. Obviously they do not want their fish bowls to disappear down the river. Fixing moorings is an important part of aquaculture. This diver commented that it was very hard work. He ascribed his initial pain to the fact that he was holding a shackle in one hand and using that hand as a vice while he worked on the shackle with a spanner. I asked him about underwater tools. He was totally mystified. His reply was approximately, "What are underwater tools?". These people are taking a very simplistic attitude to diving yet they are going to 24 m and fixing up moorings.

The CSIRO also has divers. Tasmanian Sea Fisheries has divers. The Department of Main Roads uses contract divers. The Hydro Electric Commission employs divers who dive at high altitude areas, in very cold fresh water and in nil visibility. They work in a specialist area of diving. Disaster awaits people who are used to diving in warmish sea water with good visibility, when they hop into a helicopter, get up to the dive site and are faced with an absolute barrage of new parameters. They may never have been in a nil visibility situation. They have never been in fresh water. They have never done a high altitude dive. And they have never been in such cold water before. Death has been the result for at least one of these people.

And then there are the sports divers, not only the locals but people from the mainland going to Bicheno.

The others who need hyperbaric treatment are patients already in hospital. There are three important areas which will increase patient loads.

The first is burns. We have a very good relationship with our burns unit, but I have made it clear to them that the only patients we can possibly treat at the moment are patients who have problems of wound healing. They are not acute burns at all. It is the case that has been in for weeks which is not healing that is referred. I have to knock back cases of acute burns because we do not have the staff or facilities for proper care in the chamber. The burns unit are very willing to look at our situation and I have adopted a policy with their cases which was suggested to me by Dr Janet Vial. The problem was, how were we going to measure the efficacy of our treatment. The suggestion was to get the referring physician to state the time he would expect the burns to heal without hyperbaric treatment. I believe that the clinical judgement and acumen of those clinicians is some indica-