John Miller told us last year about a successful dive to 2,000 feet at Duke University really means that little animals are only a good way of spending your research grant. They do not teach us all that much about what we want to know now that commercial divers are beginning to limit themselves in depth and use machinery instead.

SUMMARY

Medical support in Australia is a few chambers with a few well trained doctors, who work regularly in hyperbaric and diving medicine, and a large number of doctors who see and treat divers for common diving problems, who have no access to chambers, but have lots of contact with divers. Many have gone to one or other of these courses to improve their knowledge.

MEDICAL SUPPORT FOR COMMERCIAL DIVING OPERATIONS

David Elliott

The sort of diving vessel that I am associated with is the new MSV (multi-service vessel), a fire fighting, diving support and repair ship, being built in Finland for Shell in the North Sea. It will work only at our Brent oilfield. It is very large and supported on pontoons the size of a submarine. It has a large diving system with two bells. Divers can go down the supporting columns into the pontoons in the dry, lock into a chamber and then go straight out into the water on an air dive. It is a diving boat and is very expensive. We have to supply medical cover for people on board and for the medical crews. The principles are just the same for that as they are for any other diving operation.

To give you some idea of the Brent field platforms, there will be about 400 to 500 people on board, sleeping, working 12 hour days. The weather is not always very nice. Even with 50 foot waves the platform is 100 feet clear of the sea. That sort of weather means that the platforms have got to be totally self-contained for five days or more, as it may not be flying weather.

The divers in fact dive almost entirely from diving support ships. Rigs are liable to blow out and other accidents, such as fire, may occur. There are life boats which are roofed in and totally fireproof that can be dropped, so enabling the ship's company to get away. But divers under pressure are stuck in the chamber. So diving is done from support vessels which are quite independent of the rig.

PRIORITIES IN MEDICAL SUPPORT

First Aid, communications, trained medical practitioners, medical centres, intensive care under pressure and hyperbaric ambulance are the priorities which I wrote up at a time when Andre Galerne and IUC (International Underwater Contractors) were trying to sell the British Government a white elephant called the hyperbaric ambulance. He was doing a rather good sales job, saying that there were all these divers in the North Sea, and no one really cared about them. He had a portable pressure chamber made of titanium, rated to 600 feet which can be flown around in a helicopter. He suggested that it would be a good idea if we bought it. This list resulted from one of the few disagreements that I have ever had with Jacky Warner, who is the Senior Inspector of Diving with the Department of Energy. He actually fell for the hyperbaric ambulance, so we produced this list of priorities for medical support in diving.

First Aid

The most important medical support is teaching the diver resuscitation and first aid. Diving first aid training goes as far as teaching the diver how to put up drips, put in catheters and if necessary put a needle in the chest. The divers will actually be trained on cadavers in hospitals to do this. The reason is that the diver under pressure can be five or six hours away from anybody else at the surface, if there was anybody else at the surface to get into the chamber. Because of the depth of some of these dives, if you take a person down too fast they are not in good shape when they get to the bottom. So first the divers have to be very well trained. We then say, that in terms of 12 or so divers, there must be one diver who is trained to the standard of the American EMTD, which stands for Emergency Medical Technician (Diver). This requires quite an extensive period of training, which is done to the American syllabus. That ideal has not yet been attained, but we do require that at least one diver in every team has been on a special course of resuscitation and diving first aid training. That is in addition to the statutory training which is laid down in the training manual for divers by the Department of Employment. That has been fairly well taken care of and the only point which is a bit tricky, is the refresher training. First aid is the most important course, because if the guy survives the first ten minutes, or hour, he may survive a bit longer. But if nobody is there to do anything during the first five minutes or so, then the next four of the priorities cease to matter.

Communications

The second priority is communications. By that I mean both what you say and how you say it. If you get a message at 2 o'clock in the morning, you can be confident only that it is incorrect or incomplete. We therefore have a check-list which is about six pages of things which the diving supervisor should check off before he picks up the telephone. The diving system is usually at the bottom of the rig, or the furthest part of the vessel, so if you ask about the blood pressure, he will go sprinting 100 yards to find out, which takes rather a long time, particularly if you are paying for the telephone call. So we like them to get all the relevant information on the check-list and then have clear

communications. If communications go by telex, we take a chance on the confidentiality of the General Post Office, although we do know that people overhear, rather than to scramble it and put it in code. This is because I know of one case where the diver, when they decoded the message, was given the wrong treatment. Avoid coding things for confidentiality, it is much better to be in the clear and take the risk that the newspapers will find out.

Trained Medical Practitioners

In the North Sea, the Norwegian and UK sectors in particular, there are doctors who are trained in the medical emergencies of diving.

Medical Centres

Now to define a medical centre. A medical centre is a place to communicate with in a diving medical emergency. It has at least two doctors. You have got to have two doctors on call because if the first doctor has been called out to go to a case then of course another accident may occur somewhere else. In order to have two doctors on call at least three doctors must be available to cover sickness and so forth. A medical centre does not require to have its own chamber, because all divers are required to have chambers offshore anyway. So we have a team of specially trained general practitioners who are available to go to help with a diving emergency. In the North Sea it can take them five or six hours to get there because it is quite a long way, even from Aberdeen, to where the platforms are. Only one doctor need actually be available to travel, the second one needs to be available on the end of the telephone. So he can be several thousand miles away. I have in fact done that duty from overseas. So there is no problem at all in keeping the centre going with only doctor actually on the doorstep. But it should have two doctors at almost immediate availability for telephone consultation.

Intensive Care Under Pressure

If, after a bell blow up, you have two unconscious divers requiring intensive care a team of specialists from hospitals in Aberdeen is available to go out and do their thing under pressure.

Hyperbaric Ambulance

The hyperbaric ambulance, a means of getting the diver back to the shore-side chamber, is a white elephant which we were forced to accept. Using the argument that all treatment on dry land in the UK is a responsibility of the National Health Service we managed to persuade the Scottish Health Department to take over the responsibility of the shore chamber. Little did they realise that the capital cost is nothing compared to the running costs. We only maintain the little titanium chamber that will run to and from the rigs. We have never had to use it in the three or four years we have owned it. It was used once about four weeks ago, but not for medical reasons. The patient had a medical condition, but the indication for transfer was not medical, it was purely convenience, to allow the barge to leave the North Sea for some other part of the world. They had a man on board with a mediastinal emphysema and a pneumothorax, who was having difficulty in breathing during decompression. They took him ashore so they could have a slow decompression. That is the only time that it has ever been used. It is very difficult to think of a condition which would be suitable for transport, because it is quite obvious that the must important thing is to stabilise the patient before you move him. Therefore anybody who has not been stabilised does not require to be evacuated. It is far better to take the doctors to the patient.

Classification of Doctors

The European Diving Technology Committee which is associated with EEC has come up with recommended qualifications and training for medical doctors in relation to diving. You have got to be very careful what comes into national regulations the back way. The United Nations has got a whole stack of bodies like ILO (International Labour Organisation) or LMCO (International Maritime Consultative Organisation), which exist for the sole purpose of dreaming up rules and regulations to tell you why you should not. They will slip in all sorts of rules and regulations when you are not looking and you suddenly find your country has signed the agreement and it is binding. Unfortunately, the country is usually represented by the wrong Government department. If it is something like oil and gas, which interests the Department of Energy, it will be the Department of Shipping that actually goes to the meeting. So as a defensive posture in Europe, we have done this ourselves. The European Diving Technology Committee is a quasi official committee and we have come out with a classification of doctors.

We did not use the term “diving doctor” because we believe this means people such as yourselves, doctors who dive or a doubly qualified as it were. We have therefore avoided that term. We tried to use the term physician, because the abbreviation of diving emergency doctor spells DED and that would not be good news, but unfortunately physician in French is a Physicist not a doctor. So we have this rather clumsy term, Examining Medical Doctor for Divers, who is a doctor trained to conduct medical examinations on divers for fitness to dive. He is on the approved list. He need never enter a pressure chamber, nor need he have been underwater. However, he must have at least 30 hours training on the subject. He is expected to keep up-to-date by attending suitable meetings and refresher courses, so he knows whether a diver coming to him is fit to dive or whether he should be kept off diving. We will not go into the medical standards for diving but the standards are more stringent for commercial than for sports divers and are very much more stringent for those going into training, than for those who are already fully trained.

The next category is the Diving-Emergency Medical Doctor. This doctor is trained to work with divers and in particular to cope with the medical aspects of every kind of medical emergency. By that I do not mean diving illness, I mean every type of diving emergency and you will see what I mean as this unfolds. He must be fit to go under pressure. He must have been trained as an Examining Medical Doctor in the first place, then he must have another 60 hours of training, that is another two weeks. He must have had practical training in pressure chambers and be should also have had underwater experience. Again, be must keep himself up-to-date by attending suitable meetings and refresher courses. We all know experience counts, but there is no way of writing that in, but three weeks of training at least gives us a certain minimum.

Then there is the specialist in Diving Medicine. We tried the term Consultant, but the other European countries objected to this for some reason. The definition is "A doctor generally recognised in the international diving community as being well experienced in aspects of diving medicine". We have three categories. The first is a doctor who is consulted on difficult or unusual cases by the other two categories. The second is a medical doctor with an expert knowledge of diving physiology. The reason for that is because the Norwegians have already gone that far. They have produced in a Norwegian Petroleum Directorate regulation the requirement that the doctor is the person who will determine what the breathing resistance will be in the inspiratory valve of the demand regulator. He will determine what the various peak flow rates will be and what shape the pressure-volume loop will be. It is quite unreasonable to expect a General Practitioner to do this. But that is the new Norwegian regulation and might even filter through into the international Community. The third category is a specialist in some particular field of medicine (other than diving) who has an expert knowledge of the diving aspects of his special subject. In that we can include the ENT people, the pathologists who do autopsies on dead divers, all doctors in various hospital specialties, so that they too count as a specialist in diving medicine. So I think you will agree that is a constructive sort of paper.

PRACTICALITIES OF MEDICAL SUPPORT

That is how the doctors are organised for medical emergencies in diving in the North Sea and how they are trained. At Shell we try to adopt the same standards in all parts of the world. Surprisingly there are no commercially or academically available training courses in diving emergencies for helium work. None of the Navies run them. The Navies only run compressed air diving medical courses, so we have been running our own. We have now run four. What emergencies do we train these doctors for? The emergencies are certainly not limited to the bends. For training one has to use a volunteer diver simulating unconsciousness. Unconsciousness in the water is not easy to deal with. Even with his head hanging forward and small bottles on his back it is not going to be easy to get him through the small hatch into the bell above. There is no easy way of doing that. There are two tricks one can use. One is to half flood the bell so that he will be floated into the bell. The second is to have a ratchet hoist and hook on to the back of a harness and pull him up with the ratchet. This all takes time. A further problem is the amount of hose that the attendant inside the bell has to haul up first, before he can get the diver in. The maximum length of hose allowed is about 30 metres, nearly 100 feet of hose, and there is an unconscious diver on the end of that. Then you have got to resuscitate him. Comex hoist the diver from behind and put on a collar to hold his head back. Oceaneering hoist the unconscious diver from the front so that he has a better airway. There are various heroic efforts taught for cardio-pulmonary resuscitation which can only be good for morale. Unfortunately it has been shown by work on electricity workers on poles in America that there is no way, with any kind of cardiac massage, that you can get circulation into the brain in the erect position. In a bell, even with no hose in it there is just nowhere you could lie the guy down properly and bear in mind that you have had to flood it up to about thigh level to get the man in. So CPR by a diver on another diver is a bit difficult. That is the sort of medical emergency that the doctor will obviously be called to. I do not know what advice he can give. As I said, diving emergencies are not limited to bends.

We also have the problem of the lost bell. Diving bells get dropped on the bottom of the sea. The real problem there is that within an hour or so the interior temperature of the bell gets down to the temperature of the sea, which is cold. If the divers are on helium, they may well die of hypothermia within two or three hours. So one tries to provide adequate thermal protection. Another problem which one has to cope with is how to transfer the diver from the lost bell to somewhere else. The lost bell may be pulled back to the surface, in which case you can transfer the divers from the bell to the main chamber. Or, as has happened recently, the bell is stuck and can not be pulled up, then you have to send another bell down and the divers have to transfer through the water to the other bell to be taken up. A problem with hypothermia is that if you have got to the stage that they are getting bloody cold, as with the divers who were in the bell which was stuck, they will need warming up before they are fit enough to swim across to the other bell. It was a 150 foot swim at a depth of between 300 and 400 feet. Theoretically if they were warmed up too quickly, they might vaso-dilate and collapse on you. In fact a hot water hose was brought across from the rescue bell and hot water was sprayed all around the bell and over the divers. They felt fine very quickly and then did a very successful transfer.

With divers who are brought back to the surface in their bell and locked on to the main chamber, the problem is that, providing of course they are not lying across the hatchway, you have got to get in and assess them. In hypothermia you must never diagnose death in a cold body, it must always be re-warmed first. How are you going to get at them to re-warm them, because you have to shift them down into the main chamber to do it comfortably? How much warming should you do in situ to avoid ventricular fibrillation when you start trying to get them down from the bell into the main chamber? These are unanswerable questions, but

you will be asked them if you are the doctor at such an emergency.

Then there is the problem of the abandon ship. It is a Norwegian rather than a UK regulation, but we find we are adhering to it in the UK, to require a hyperbaric lifeboat. It is a lifeboat containing a chamber which will lock on to the main chamber allowing divers to transfer under pressure. Then the whole thing will be dumped over the side of the vessel and float away. The principle problem is of course sea sickness, the secondary problem is cold.

Although diving bells are very small, you can evacuate divers inside that as well. In fact divers have been transferred by bell as far as 150 miles to another rig and successfully locked on.

Talking about chambers and the availability of chambers, there is a rather neat one-man chamber built by Drager, which is readily transportable. It is a boot shaped chamber which will fit inside a Lear Jet. The reason for the special design is that the standard one-man chambers will not fit into a Lear Jet, but this is a very short chamber and it will. It can also go into an Alouette Helicopter. It has to go transversely, but it will fit. In fact there are a dozen or so such chambers in one country. It is absolutely ridiculous that the country with the most organised diving emergency system is Switzerland. The reason for this is that the Swiss Army and the Swiss Police do a lot of diving in the mountain lakes. That is diving at altitude. They need to check the hydroelectric schemes and practice anti-mine warfare. They have portable chambers that can go by vehicle or by air. The army now tends to send their chamber by lorry to the site of the diving and treat the diver on site. The system is available for civilian divers and I would like to draw your attention to it. I had great joy in drawing the attention of the National Health Service to it in the hope that they may be able to do something similar in the UK, because we have a slightly longer coastline than Switzerland. Believe it or not, this scheme costs anyone who wishes to subscribe $10.00 per year plus the cost of the actual emergency if you ever have one. One can insure for that cost also. The Swiss Air Rescue Service was built up to collect injured people from skiing accidents and motor accidents, particularly road traffic accidents, in remote parts of Switzerland. It is a very well organised service. If you are a member, you will be picked up by Lear Jet from any other country in Europe and flown back to Switzerland for treatment. That service includes under pressure. They have done it from Spain and other Mediterranean countries under pressure to Switzerland for treatment. The only cost is the cost of the flight itself, and that cost comes out of a medical insurance policy. So it is a good scheme. It is a great pity we cannot have it in the UK. Perhaps you can manage it in Australia.

The White Elephant titanium chamber is quite easily portable. It goes inside a Sikorski S61 helicopter. It consists of a white two man chamber and a red single man chamber which can be manhandled down to the diving chambers at least a deck or two below the helicopter pad. The attendant is brought up first, if there is not an attendant already under pressure in the two man chamber. Then the patient is transferred under pressure. It is a fairly expensive chamber system and is good to 600 feet. At the end of the helicopter ride the two man chamber is locked onto a fairly standard saturation diving system for medical treatment as required. It is a bit of a white elephant, because you are not going to save the diver who got unconscious in the water.

DISCUSSION

Question: Dr Bill Hurst

When unconscious divers are hauled into the bell is there life line already attached, or does the tender have to swim out and attach one?

Dr David Elliott

All divers in commercial diving are on a hose which is gas and hot water and communications. The standby diver may be able to haul the diver in by his hose or he may actually have to swim out and fetch him. On our diving emergency doctor courses we actually train the doctors to do this. We put the bell down to about 30 feet, put one doctor out, tell him to flake out and then send the other doctor out to try and pull him in. It is quite a bundle of fun.

Question:

What about CPR head down rather than head up?

Dr David Elliott

It would be feasible theoretically. It would not be easy to do however. First you would have to get a hitch around their feet. Secondly, their heads would be under water until you blew down the water that was in the bell. Quite honestly, I think it would be easier to get them in head first.

Question:

Would that not involve re-designing the bells?

Dr David Elliott

There is no way you could re-design any existing bell.

Question:

Do all commercial divers wear the harness all the time?

Dr David Elliott

They all have the harness on. It is part of the gear.

Question: Dr Tony Slark

I was rather surprised at your enthusiasm for the Swiss chambers, compared with your helicopter chamber, which admittedly appears to have very little practical usage so far and hopefully never will have. But how is it that you are so enthusiastic about the Swiss monoplace chambers which can flash around Europe with sports divers?

Dr David Elliott

The around Europe bit is very rare. In Switzerland they have got three hospitals which have got treatment centres. To get patients into these hospitals they would otherwise have to go over high mountain passes. So the only way to get a patient safely from a diving accident to a treatment centre is to take him under pressure.

Question: Dr Janene Mannerheim

What sort of gas banks or compressors accompany the small ambulance chambers?

Two or three cylinders. Enough to last an hour or two.

Question:

You mentioned the first aid resuscitation. Have you come to grips with the problem of updating CPR? It seems to be fairly well known that at least yearly practice is required by not only first aiders, but also medical practitioners, if they are going to safely and adequately use cardio-pulmonary resuscitation. Surely the updating is as important as the initial training. How do you cope with this problem?

Dr David Elliott

I think that is equally true of all the other techniques that divers are being taught. At Dundee and Aberdeen they are being taught intravenous drips and pleurocentesis and that sort of thing, which I think is very important. The trouble is that having had that training they are then sent out somewhere remote like Angola and they will not be back for three years. It is a problem, but at least initial training is better than nothing.

Question: Dr Tony Slark

I was most impressed with that photograph of the Brent field rig and the swell around it, a most dramatic photograph. The thought of launching a hyperbaric lifeboat from that fills me with absolute horror. Is it envisaged that this would ever be the case?

Dr David Elliott

In one word, yes. If the system were to blow up, if there was a gas blowout and it caught on fire, the hyperbaric lifeboat would be better than burning to death. There are divers who say that they would only get into a hyperbaric lifeboat if the diving supervisor was to use a grizzly bear to chase them out of the main chamber.

Question: Dr Tony Slark

You said that the local hospital has a team of specialists, all available to fly out to manage the accident that occurs on the rig. I wonder whether this situation exists in Newfoundland?

Dr David Elliott

Not at all. It is unique to Aberdeen in Scotland and it really consists of an anaesthetist and a surgeon who know enough about the peculiarities of pressure to be able to give regional blocks and do whatever is necessary and if intensive care is required, to do that. That is about all it is.

Question: Dr David Davies

In Adelaide, the plan for decompression sickness was to take the patient to HMAS PENGUIN in a Hercules. The Vickers monoplace oxygen chamber at the Royal Adelaide Hospital is only used for gas gangrene. It seems to me that Australia, a country of vast distances, is ideal for the use of the Drager chambers.

Dr John Knight

Yes, transport under pressure could be the thing in Australia. The trouble is that is costs money. It is another story of competing departments. Some ten years ago the Department of the Navy decided that they could afford thirteen two-men portable chambers, which could be locked onto new two-compartment chambers in Sydney and Fremantle. The order had to go through the Department of Supply, whose engineers got in on the act. They said that the specifications were not adequate. They were not happy to use off-the-shelf proven valves used in commercial diving for controlling gas supply. They wanted specially designed valves made. Designing these kept engineers busy for about a year. When they had finished the cost of each of the thirteen small chambers was going to be more than the off-the-shelf cost of a Babcock and Wilcox ten person two compartment chamber. By this time the thirteen aluminium shells were ready to be fitted out. At that point there was one of the recurring financial crises, and anything that could be scrapped was scrapped. So the chambers were put on the “no further progress” shelf. That was some seven years ago. I assume they have now been sold for scrap aluminium.

There was an effort by the officer in charge of the School of Underwater Medicine about three years ago to purchase commercially available Babcock and Wilcox two person portable chambers, which would have cost somewhere around $20,000 each. The trouble was that portable to Babcock and Wilcox is not portable to anybody else. It took eight men to lift it empty. Trying to put it into a boat,

using a hand operated derrick, with sandbags inside representing the weight of two men, had to be called off when it looked very likely that the thing would go through the bottom of the work-boat. So that was rejected as unsuitable. It could be transported on the back of an army lorry. The army was very keen to buy them but they were talked out of it because it could not lock onto the RAN two-compartment chambers. If you are going to use portable chambers, they have got to lock on so that the patient can be transferred for treatment in the larger chamber.

Question: Dr David Davies

Surely there are enough divers in Australia to rake up $20,000 and get a portable chamber?

Dr Tony Slark

I think they did a magnificent job in Christchurch. It was largely due to the guidance that came from two very capable physicians that it was a success. In general, I am adamantly opposed to this whole business of small portable chambers. I think it is not a very good system for the ordinary sort of scuba diving accident. In the working diving accident you are bound to have proper chambers on top of the diver who is sick. In a scuba diving accident this does not happen. There is no way that your portable chamber is going to be anywhere near the sick diver when he first shows his illness. He has got to be evacuated first. So you are evacuating him as quickly as you can to a small chamber with no hospital facilities and with no proper medical management. You are interposing just one of the aspects in the treatment of the sick diver, pressure, at an intermediate stage in his management. In most cases you would do better to carry out your evacuation completely to the site where he can be treated fully.

In Tauranga, about 150 miles south of Auckland, there was a movement such as you have suggested, when the local divers got together after the death of the man that I spoke about. They got a lot of money and bought a one-compartment chamber. You can put a sick diver and an attendant in it. They have run out of money and nobody else wants it. It is a white elephant in just the same way as the more complex hyperbaric ambulances. It sits on the back of a truck and is never used. It would have been a far better memorial to this poor chap who died if they had had a fast lifeboat in that area, instead of this chunk of metal which, so far as I can see, is never going to be useful.

Question: Dr David Davies

You are talking of 150 miles. In Australia we are talking about getting them from Adelaide to Sydney, after they have come 200 miles up the Eyre Peninsula by road. One has got to evacuate over very long distances. The Hercules has to fly from Richmond in NSW to Edinburgh in SA to collect the patient and back again with him. It is many hours of flying.

Dr John Knight

You can always charter a helicopter and fly low.

The great joy for most of Australia is that decompression sickness is rare. I do not know how many cases there have been in South Australia in the last 5 years, but I expect very few. In Melbourne, there would have been less than ten. But in Sydney there are about twenty a year. They do have an aerial ambulance. The Surf Rescue people have a chopper and they can get people to HMAS PENGUIN quite easily. But few divers ever contact that organisation. They nearly always turn up in their own car, usually driving themselves.

Getting back to where people feed into the system, it is the person himself who makes the decision to go to a chamber. A doctor from Sydney found himself Safety Officer of his club. He was an ophthalmologist, so you do not expect him to be an expert on resuscitation. The safety equipment included an Oxy-viva. He asked around the club to see if it had ever been used. The answer was no. He went on a dive when the captain of the club got himself bent. All the way home he refused oxygen. He refused any treatment at all, except getting into his motor car and going to Prince Henry Hospital. It is no good setting up a wonderful evacuation system unless the divers are giving themselves first aid. I agree with David's point that the first thing is to make the diver capable of helping his colleagues.

Dr David Elliott

There are two other examples which are worth considering. In Israel many of the diving resorts have portable one man chambers. A lot of them are portable two-man chambers, where the attendant can sit at the head of the casualty, the L-shaped chambers made by Drager. After pressurisation, the chamber is flown to Haifa, where the patient is then transferred under pressure to the main facility. TUP (Transfer Under Pressure) only works when you are transferring under pressure to a main facility. It must be organised so that the portable chambers are available at the diving site so there is no delay in getting the guy under pressure and away. Israel is a very good example of how TUP can be done.

In the USA they now have DAN, the Diving Advisory Network. It is a code 800 number, a toll-free call. From anywhere in the United States you can telephone this one number and be connected to the co-ordinating centre for all diving accidents. This has been evolved partly because the US Navy does not want to load themselves with too many civilian diving accidents. NOAA (National Oceanic and Atmospheric Administration) has given a grant to Duke University to set this up. Besides the national centre there are five or six regional centres. Jeff Davis in San Antonio for the South-west, Duke itself for the mid-east, somewhere in Florida for the Florida region, somewhere up in the Great Lakes region and one or two on the west coast. All these places have chambers and doctors who are on 24 hour call specifically for compressed air diving accidents. It has just been set up but it is very expensive. It is a trial for two years to see how it goes.

Question: Dr Ray Leach

For Australia, it seems that the pattern is to treat the patient with 100% oxygen as close in time as possible to the accident and then transport him by Hercules to Sydney. But using a large plane like a Hercules does seem somewhat unnecessary. I understand that even commercial aircraft can be pressurised to atmospheric pressure, but at some expense to the airline. Should we not have some sort of simpler aerial ambulance for divers, smaller Jets, which could be pressurised to atmospheric pressure, during which time the diver could receive 100% oxygen during transport, rather than bothering the Air Force for these expensive Hercules?

Dr John Knight

If the diver can afford to charter a Lear Jet he can be flown at ground level. But how many of the divers you know can afford to have his own private jet? That is one of the problems. Another problem is that civilians are only treated at the School of Underwater Medicine because they are emergencies that turn up there.

Because the demand is small outside New South Wales it is very difficult to set up a comprehensive system that will be cost effective. If we are going to have an Australia wide system it is going to have to be Government funded and with present financial attitudes the Commonwealth Government is not going to pay for it.

DYSBARIC OSTEONECROSIS

David Elliott

Dysbaric osteonecrosis, although we are not absolutely certain of its cause, is an association of bone necrosis with exposure to pressure changes. The first cases were reported about 70 years ago. Pain was the problem and they were found on X-ray to have damaged joints.

The British Medical Research Council decided that they would do surveys first on compressed air workers and then on divers. They really got going in the 1950's and 1960's and came up with quite a few useful reports in the Journals. One must appreciate that the radiological classification of bone necrosis scooped in a whole lot of people who were totally asymptomatic. Bone necrosis occurs in two places, in the shaft of a bone and in the juxta-articular region. It is only collapse of the joint surface that will give rise to pain. The shaft lesion is for practical purposes totally benign. The shaft lesions are histologically exactly the same as osteonecrosis due to other aetiologies. It has the same prognosis - a one in approximately 10,000 chance of osteosarcomatous change. Two cases of osteosarcoma occurring in compressed air workers with bone necrosis have been written up.

So far as we are concerned it is a juxta-articular lesion that is important, because it can be a crippling disease. In the 1950s and 1960s there was a ten year survey of divers in the Kiel Canal in North Germany. Of about 40 divers, 7 became totally unable to work.

A group of 79 Japanese divers had about 20% definite lesions, of which about 15 were juxta-articular. John Harrison and myself reviewed Royal Navy divers about the same time. Out of 350 divers we found only 4% with lesions, of which less that 2% were juxta-articular. Ohta and Matsinuka from Japan had 50% of divers with lesions. About 15% or 16% were juxta-articular. There is a significant difference between the British and the Japanese figures. If you look at Ohta's original report, which was in Japanese (I had it translated) you find that the divers aged 18 only had about 2% incidence, the divers in their twenties had a 5%-10% incidence, divers in their thirties about 50% incidence and the divers in their forties had about an 80% incidence of bone necrosis. There were 60 or so divers aged 18 down to 2 divers aged 40. The dive profile for these guys was given. Two divers went down to 120 feet or so for four hours in the morning. Being of peasant stock they knew nothing about decompression tables, so they came up for their lunch and in the afternoon they went down and did the same thing all over again. Which, as was said in the paper, is why the flag of the factory ship was always at half-mast. So there could be some clue there as to the aetiology of bone necrosis.

The shaft lesions are benign and appear to be basically ossified fat. So to the pathology of the juxta-articular lesions. The first change is a creeping substitution. New trabeculae grow over dead trabeculae. The radio-opaque area is a failure of new growth coming into that part. But if you examine the area histologically you would find evidence of new trabeculae replacing trabeculae over as much as two thirds of the head of the humerus. The lesion is very much more widespread than can be seen on X-ray. There is a latent period. It takes three to four months before the first X-ray evidence can be spotted. This makes it very difficult to give a diver the OK at any particular time, if he is going along to a new employer.

What is the possible pathogenesis? As with spinal cord decompression sickness, there are a whole stack of hypotheses and you can take your pick. They are probably all true. There is an embolic hypothesis which suggests that lipid emboli, which are formed from bubble activity, enter the end vessels of the bones. Autochthonous bubbles, bubbles which are generated per se, formed in the bone, may expand and cause occlusion of the blood supply. Then there clever hypotheses like the isobaric counter diffusion of gases inside the bone, gaseous osmosis, change of intermedullary pressure and all those things. What it really means is that we have not got a clue.

After all sorts of clever papers have been written on the pathogenesis of this lesion, what do we actually find? In the original programme that John Harrison and I did the surprising thing was that we got nothing in the hip joints. The hip and shoulder are two juxta-articular regions that are affected. You can get shaft lesions in both upper humerus and upper femur, but they are much more common