Robyn Walker, Royal Australian Navy.

Getting back to oxygen and fluids. I think while we are telling everyone to use them, we have to encourage people to talk to the treating unit. Just this week, we received a patient, evacuated from Vanuatu by a private company. We were not asked to comment on how she should be transported. She had 15 hours of 100% oxygen without an air break. Although she arrived asymptomatic she had significant pulmonary oxygen toxicity. Those who arranged the evacuation had not realised that oxygen toxicity could be a problem for us if we then had to treat that person in the chamber. Secondly, she was given five litres of intravenous fluid in five hours. However, she was asymptomatic when that fluid treatment was commenced. Certainly while fluids and oxygen are very important, I think we need to give people some advice before patients are transported. I would urge them to talk to the treating unit before transport.

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DECOMPRESSION ILLNESS SEQUELAE IN TUNA FARM DIVERS

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Key Words

Decompression illness, hyperbaric oxygen, occupational diving, sequelae, training, treatment.

Introduction

Fisherman divers, the abalone divers of south and south-eastern Australia, salmon farm divers of Tasmania and the pearl divers of the tropical north, are part of the fishing culture of Australia. Some Australian coastal towns are dependent on such fishing.

Tuna fish are one of South Australia's natural resources. The majority of tuna fishing is conducted in the Southern Ocean by vessels based in Port Lincoln.

Port Lincoln, near the tip of the Eyre Peninsula, was first settled in 1834. It was to have been the capital of the new colony of South Australia because of its deep natural harbour. However, lack of an adequate fresh water supply and the low rainfall inland saw that Adelaide, 250 km (156 miles) east as the seagull flies, became the capital. Port Lincoln, with a population of 12,000 and over 600 km (375 miles) by road from Adelaide, is the centre of the South Australian Tuna industry. Its main industries are fishing (tuna and abalone), grain exporting, tourism and wine production.

Tuna fishing

Until the 1990s the Tuna industry used single vessel techniques, baited lines, often attached to poles which enabled strong men to swing the heavy fish inboard. Tuna schools are now co-operatively netted in the open sea and then the nets are towed back to Port Lincoln. Here the tuna are kept in netted enclosures, near the shore, for fattening before harvesting. The main export market for the tuna is Japan. Divers are employed for net maintenance, clearing the dead tuna from the enclosures and in the tuna harvest. In the early years harvesting was by swimming each fish to the surface, which involved many extremely rapid ascents, from depths of up to 18 m, in each "dive". This practice contributed to the high incidence of decompression illness (DCI) and was stopped by regulations introduced in 1995.[1]

The tuna are kept inside an inner net while an outer net prevents any intrusion by sharks. Sharks have been found between the nets but to date (May 1999) no diver has been attacked by a shark, however, this may reflect a lack of reporting of any such attack.

Government marine biologists have expressed concern about the impact the nets have on the environment. All the debris from feeding and fish excrement are deposited below the nets, and no attempt has been made to clear this rubbish away. Already one storm has stirred up this debris and suffocated millions of dollars worth of fish. Furthermore the presence of the tuna has lured sharks, in particular Great Whites, to the area where the nets are sited. These areas are close to the local beaches.

The divers

Between August 1993 and January 1995, 17 divers employed in the tuna industry were treated for decompression illness by the Hyperbaric Medicine Unit at the Royal Adelaide Hospital [RAH HMU]. Many of these 17 divers had continued to dive while symptomatic. In all but one case there was a delay before medical treatment was obtained. From January 1995 a further four divers have been treated, making a total, to May 1999, of 21 divers.

Amazingly, the initial response by the South Australian Government and Medicare, the Australian Federal Government's national health insurance system, to this cohort of 17 divers with DCS was that the RAH HMU's

medical practitioners were "over servicing" these divers and so were guilty of fraud. This was despite the RAH HMU's attempts to alert the appropriate South Australian regulatory body, the divers and their employers to the dangers of their diving practices. It was later discovered that an investigation into the treatment practice of the RAH HMU had been carried out secretly by Medicare. By the end of 1994 the bureaucrats finally recognised that there was a significant problem and regulations for safer diving practices were put in place, despite considerable opposition from both the tuna farm owners and the divers' employers.

From 1995 these regulations produced by the Department of Industrial Affairs and Workcover have resulted in a decrease in the incidence of **reported** cases of DCI. The actual incidence of decompression illness in this diving population is unknown. Many divers elect not to seek treatment nor to report their symptoms for various reasons, the main one being a fear of losing their employment. However there have been two deaths since the 1995 regulations were introduced. Despite regulations requiring training to occupational diver standards before employment as a tuna farm diver being in place, in 1996 an untrained diver failed to surface after running out of air. The other death was a suicide related to the death of the first diver. These two deaths are under police and coronial investigation and will not be discussed.

Diving practices

The initial working environment was undisciplined and unregulated. Diving profiles involved multiple rapid ascents, multiple dives per day and multiple days diving, with only one day off per week. Following their daily diving duties the divers were involved in hard manual labour.

The divers' diving experience ranged from ex-Royal Australian Naval divers to those who had recently obtained a recreational open water diving certificate. Frequently, Port Lincoln's unemployed youths were sent by the local government unemployment agency to the local dive shop to obtain a recreational diving qualification to enable them to be employed as a tuna farm diver. This not only decreased the area's unemployment figures but also gave the tuna farmers a cheap labour force.

The majority of the dives were done using surface supply, from petrol driven compressors which were frequently left unattended. Compressor malfunction, usually running out of petrol, inevitably caused an out of air ascent. Verbal communication systems and "bail out" bottles were not used.

Since 1995 all tuna divers must be trained to occupation air diving standards. The 1995 regulations, when adhered to and enforced, have altered diving practice for the better. However, there are still many instances where divers have run out of air due to compressor malfunction. Unfortunately, it appears that bail out bottles and a diver's attendant are only present when a "secret inspection" is known to be about to occur. In 1996 an untrained diver died while diving in the nets.

The tuna industry's diving practice will always differ substantially from other occupational, recreational or abalone diving practice. Indeed, its nature may be provocative for decompression illness but safe diving practice should never be discarded because of cost or convenience.

Treatment

Divers have been initially treated with a RN 62 with daily follow up treatments. The follow up treatment tables used were at the discretion of the physician in charge. Usually a 60 minute "soak" at 18 m, followed by a 30 minute ascent was used. This is the RAH HMU's 18:60:30 treatment table. Daily soaks were continued until the diver's symptoms had ceased improving.

The initial treatment response was good but subsequent follow up produced 9 divers with an unusual pattern of symptoms.

Post-treatment syndrome

Nine divers, three of whom have since been lost to follow up, developed a post-treatment syndrome characterised by:

1 generalised arthralgia, muscle and bone pain which is worse in the winter;
2 fatigue and weakness;
3 agitated depression;
4 mood swings;
5 poor libido;
6 breakdown of personal relationships;
7 and cognitive dysfunction, poor short term memory and concentration problems.

All of these symptoms and signs have been exhibited by the majority of these 9 divers at some stage after treatment. The muscle and joint pain is crippling at some stages during the winter. Four of the divers have developed degenerative changes to their right acromio-clavicular joint and two have symptoms of prostatism.

All investigations and specialist consultations have been inconclusive. Bone scans, plain X-rays and MRI have been negative for osteonecrosis. Some bone scans have been positive but the follow up MRIs have been negative. In one diver the MRI scan was positive but subsequent screening was negative. Rheumatological investigations

have all been negative for any arthritic conditions. Two divers have undergone arthroscopies, synovial fluid analysis and synovial biopsies of their worst effected joint, these have all been negative. The RAH's Chronic Pain Unit has had little success in controlling their pain. Urological consultation has not shown an enlarged prostate but has demonstrated poor bladder capacity.

Psychiatric consultation has helped in diminishing their depression and anger.

Their rehabilitation has been hampered by:

1 an inability to move fluently,
2 feelings of anger and resentment directed particularly towards their employers and Workcover,
3 lack of insight into their problems,
4 inability to accept that their injury did not respond well to treatment
5 and a lack of understanding and support by their local community and peers.

In many respects their complaints are similar to those reported by other Australian and New Zealand hyperbaric units which have reported their DCI cases after follow up for a year or more. The earliest report was by Gorman et al. in 1987.[2] They reported on patients treated by the Royal Australian Navy in Sydney. Those who had longstanding sequelae largely had EEG and neuropsychiatric changes. In 1989 Sutherland found that of 30 cases, 23 could be followed up a year later. Of these 8 were permanently and significantly damaged as a result of their diving accident and five were unable to return to normal employment.[3] Sutherland, Veale and Gorman reported in 1993 that 74% of their patients were left with problems.[4] The complaints, in order of frequency, were mood disorders (including mood changes from uncontrollable irritability to depression, lassitude and social withdrawal), impaired short term memory and often other problems such as difficulties with arithmetic, headache, sensory disturbances, impaired balance, motor weakness, arthralgia and myalgia, visual disturbances, dysphasia and dyslexia, bowel and bladder problems.

About the same time Sutherland reported a patient who had suffered personality changes and difficulty with his hands. These led to writing problems and difficulty with employment.[5] The most recent report is from Chapman-Smith whose patient developed psychosexual dysfunction, hands seizing up and short term memory problems.[6]

Although some of the patients in these reports reported arthralgia and myalgia there have been no earlier reports of muscle and bone pain which gets worse in winter nor of the development of degenerative changes in the joints.

Discussion

Divers suffering from this post-treatment syndrome present a management problem which does not seem to have a solution. The majority of our affected divers are seeking compensation. It will be interesting to see if these symptoms persist when compensation is paid.

The future

A longitudinal survey of the health of tuna farm divers in South Australia, funded by Workcover and the Department of Industrial Affairs, is being conducted. The principle researcher is David Doolette. The study is to define the true risk of decompression illness in the tuna farm divers and the risk factors associated with diving in the aquaculture industry. The aim is to improve the health of tuna farm divers and to prevent a similar scenario being repeated in other aspects of the emerging aquaculture industry in South Australia.

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