Analysis of a complex recreational scuba diving accident: French Pass, New Zealand, 2000

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Key words
Diving accidents, scuba accidents, diving deaths, decompression illness, legal and insurance, case reports

Abstract

(McGeoch G, Davis FM. Analysis of a complex scuba diving accident: French Pass, New Zealand, 2000. *Diving and Hyperbaric Medicine*. 2009;39:20-8.)
In March 2000, six students and an instructor dived using open-circuit scuba in a narrow pass and were swept by a strong current to a depth of 90 metres' sea water. Three died and four were injured, which makes the incident the worst diving accident in New Zealand history. The group was on an officially-sanctioned course with many factors contributing to the final tragic events. The dive is described and the medical response examined. The legal consequences are reported and their implications for diver training and employment are discussed.

Introduction

On 10 March 2000, seven divers (six divemaster students and an instructor) undertook a planned drift dive at French Pass in the Marlborough Sounds, New Zealand. French Pass is a channel between D'Urville Island and mainland South Island approximately 600 metre-wide at its narrowest ('The Gap', Figure 1). The current flows up to seven knots in either direction, depending on the tide. The area contains numerous rocks and depth varies rapidly and irregularly with a scour hole (Jacob's Hole) of up to 105 metres' sea water (msw) deep on the northern side (Figure 2).[1] There is a brief 20-minute period at high and low tides when currents through the Pass are less.[2] During this dive, three divers died, three suffered decompression illness (DCI) and one suffered barotrauma to the middle ears and face. The authors were involved in the subsequent management of the survivors, and one (GMcG) undertook a detailed investigation of the incident and its subsequent medical and legal ramifications. The results of this study are reported here.

Methods

The study was approved by the Upper South B Regional Ethics Committee with the request that all due care be taken to ensure that any published material protected the privacy of the individuals involved. The first author (GMcG) visited the area by land and boat and met with two survivors who could be located and who agreed to be interviewed. No relatives of the deceased were contacted. A comprehensive collection of resources was obtained, including legal documents and the coroner's reports, court proceedings, media reports, and interviews with various individuals, and access was obtained to the files and logbooks of one of the survivors and the Christchurch and Nelson Hospitals' patient records.[3–8] The two interviewed survivors have read and approved the manuscript.

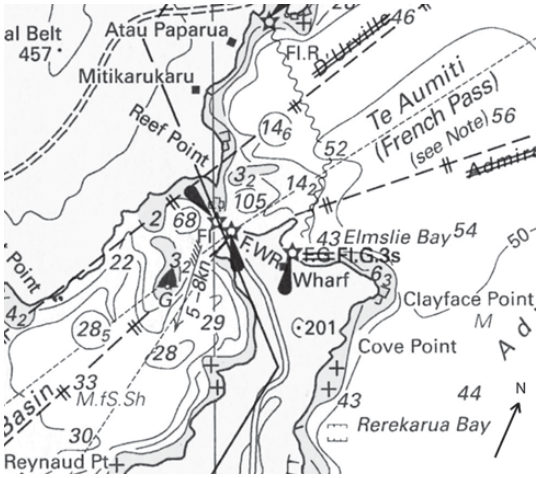
The French Pass dive

CHRONOLOGY OF EVENTS

- 1 February 2000: six students commenced a 14-week Professional Association of Diving Instructors (PADI) Divemaster course run by the Nelson Dive Centre (NDC) and funded by Work and Income New Zealand (WINZ) and approved by the New Zealand Qualifications Authority (NZQA).
- 9 March 2000: all but one of the six divers and their instructor attended an evening party until 0200 hr.
- 10 March 2000; 1300 hr: the group arrived at French Pass by boat. The two interviewed survivors say the intent was to dive when the current was running so that they would drift east along the southern wall of the pass into Elmslie Bay (Figure 2).
- 1400 hr: seven divers, using single-cylinder open-circuit scuba air, entered the water 20–50 metres from the Channel Point lighthouse on the northeast side (Figure 2). The group held on to loops on a 30 metre-long rope with a small float and a 'ski biscuit' on the surface end. Weather conditions were good, with light winds and the ebb tide running southwest to northeast. Unbeknown to them, the divers were carried rapidly into a whirlpool and sucked down into Jacob's Hole. The dive profile is shown in the printout of one of the diver's computers (Figure 3). For the first three minutes, the dive was at a depth of less than 12 msw. This was followed by an uncontrolled descent to 89 msw in three minutes. After briefly leveling out at about 85 msw they were swept by the current towards the surface over four minutes at a fairly constant rate.
- 1415 hr: the boatman discovered the inflatable tube of the ski biscuit, which he had been following, had detached and deflated and he was, therefore, not following the divers. Other boats rescued three students and the instructor about 1 km away from the starting

Figure 1
'The Gap', French Pass, from near Channel Point light looking northwest to D'Urville Island, tide flowing northeast to southwest. Entry point for the fatal dive would have been close to right foreground and divers swept northward into the main current.

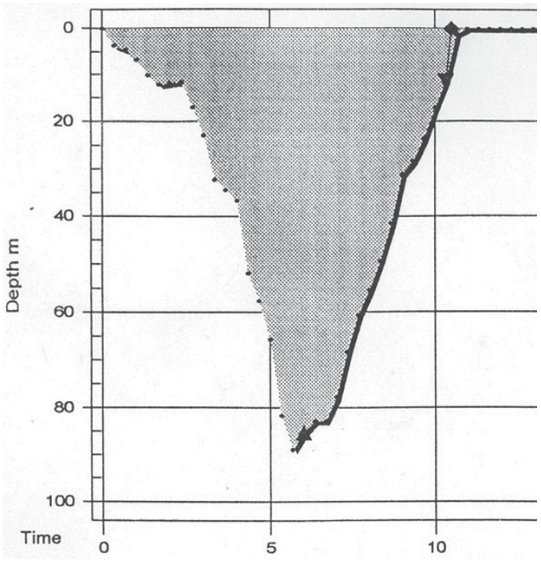
Figure 2
Detail of Chart 6151 showing French Pass and Jacob's Hole, labelled 105 msw; North shown at bottom right (with permission Land Information New Zealand; not to be used for navigation)



point. One deceased student was found tangled in the diving line. A further deceased person was removed from the water. One student was missing.

- The survivors were evacuated by helicopter to Nelson Hospital. No indication for recompression other than missed decompression was elicited and all but one (see below) were discharged from hospital that day.
- 11 March 2000: one diver presented with symptoms suggesting decompression sickness (DCS). All four surviving divers were then transferred by pressurized air ambulance to the regional hyperbaric unit in Christchurch and underwent an extended Royal Navy treatment table 62 (RN 62 ext) hyperbaric oxygen treatment.
- 12 March 2000: the three divers with suspected DCS were retreated once or twice with a Royal Adelaide Hospital treatment table 18.60.30. Following these treatments, all appeared to be asymptomatic and were discharged back to Nelson.

Figure 3
Computer printout from one of the divers showing the dive profile with time (min) against depth (msw)



Case summaries

All divers had passed a recreational dive medical. The divers are listed in the order they dived from the surface downwards, with their outcomes.

- Male, aged 37; Student C; neurological and musculoskeletal DCS with full resolution
- Male, aged 41; deceased; cause of death given as drowning secondary to cerebral arterial gas embolism (CAGE) from pulmonary barotrauma; alcohol and tetrahydrocannabinol in blood
- Male, aged 21; deceased; body not found; assumed cause of death drowning secondary to massive AGE
- Male, aged 23; Student B; minor aural and facial barotrauma only
- Female, aged 24; Student A; nitrogen narcosis, near-drowning, neurological and musculoskeletal DCS, aural barotrauma and probable global hypoxic brain injury with moderate sequelae; rescued by Student B
- Female, aged 27; deceased; upper mediastinal gas;

cause of death given as drowning secondary to AGE from pulmonary barotrauma. The instructor saw her with her regulator out and unconscious on the bottom and brought her to the surface where she appeared to vomit but never recovered consciousness.

- Male: aged 36; the instructor; equivocal DCS (right shoulder pain), full physical recovery

Two of the survivors (Students A and B) were interviewed by one of the authors (GMcG) in 2007. These two case histories demonstrate very different outcomes from the same extreme dive. One diver survived virtually unscathed whilst the other nearly died and has been left with moderate sequelae.

STUDENT A

This 24-year-old woman had dived 33 times. The evening before, she had drunk about six cans of beer with a meal at the party. She had not smoked marijuana. On the dive, she stated there was no time to ditch her weight belt or inflate her buoyancy compensator (BCD). It then became very dark and she hit the bottom. She thought her regulator was not working properly, spat it out and recalls inhaling water. She recalls feeling very narcotized and "feeling like hell". Student B reported that she floated off the line at about 50 msw depth on the way up from 88 msw and looked as though she had lost consciousness, losing her regulator. He gave assistance by bringing her back to the line and carrying her to the surface. The next thing she remembers is regaining consciousness on the surface, coughing and spluttering. She had three-quarters of her air left, whereas the other survivors were nearly out of air.

Following helicopter evacuation to Nelson Hospital, her main symptom was pain in the ears. After phone discussion with the duty hyperbaric physician (GMcG) in Christchurch, she was admitted for observation. A transient rash developed that evening, and overnight she also developed a headache, arthralgia and myalgia in the hands and feet and occasionally in the arms, altered sensation over the scalp, a full feeling in the face and ears, central chest discomfort and a productive cough. When these symptoms were reported the following morning, arrangements were made to transfer her for recompression treatment.

On arrival in Christchurch she still had leg pains, poor balance, ear pain, facial discomfort and a persistent, productive cough. Neurological examination was normal except for her inability to perform a sharpened Romberg's test. Chest X-ray was normal; an audiogram showed a high -frequency (6 and 8 KHz) hearing loss on the right. The diagnoses made were of near drowning secondary to loss of consciousness at depth, DCI probably due to a combination of AGE and decompression sickness, and middle ear and sinus barotrauma with possible inner ear barotrauma with residual high-frequency hearing loss. She was treated with an RN 62 ext, followed by two more hyperbaric treatments on the following days, after which, apart from her right ear problem and mild chest soreness, she appeared to have made a full recovery.

On follow up, however, Student A had lost her *raison d'être,* which was to become a dive professional, and was severely traumatised by the experience and the loss of her group of companions. She found that her memory was impaired and it was difficult to learn new tasks at work. Eventually psychiatric assessment in 2006 concluded that she was suffering from an adjustment disorder with mixed anxiety and depressed mood, and that there was possible mild cerebral damage accounting for her sensory and memory problems. When interviewed in 2007, poor performance on serial 7s and on recall of an address five minutes later was noted. She has a minor residual high-frequency hearing loss which is troublesome in noisy environments, and describes some altered (dysaesthetic) sensation in both thighs.

STUDENT B

Student B was the only student diving regularly prior to joining the dive course, with Advanced Diver and Nitrox Diver certifications. He reported a history of asthma treated with intermittent inhaled bronchodilators. He was very fit and confident in the water. He confirmed that they were not planning to dive at slack water. He remembered the descent as very fast once it started. He communicated with the instructor, who was below him, and signalled to abort the dive. He then went back up the line, passing Student A, who was then about five metres below him. He graphically describes biting down hard on his regulator and telling himself not to let it come out. He describes feeling very narcotized, "Hell narked up; very woolly," and blacked out briefly on the bottom. He came round enough to notice that Student A had no regulator in her mouth and no bubbles were coming from her. He left the line and grabbed hold of the left side of her BCD. He tried to push his 'octopus' regulator into her mouth, but her teeth were clamped shut. They were coming up fast while bumping on rocks. Student A's body was shuddering on the way up but she was unresponsive on the surface and not moving. He shouted and shook her; she vomited seawater and started breathing then regained consciousness. Student B says that he had 40 bar gauge pressure left in his tank. He noticed they were a long way from land. Eventually, people on the beach heard them shouting and recovered them by boat.

He felt clear-headed and well after the dive, and felt that people did not seem to believe they had been to 90 msw and did not appreciate the significance of this. He was discharged from hospital the same day. The following day, he went to the NDC where he met Student C who was clearly unwell. He persuaded him to return to Nelson Hospital and then went home where he was rung by Student A who told him to return to hospital for transfer to Christchurch. On examination, he had moderate bilateral middle ear barotrauma and subconjunctival haemorrhages, but was otherwise asymptomatic. Although asymptomatic

of DCS, he underwent a single, uneventful RN 62 ext with the other divers as a precaution, given the profound depth of the dive.

Following the incident, Student B was treated with inhaled fluticazone for his asthma. He felt that he was unaffected by the accident but never completed his dive instructor's course. He was anxious during penetration dives on wrecks following the incident and became very upset when involved coincidentally in another fatal diving accident.

Legal aspects

The issue of legal responsibility for the events at French Pass has caused considerable debate in New Zealand. The police investigation concluded that there was insufficient evidence for criminal prosecution under the Crimes Act,[9] and that lesser charges than manslaughter would be difficult to prove when there was clearly no intent to injure by the instructor, the boatman or the NDC (McCoy W, personal communication, 2000). The Police summary of the case states "[the instructor] *claims that upon assessing the water conditions and the tide he deemed it entirely appropriate to put in the party where he did and did not think they were at any risk. He himself had previously conducted a dive course at that location, and been taken through on his instructor course by* [his instructor] *at that location*."

In the absence of criminal responsibility, the burden of obtaining some accountability fell to the Department of Labour (DoL) Occupational Safety and Health Division (OSH). The case was heard in the District Court at Nelson in April 2001 with the Nelson Dive Centre and the instructor as defendants. They were prosecuted under the Health and Safety in Employment Regulations 1995,[10] and faced six charges of "*being an employer, it failed to take all practicable steps to ensure that no action of an employee, namely X, while at work harmed any other person, namely Y, in respect of a training dive in French Pass*." These charges were proven.[4]

They were also charged as follows, "*It, being a person who controlled a place of work, did fail to take all practicable steps to ensure that hazards that arose in the place of work did not harm Y who had paid NDC to undertake an activity there*." This was not proven because the regulation applies to buildings or equipment and was not thought to apply to the open ocean.[4]

There was considerable legal argument during the trial as to whether the instructor was an employee or an independent contractor. The key issue was the control test, the identification of an employer's right to control how the work is done. It was determined that both integration and control indicated the instructor was an employee of NDC.

The next issue was whether the NDC took all practicable steps to ensure that no action of the instructor while at work harmed any other person in respect of the training dive at French Pass. The Court examined the experience of the instructor and an NDC director on previous dives in French Pass. They had been swept away from their intended drift path and into 'The Gap' on a previous dive. The instructor had also dived at the Pass with a previous group of students. He described this dive as "extreme" and the group were "tossed and turned in whirlpools." The NDC director was made aware of this dive and the problems that arose, although he subsequently denied knowledge of other groups getting into difficulty.[4] The Court concluded that the instructor selected the site for the 10 March dive fully aware that at least a turbulent dive could be expected by the students. Another instructor warned him the day before the accident that he would be "crazy" to train divers in French Pass. The Court heard the instructor was relatively inexperienced, qualified but without a Certificate of Competency and had made a similar mistake before. In spite of this, no steps were taken by NDC to stop the instructor diving in the Pass. The Court thus concluded that the defendant failed to take all practicable steps to ensure that no action of the instructor, its employee, at work harmed the student divers.

NDC was also found guilty of failing to ensure their employee had a Certificate of Competency to work as a dive instructor. The NDC was fined and ordered to pay reparations totalling NZ$75,000 and the instructor fined NZ$15,000. The judge made it clear that he considered the NDC was more culpable than the instructor.[4] NDC was declared insolvent and went into liquidation and is reported to have not paid its fines.[8] The survivors say that they have not received reparation from NDC. In contrast, the instructor paid his dues promptly.

The two students interviewed are still paying off their student loans. Nelson MP, Nick Smith, commented "*It just adds insult to injury that the students caught up in the tragedy did not receive the tertiary education they paid for and end up saddled with thousands of dollars of debt. The Government approved the dodgy course, the Government should write off the loans for these students who never received the tertiary education for which they paid. Not only was the course useless and uncompleted, it was downright dangerous*."[8]

Discussion

CONDUCT OF THE DIVE

The US Navy Standard Air Decompression Table for a dive to 300 feet (91.4 msw) for a bottom time of 10 minutes gives a total decompression time of 37 min.[11] Once taken to that depth by the current, the divers were unable to ascend safely even if the current had not swept them back towards the surface, because they had insufficient air to complete the required decompression. They would have had no idea about the duration or depths of decompression stops required and were unable to maintain depth in the fast current. They were also in no fit state to conduct decompression stops as

Table 1
The compliance of the dive with the PADI Drift Diver course requirements

Drift Diver course requirements	Compliance	Comments
PADI Open Water Diver	yes	limited experience
Age >12	yes	
Student to instructor ratio	yes	maximum 8:1; this dive 6:1
Confined water training	no	discretionary
Maximum depth 18 msw	no	PADI does not specify water depth, only dive depth
Equipment	yes	all checked after the dive and no issues found
Diving with surface reference float	no	inadequate; see text
Surface supervision	no	only single boatman in the boat
Planning and entry to water	no	intensity of current was not considered
Drift dive descent	no	PADI clearly describes descent to bottom, not free-water drift dive which is more hazardous
Constantly manipulate BCD to maintain neutral buoyancy	no	see text
Perform a normal ascent as a group	no	rate greater than recommended and uncontrolled; group fragmented
Safety stop at 5 msw for 3 minutes	no	uncontrolled ascents

they were more concerned with rescuing themselves and their injured and dying friends. Thus this dive carried a high risk of DCS.

The dive should have been conducted in accordance with the PADI Drift Diver Specialty Course Instructor Outline, from which it deviated considerably (Table 1).[12] The boatman reported that the instructor told the divers not to let go of the loops in the rope; this was confirmed by Students A and B. None of the students appears to have let go until they lost consciousness, preventing earlier individual remedial action such as inflating their buoyancy compensation devices or dropping their weight belts. The exact site of the dive for the state of the tide caused the divers to be swept into Jacob's Hole, the largest and deepest whirlpool in the Pass. The instructor had dived the site before only with the tide running in the opposite direction (as seen in Figure 1). The timing was intentional because the instructor wanted the students to have the thrill he had experienced diving in the area, which suggests he did not appreciate the significance of the timing in relation to tidal flow.

MEDICAL ASPECTS

Fitness to dive on the day

The students and instructor had no absolute contra-indications to diving. One diver had asthma but was already a moderately experienced diver; he was the one who survived without significant injury and performed a deep-water (50 msw plus) rescue saving the life of one of his buddies.

The issue of whether these were suitable candidates for training as diving professionals is more difficult. Both hyperbaric units in New Zealand noted an increase in cases of DCI around this time, contributed mainly by students on WINZ-funded courses (Figure 4). Professional divers ideally need to have good medical, social and psychological fitness and skills combined with some experience of the marine environment. Without these aptitudes, decisions will be made that increase risk. It appears many of the candidates for these courses were encouraged to join them by WINZ as a means of removing them from reliance on unemployment benefits. Diving was not an occupation that many of them would have considered without such assistance. Many students would have been unable or unwilling to finance the course themselves if student loans and WINZ living allowances had not been available. This means that some candidates were potentially less personally motivated and already had

Figure 4
The numbers of divers with decompression illness treated at Christchurch Hospital, 1995–2006; there were 14 divers on funded divemaster courses in 2000–2002, but none since

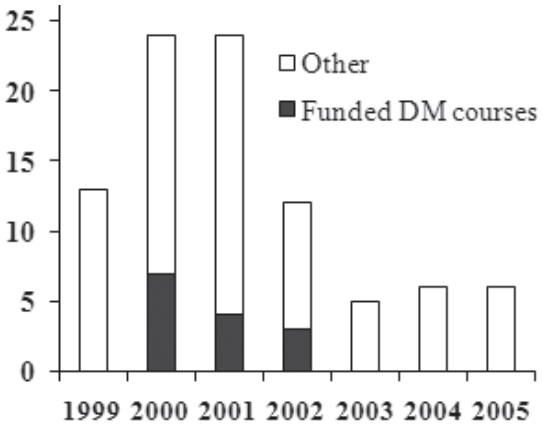


Table 2
Physiological and medical risks of a 90 msw dive with rapid descent and ascent

Oxygen toxicity
Acute carbon dioxide retention
Nitrogen narcosis
Hypoxia
Salt-water aspiration and drowning
ENT barotrauma
Pulmonary barotrauma
Cerebral arterial gas embolism
Decompression sickness

proven themselves less able in life skills. We have gained the impression the survivors of this incident were the stronger and more able divers, supporting the contention that aptitude is an important factor in determining diver risk.

Irrespective of their previous fitness and suitability for diving, were they at their peak on that day? According to Student A's logbook, they had been diving on 15 of the previous 23 days. They had all completed about 30 dives in various sites and conditions. The previous day had involved a drive of some hours and three shallow but cold dives in freshwater springs and caves. They then drank some alcohol; some smoked marijuana and had a short, disturbed night's sleep. Alcohol and marijuana were detected in one of the deceased but no blood was taken from the survivors. Thus fatigue may have played a part, combined with some residual drug effects. Why did seven adults jump into an area of ocean that is so obviously very hazardous? The power of peer pressure, belief in the leader and naivety are likely explanations.[13]

THE MEDICAL RISKS OF THE DIVE

The pathophysiological risks of such a rapid bounce dive to 90 msw on air are numerous (Table 2). The maximum partial pressure of oxygen experienced by the divers was about 202 kPa breathing air; the risk of acute oxygen toxicity for a dive of this short duration would be low. There is early transient acute carbon dioxide (CO_2) retention during a deep dive with a rapid compression, causing dyspnoea and exacerbating nitrogen narcosis.[14,15] The main mechanism is hypoventilation due to the increased work of breathing from increased gas density and diving regulator resistance. CO_2 retention may also sensitize the myocardium to arrhythmias such as those induced by the diving reflex and by enhanced catecholamine release from severe anxiety.

The effects of compressed air at 1,013 kPa are stupefaction, severe impairment of practical activity and judgement, mental abnormalities, memory defects and almost total loss of intellectual and perceptive faculties. Nitrogen narcosis is most severe early in a dive, especially with rapid compression as occurred here, followed by rapid recovery on decompression, as described by the survivors.[14] The sequence of nitrogen narcosis and CO_2 retention leading to loss of consciousness would then result in salt-water aspiration and laryngeal spasm. Laryngeal spasm followed by a rapid ascent may have resulted in pulmonary over-pressure and the massive AGE apparently observed at autopsy. An alternative pathophysiological sequence may have been drowning following nitrogen narcosis and the air observed post mortem could be an artefact. Symptoms of salt-water aspiration were observed in Student A, who was the only survivor to lose her regulator.

Air consumption was high given the short duration of the dive. None of the divers (survivors or deceased) were reported to have been out of air but all except Student A used three-quarters of their air supply within 12 minutes. Student A used only a quarter of her air supply suggesting that she lost her regulator fairly early in the dive and suffered cerebral hypoxia, but survived because of her rescue by Student B. Her long-term symptoms of memory loss and difficulty concentrating and following instructions are readily explained on this basis.

Two of the survivors suffered from tympanic membrane barotrauma with Student A requiring myringotomies for her hyperbaric treatments. Pneumothorax was not observed, but AGE may have occurred in the deceased and contributed to Student A's condition. DCS was present in two and probably a third of the survivors. One completed the dive with minor barotrauma only, demonstrating the variability in susceptibility between individuals.

MISSED DECOMPRESSION AND DELAYED DIAGNOSIS OF DCS

Recreational divers frequently miss decompression stops because of lack of or improper use of depth and time monitors, carelessness, equipment failure, lack of air supply and changes in environmental conditions. Most lapses are minor and result in no symptoms, but some will result in DCS. Hyperbaric units rarely receive requests for treatment of recreational divers who have missed decompression but are asymptomatic. This event was the first for the Christchurch Unit and advice was given pragmatically and not based on an established protocol. GMcG was informed about the incident following evacuation to Nelson Hospital, which is 250 km by air from Christchurch. The view of the attending doctors in Nelson was that none of the survivors had DCI and so transfer was not requested. Pressurized air ambulance with specialist crew on the day would have raised funding issues had transfer been requested, since DCS injury did not appear at that time to have occurred.

Student B's medical records from Nelson indicate a brief but adequate assessment. Where Student A was concerned, the assumption was that her symptoms were due to aural barotrauma, salt-water aspiration and near drowning. A specialist physician completed an adequate neurological

examination. It was only that evening that she developed a skin rash. This alone is not an indication for recompression. In hindsight, all the divers should have been admitted overnight for observation, oxygen and oral hydration and undergone a full neurological examination initially and prior to discharge. When initially assessed in Nelson, the survivors did not appear to the assessing medical staff to meet the criteria for DCI but rather to have missed decompression. On this basis, it was a reasonable decision not to evacuate them immediately. However, once symptoms appeared, the decision to evacuate and treat was also correct.

Phone advice and the consequent duty of care accepted by the doctor providing the advice is a contentious issue. Generalists, both in the hospital and in the community setting, rely on remote specialist advice via various media; an increasing trend in medicine. The availability of standard protocols for managing uncommon presentations in remote settings may assist physicians with many of these problems. Doctors have been concerned that guidelines may be used to deskill them and expose them to risk if they are not followed. However, the use of guidelines for remote advice protects both the specialist and the generalist.

AUTOPSY FOR DIVING ACCIDENTS

A senior specialist pathologist conducted the two autopsies about 21 hours after death. CT scans showed widespread gas in the cerebral arteries and systemic vessels. CT is a very sensitive way of detecting gas in the body. This was interpreted as indicating widespread air embolism. However, gas in the systemic circulation is not specific for CAGE and occurs in many diving fatalities.[16,17] The direct cause of death was given as drowning with the antecedent cause as massive air embolism and the underlying cause as pulmonary barotrauma. For this sequence to be correct, the CAGE would have occurred at depth with loss of consciousness during ascent causing the diver to lose their regulator and drown. CAGE usually occurs in the surface 20 msw during rapid ascent with loss of consciousness on the surface. This was not the observed sequence. Based on the evidence, it is the authors' view that it is more likely the deceased suffered the same pathological sequence as the survivors clearly describe – severe nitrogen narcosis and impairment or loss of consciousness with or without loss of the scuba regulator and salt-water aspiration. This sequence might lead to panic with breath-holding or laryngeal spasm, which might have caused CAGE. In summary, the true cause of death depends on the interpretation of the gas seen on CT. CAGE is unproven, and in our view an alternative cause of death of severe nitrogen narcosis and drowning is possible.

THE LATE EFFECTS OF SCUBA DIVING ACCIDENTS

The neurological consequences of DCS are well known but there is little literature on the long-term follow up of survivors of recreational diving accidents, particularly relating to psychological injury.[18] The survivors described above have both suffered psychological consequences and one is still moderately impaired from her previous level of functioning. The aetiology in her case is most likely hypoxic brain injury secondary to near drowning, post-traumatic adjustment and residual symptoms from DCS. It has not been possible to differentiate the contributions of each of these causes. Psychological support for her was slow in coming.

THE ROLE OF EACH ORGANIZATION

DoL regulates occupational diving in New Zealand. The requirements are documented in the *Guidelines for occupational diving* which were in final development but not fully introduced in 2000.[19] Any person who wishes to work as a diver is required to gain a Certificate of Competency under the Health and Safety in Employment Regulations 1995. The diver requires a medical clearance from the Diving Hyperbaric Medicine Services that involves a five-yearly medical examination and an annual questionnaire. They also require suitable qualifications and references for their prospective branch of diving. A Certificate of Competency is required to be an instructor or tutor in recreational diving and this was the goal of the students involved in the incident. At the time, the majority of divemasters and instructors had not applied for certification.

The six divemaster students were all receiving a training allowance from WINZ, and had also received student loans of NZ$7,500 each. Dive shops providing courses to PADI standards require approval by NZQA. NZQA contracted a private training establishment, Adventure Sports Institute of New Zealand (ASINZ), to take responsibility for ensuring courses met these standards. NZQA advised that they believed this was happening and that ASINZ had the necessary policies and procedures in place. ASINZ also advised the Coroner in rather general terms that they had done everything required, but acknowledged ASINZ was not ensuring that all instructional staff had a Certificate of Competency.

RECREATIONAL DIVING INSTRUCTION AS AN EMPLOYMENT SCHEME

It has always been hard to manage recreational diving training in New Zealand. Instructors, for many years, were enthusiastic amateurs working through shops for some extra money and as a hobby. This was beginning to prove difficult given the new OSH regulations. Shops needed to employ instructors and provide them with full-time employment. The divemaster courses were fully funded at the start of the course by student loans and were thus a guaranteed source of employment for staff. The funds were received even if the student did not turn up or dropped out of the training. From the material available, it is our opinion that WINZ at that time appeared to regard recreational diving as a useful industry for young people, without appropriate mechanisms in place to assess their suitability.

In turn, many dive shops regarded these programmes as a 'cash cow' and were not particularly selective. Some operators even offered inducements to students such as free equipment. The students required a medical examination, but not a DoL one, and this could be with any general medical practitioner, irrespective of whether they had any training or experience in diving medicine. Most students probably did not discuss their aspirations to become occupational divers with their doctors, many of whom would not have the diving medicine or occupational health experience to recognize the different standards required for occupational divers.

PADI guidelines for their courses were fully documented in 2000. However, the framework for risk management had not evolved, so that the responsibilities were unclear at each level from student to the NZQA. PADI was not supervising and auditing the standard of their operators closely and hence the chain of accountability was broken. NZQA accredited the Course as being of suitable educational quality but clearly did not ensure that monitoring was effective. The shops were (and still are) required to be accredited with NZQA. As a training institution, their protocols have to be approved but this was new to all parties in 2000.

In conclusion, some students were enrolled on these courses with no institutional checks and balances to ensure they were physically fit to dive daily, psychologically able to cope with the stresses, socially and intellectually capable of a leadership and management role or with sufficient life experience to manage risk. There was inadequate institutional monitoring of standards of instructors, instruction and safety. There were financial advantages to be gained by dive shops in this environment to use poorly trained and inexperienced staff and to take short cuts in supervising these staff and students. The stage was thus set for a disaster to occur.

TRAINING CHANGES

In March 2000, NZQA introduced an audit of private training establishments, and ASINZ was audited in March 2001. This showed significant non-compliance with the standard of registration. Following the prosecution, NDC lost its membership of PADI in June 2001 and was expelled from ASINZ. In September 2001, NZQA conducted a further audit of ASINZ that showed considerable improvement. The auditors said that ASINZ was monitoring the quality of diver training at its delivery sites very closely and had initiated new procedures to further assure student safety.

WINZ is part of the Ministry of Social Development, and required courses to be NZQA-approved. However, WINZ case managers were not provided with guidance about selecting appropriate clients to consider diving as a career. The large numbers of students referred by WINZ suggests there was considerable enthusiasm from case managers who probably thought this was an easy way of moving clients into an expanding industry. Unfortunately, the recreational diving industry was also incapable of selecting suitable candidates or adequately supervising less able students. It is still possible for students to receive assistance from WINZ for diving courses.

THE AFTERMATH

After a tragedy, those involved frequently want to know if anything has changed and whether their loss might help prevent others from suffering the same. The consequences for two of the survivors have been detailed above. The pain of the seven orphaned children and the families of the bereaved can only be imagined. The instructor has paid his fine and seems to have accepted his share of responsibility, whereas the directors of the Nelson Dive Centre appear not to have done so.

DCI incidence

During the four years 1996–1999, 40 divers with decompression illness were treated in Christchurch. In the two years 2000 and 2001, 48 divers presented, including 11 on various student-loan, or WINZ-funded, NZQA-approved courses (Figure 4). A similar pattern was noted by the Slark Hyperbaric Medicine Unit in Auckland (Murphy B, personal communication, 2003). No cases have been noted to be on student-loan schemes since 2002, although these courses have continued to be funded.

Medical lessons

The treatment of the survivors from a medical perspective was adequate. However, their care could have been improved by more detailed neurological examination, closer observation in hospital and better communications between on-site hospital staff and the regional hyperbaric unit.[20] The standard procedure in most of New Zealand is to evacuate diving accidents to the nearest base hospital. This has the advantage of rapid administration of first aid and resuscitation by medical personnel, but has the disadvantage of sending the diver to a hospital without specific diving medicine expertise. Of course, this issue applies to many specialist services across the health sector in many countries.

Conclusions

This tragedy changed the delivery of recreational diving training in New Zealand. It demonstrated a failure of the institutional controls on instructors and on the courses delivered. This allowed a dive shop to use an inexperienced, uncertified instructor to train a group of students of varying suitability. Supervision of the instructor appeared to be such that he took a group of hung-over, sleep-deprived students to one of the most hazardous dive sites on the NZ coast. The psychological inertia in the group meant that none was willing or able to refuse to dive or accurately assess the degree of risk involved. The conduct of the dive, in failing to apply the PADI protocols correctly, contributed to the

ensuing mortality and morbidity.

This review has documented some observations differing from previous coronial and legal proceedings.

- The divers say they intended to dive when the current was running and were not concerned about tide times.
- The arrangement of the drift line and inadequate surface floatation for it may have contributed to the accident.
- The female survivor probably suffered a clinically significant global hypoxic brain injury.
- The cause of death may have been drowning due to loss of consciousness secondary to nitrogen narcosis *ab initio* rather than CAGE.
- The instruction to the divers not to let go of the rope under any circumstances was important as it stopped useful (and previously successful) remedial action.

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Erratum

Douglas Walker, who was the Editor of the *SPUMS Journal* at the time, points out that the cartoon on page 188 of the December 2008 issue was attributed incorrectly.
"*The cartoonist was Peter Horrigan and his obituary was on the cover of the Journal following his death. He was the cartoonist on the Manly Daily for years and kindly donated his talents to translating ideas I put to him into cartoons.*"