Postal survey of fitness-to-dive opinions of diving doctors and general practitioners

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Abstract

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Aim: To determine the consensus and concordance with published standards and expert opinion among New Zealand's designated diving doctors (DDDs) and general practitioners (GPs) regarding medical fitness-to-dive.

Methods: A postal survey canvassed doctors' opinions regarding fitness to dive of 20 'real-life' applicants with potentially relevant medical conditions. In 17 cases, a 'desired response' was identified as expert opinion and the relevant published Standard concurred; the remaining three cases were excluded from analysis. Consensus was measured between the groups of doctors, and concordance measured against the 'desired response'. The performance of the DDDs was also correlated with both the number of diver medical assessments conducted annually and time since completing a diving medicine course.

Results: Seventy-seven of 98 DDDs (79%) and 75 of 200 GPs (38%) responded to the questionnaire. The mean concordance was 60% and 50% for DDDs and GPs respectively. Consensus between DDDs and GPs was generally high, but was low between these groups and the 'desired response'. DDDs' concordance was negatively correlated (r = -0.3) with time since undertaking a diving medicine course, but was positively correlated (r = 0.2) with their annual number of dive medical assessments. Both groups were more likely to differ from the 'desired response' by considering an 'unfit' diver as 'fit' than the converse.

Conclusions: There is poor concordance between doctors assessing fitness to dive and both published recommendations and expert opinion when there is a relevant medical condition. This supports the current New Zealand practice of centralised audit of occupational diver medical fitness prior to certification.

Key words

Fitness to dive, medical examinations, compressed-gas divers, scuba divers, recreational divers, occupational divers

Introduction

In New Zealand (NZ), the estimated compressed-gas diver fatality rate was 5.8 deaths per 100,000 divers per year during 1996–2000,[1] or a mean death rate of 6 per year from 1980–2006.[1,2] This figure represents only about 5% of drowning fatalities and suggests that diving is a relatively safe occupation or pastime. However, of the 40 diver deaths in NZ from 2000–2006, 12 should have been disqualified from diving on medical grounds and, although the relationship between the medical condition and the accident was often unclear, these pre-existing medical conditions were considered by the coroner to be either causative or contributory to their deaths.[2]

Recreational divers in NZ are required to undergo a medical examination conducted by a medical practitioner prior to concluding training. There is no requirement for the examining doctor to have undergone training in diving medicine, and there is no ongoing health surveillance for these divers. In contrast, occupational divers undergo a five-yearly medical examination conducted by a 'designated diving doctor' (DDD) who has undertaken post-graduate training in diving medicine recognised by the South Pacific Underwater Medicine Society (SPUMS). In intervening years, the divers complete an annual health questionnaire. Both the medical examination documentation and the annual health questionnaires are independently reviewed by an expert medical panel. This system has been shown to be reliable, but controversy periodically arises about the justification for expert and independent review of the medical documentation.[3]

One reason for such a review is the potential for inconsistency in decision making, even between doctors trained in diving medicine. A previous study of doctors in Queensland, Australia, who had training in diving medicine, showed a low level of consensus in regard to the impact of certain medical conditions on 'fitness' to dive.[4] Similar problems were found in a review of the process used to certify civil pilots fit to fly in NZ.[5,6]

The present study re-examined this issue in NZ; the aim was to determine consensus and concordance with expert opinion among NZ DDDs and general practitioners (GPs) regarding fitness for diving (both occupational and recreational), to consequently see if there is an ongoing need for independent review or arbitration of occupational diving medical evaluations and to identify possible improvements to recreational diving medical evaluations.

Method

A questionnaire describing 20 compressed-gas diving candidates who had a medical condition that could affect diving fitness was mailed, along with a reply-paid envelope,

to two groups of doctors. The first was the cohort of DDDs currently registered with the NZ Department of Labour for the conduct of occupational diving medical evaluations (n = 98). The second group comprised GPs selected alternately from the local (Auckland area) telephone book (n = 200), who were asked to complete the survey if they conducted diving medical fitness examinations for recreational divers as part of their normal practice, but only if they had not done a course in diving medicine. The questionnaires were anonymous, but coded by administrative staff for later identification to enable feedback. Incentive to complete the questionnaire was offered in the form of Continuing Medical Education (CME) points (RNZCGP), and for the DDDs, the completion was a requirement to retain registration.

The cases were selected by one of us from recreational diver candidate clinical records and the NZ occupational diver medical database on the basis that there was a medical condition that could adversely impact risk in compressed-gas diving. The case set was then culled to a final set of 20 to obtain a mix of organ system issues and to obtain a set where the 'certification outcome' would include a selection of positive, uncertain (where further investigations were needed to better define the level of individual risk) and negative responses (see Table 1). Two of us (DG and SM), both of whom are certified in diving medicine by the Australian and New Zealand College of Anaesthetists, represented the 'expert review panel'.

Respondents were asked to categorise the medical fitness for compressed-gas diving for each of the 20 scenario candidates into one of three categories: medically fit to dive in accordance with the standards that apply in New Zealand; uncertain medical fitness for compressed-gas diving or as being medically unfit for compressed-gas diving. Respondents were also asked to write brief comments to justify their answers.

The DDDs were also asked to provide additional information in the form of an estimate of the number of dive medicals that they conducted per year, and the number of years that had elapsed since they had completed a diving medicine course that would entitle them to DDD recognition.

Responses were compared to the opinion of the expert panel and on the outcome likely from a consideration of the Australian and New Zealand Standards for compressed-gas divers.[7–9] Expert opinion differed in three cases (scenarios 10, 11 and 19), which were therefore excluded from further analysis. The expert opinion for the remaining 17 cases was also predictable from a consideration of the Standard and hence is used here as the 'desired response'. Unless specifically stated, the scenarios were assumed to refer to recreational divers. For each respondent, the 'concordance score' was the percentage of scenarios where there was agreement with the 'desired response'. For each scenario, the 'concordance score' was the percentage of respondents agreeing with the 'desired response'. We have used the term 'consensus' to describe agreement within or between groups, whereas 'concordance' is used to describe agreement of an individual or group with a reference standard.

STATISTICS

Statistical analysis was completed using SPSS software. Randolph's free-marginal kappa values (k) were derived to demonstrate consensus within each group of assessors and account for agreement by chance. To compare the DDDs with the GPs, both having been measured against the 'desired response', Student's t-test of means (two-tailed) was used. To describe the correlation between concordance with the 'desired response' and time since completing a dive medicine course or number of dive medicals annually, Pearson's correlation coefficient (r) was derived.

Results

The responses to the 20 scenarios are shown in Table 1, as well as the 'desired response' and the relevant Standards sections. Seventy-seven of 98 DDDs (79%) and 75 of 200 GPs (38%) responded to the questionnaire. The mean concordance score was 60% (range 24–88%) and 50% (range 12–82%) for DDDs and GPs respectively. By scenario, the mean concordance was 61% (range 26–94%) and 50% (range 19–89%) for DDDs and GPs respectively (Figure 1). Consensus within each group was 52% (k = 0.28) and 46% (k = 0.18), for the DDDs and GPs respectively. Although both groups scored poorly, Student's t-tests of means showed DDDs were significantly more likely to express concordance with the 'desired response' than GPs (t = 3.88, 150 df, P = 0.0002). For those DDDs who provided the additional information (n = 51), there was a negative correlation (r = -0.3, P = 0.03) between their concordance score and the time elapsed since they completed a designated dive medicine course, and a positive correlation (r = 0.2, P = 0.03) with the number of dive medicals they did each year.

The probability of assessing an 'unfit' diver as 'fit' was higher for GPs than DDDs (17.3% versus 11.7% respectively), and

Figure 1
Concordance of responses of doctors with basic training in diving medicine (DDD) and non-trained general practitioners (GP) with Standard responses to fitness-to-dive scenarios

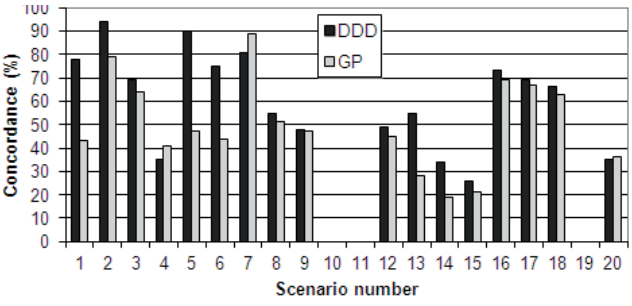

Table 1
Twenty fitness-to-dive case scenarios with responses from doctors with basic training in diving medicine (DDDs; *n* = 77) and non-trained general practitioners (GPs; *n* = 75)

Case	Scenario description, 'desired response' and relevant Standards sections	Group	Fit	Unfit	Unsure
1	A 23-yr-old female with bipolar affective disorder and a history of psychotic symptoms, well controlled on Lithium. **Unfit** Refs: 7) A4.14b 8) A4.9 9) K4.15d,g	DDDs GPs	6 21	60 32	11 22
2	A 32-yr-old female who has a history of 2 spontaneous left-sided pneumothoraces, but who has had corrective surgery to the apex of her left lung; spirometry normal. **Unfit** Refs: 7) A4.10b,ii 8) A4.10b,ii 9) K4.11ii	DDDs GPs	2 1	72 59	3 15
3	A 190 cm 31-yr-old customs diver with an FVC of 7L but an FEV1/FVC of 0.69; chest X-ray, hypertonic saline challenge results and exercise tolerance all normal. **Fit** Refs: 7) A4.10c 8) A4.10d 9) K4.11c	DDDs GPs	53 48	2 5	22 22
4	A fit 21-yr-old male who has Mobitz type 1 (Wenckebach) second degree heart block on resting ECG, but a normal exercise ECG. **Indeterminate** Refs: 7) A4.9 8) A4.9a 9) K4.10	DDDs GPs	39 29	11 15	27 31
5	A fit, asymptomatic 25-yr-old female with a soft systolic cardiac murmur heard best in the aortic region. **Indeterminate** Refs: 7) A4.9a 8) A4.9a 9) K4.10	DDDs GPs	5 37	3 3	69 35
6	A 20-yr-old female with a history of 'wheezy bronchitis' in childhood. She used inhalers until she was 12 yrs old but has not used any since then. Plain spirometry results are normal. **Indeterminate** Refs: 7) A4.10b,iv 8) A4.10b,v 9) K4.11	DDDs GPs	19 32	0 10	58 33
7	A 54-yr-old male hypertensive controlled with a diuretic. He has a normal exercise ECG and renal function. **Fit** Refs: 7) A4.9c 8) A4.9c 9) K4.10	DDDs GPs	62 67	2 0	13 8
8	A 24-yr-old male with cerebral palsy who is able to walk with the use of sticks. **Unfit** Refs: 7) A4.3/A4.12 8) A4.3/A4.12 9) K4.13	DDDs GPs	12 7	42 38	23 30
9	An asymptomatic 45-yr-old male with atrial fibrillation diagnosed and fully investigated 10 years ago. He remains on warfarin and has normal exercise tolerance. **Unfit** Refs: 7) A4.9 / 4.14b 8) A4.9a / 4.14a 9) K4.15d / K4.10	DDDs GPs	15 17	37 35	25 23
10	A 28-yr-old male with a BMI of 40. An exercise ECG to level 4 Bruce protocol showed no ischaemic changes. **No agreement between 'experts'** Refs: 7) A4.4 8) A4.4 9) K4.3	DDDs GPs	29 37	25 20	23 18
11	A 32-yr-old diver found on an epidemiological survey to have a patent foramen ovale (bubble contrast echo). He has been a Navy operational diver for 10 years without incident. **No agreement between 'experts'** Refs: 7) A4.9 8) A4.9 9) K4.10	DDDs GPs	22 16	27 22	28 37

Table 1 (cont)
BMI – body mass index; CXR – chest X-ray; ECG – electrocardiogram; EEG – electroencephalogram; FEV_1 – forced expiratory volume in 1 s; FVC – forced vital capacity; MRI – magnetic resonance imaging

Case	Scenario description, 'desired response' and relevant Standards sections	Group	Fit	Unfit	Unsure
12	A 19-yr-old male with a history of convulsions as an infant, for which he was maintained for several years on phenobarbitone. The family GP has no record of any fits. **Indeterminate** Refs: 7) A4.8b 8) A4.8b 9) K4.9	DDDs GPs	17 20	22 21	38 34
13	A 25-yr-old male who had a chest drain inserted after he suffered broken ribs and a haemo-pneumothorax three years ago in a car accident. He is back playing club rugby. His CXR and spirometry are normal. **Unfit** Refs: 7) A4.10b,ii 8) A4.10b,ii 9) K4.11a,ii	DDDs GPs	16 36	42 21	19 18
14	A 45 kg, 14-yr-old female school swimming champion. **Indeterminate** Refs: 7) A4.2 8) A4.2 9) K4.2	DDDs GPs	39 55	12 6	26 14
15	A 35-yr-old female with asthma since her teens. She is well-controlled on twice daily Fluticasone and last used her Salbutamol inhaler three months ago. She had a normal result on a recent hypertonic saline challenge test. **Indeterminate** Refs: 7) A4.10b,iv 8) A4.10b,v 9) K4.11a,iii	DDDs GPs	39 29	18 30	20 16
16	A 22-yr-old female with a history of severe head injury 5 years previously with small subdural haematoma but no surgical intervention. She fitted at the time. Was on Epilim for 2 years and has had no fits since discontinuing it. Recent MRI and EEG normal. She has had ongoing minor cognitive deficits and headaches. **Unfit** Refs: 7) A4.8c 8) A4.8d 9) K4.9	DDDs GPs	9 4	56 52	12 19
17	A 29-yr-old female with a history of migraines. She has had no symptoms for the past year on prophylactic medication, but suffered severe bifrontal and occipital headaches during two familiarisation dives, the headaches onset at depth. **Unfit** Refs: 7) A4.8 8) A4.8c 9) K4.9	DDDs GPs	4 6	53 50	20 19
18	A 26-yr-old professional diver who was treated for neurological DCI 3 weeks ago. **Unfit** Refs: 7) A4.8 8) A4.8 9) K4.15j	DDDs GPs	1 2	51 47	25 26
19	A 49-yr-old male diabetic controlled by diet alone. He has mild diabetic retinopathy. **No agreement between 'experts'** Refs: 7) A4.14 8) A4.14 and appdx D 9) K4.15	DDDs GPs	21 46	13 8	43 21
20	A 48-yr-old male with a past history of severe angina who has undergone successful coronary vessel grafting three years ago; no angina now and good exercise tolerance. **Unfit** Refs: 7) A4.9 8) A4.9 9) K4.10	DDDs GPs	16 23	27 27	34 25

was also significantly higher for both GPs and DDDs than the converse probability of assessing a 'fit' diver as 'unfit' (3.3% and 2.6% respectively).

Concordance scores varied by greater than 15% (mean variance 27.7%) between DDDs and GPs (DDDs higher than GPs) in six of the scenarios (1, 2, 5, 6, 13 and 14). For the remaining 11 scenarios, the consensus between DDDs and GPs was high (mean variance 3.9%). The concordance with the 'desired response' was < 40% for both DDDs and GPs in four of the 17 scenarios (three in common: scenarios 14, 15 and 20; DDDs in scenario 4, and GPs in scenario 13).

Discussion

The scenarios used in this survey were selected to include important respiratory, cardiovascular and neurological health issues for divers. Many of our 'real-life' cases were similar to those used in the Queensland study, some of which were fictitious and some real, emphasising that these are the kind of medical conditions that arise relatively commonly in assessing would-be divers.[4] They were also selected to present a challenge to the assessing doctors as compared to more straightforward cases, which represent the great majority of assessments. It follows that the current survey does not represent the outcome likely from a random selection of cases in which a much higher concordance would be expected.

The overall 38% response rate for surveyed GPs is likely to mask a much higher response rate for those GPs who fulfilled the inclusion criteria (those who conduct recreational diving medical fitness examinations but have not completed a diving medicine course) as many GPs do not undertake diving fitness assessments.

The published standards for fitness to dive are conservative, and if strictly applied they may result in divers being inappropriately denied medical clearance for diving.[7–9] However, the finding that both DDDs and GPs were more likely to assess an unfit or indeterminate diver as fit, rather than the converse, suggests either disagreement with, or a lack of familiarity with the published standards, as the bias in the latter is in the opposite direction.

There was a wide range of opinions and a low mean concordance with the 'desired response' for both DDDs and GPs. This, together with the negative correlation between concordance score and time since completing a designated diving medicine course, suggests potential benefit could arise from periodic refreshers and/or regular formative assessments of DDDs and GPs. It also suggests that the most reliable method of assessing someone's medical fitness for occupational diving involves an expert in diving medicine and/or a risk evaluation conducted by a specifically trained doctor who has ready access to expert advice. The problem with either of these 'solutions' is that there are very few diving medicine experts and hence access would be limited. The central audit facility for employed divers that exists in New Zealand is a workable solution to this problem and is clearly independent and less vulnerable to diver-advocacy bias. It is noteworthy that many divers who might otherwise have been disqualified, have been able to continue a career in diving, with specified constraints, due to the intervention of this facility.

For recreational divers, there is evidence both supporting and refuting the utility of a medical examination prior to training.[10–12] In the face of this controversy, most countries have now adopted a self-declaration health questionnaire for recreational scuba diving candidates in line with the ISO standards.[13] However, for occupational divers, there remains a widespread reliance on annual medical examinations conducted by doctors analogous to our DDDs. Our study suggests that in the absence of independent review, there is a strong possibility that candidates with significant medical conditions who undergo such an examination will receive a determination of fitness different to that which an expert would deliver or that expected by consideration of the relevant Standard. To the extent that we derived a 'desired response', this study suggests that independent review by such experts is a valuable adjunct to the process of occupational diver evaluation.

LIMITATIONS OF THE STUDY

The respondents, both DDDs and GPs, were asked only to assess the diving candidates' fitness to dive on the basis of the brief vignette. There was no specification regarding fitness for occupational versus recreational diving. Therefore, it is possible that some of the respondents, especially the GPs, may have applied a more liberal 'informed risk acceptor' approach in their decision making. It should be noted, however, that there are very few differences between the published standards for occupational and recreational diving.

Conclusions

This study supports the need for better, iterative and formative diving medical education for DDDs, and the desirability of diving medical education for any GP who wishes to conduct recreational dive medicals. The overall low concordance of both DDDs and GPs with published recommendations and expert opinion is mitigated for DDDs performing occupational diving medicals in the New Zealand setting by the existence of a central, independent and expert audit authority.

Conflict of interest

Drs Des Gorman and Chris Sames are members of the Department of Labour Diving Medical Directorate, which is responsible to the Department of Labour for the certification of the medical fitness of occupational divers in New Zealand.

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