

BRONCHIAL PROVOCATION TESTING IN ROYAL AUSTRALIAN NAVY DIVERS AND SUBMARINERS

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Abstract

Royal Australian Navy diving/submarine branch candidates who fail to meet the prescribed respiratory standards are often referred for bronchial provocation testing. Many of these candidates are subsequently passed fit to dive or fit for submarines. A retrospective analysis of 178 Royal Australian Navy members who attended Royal Prince Alfred and Concord Hospitals for bronchial provocation testing was undertaken. Clinical factors which led to the ordering of the test were correlated with the outcome of the testing. The results suggest conventional measurements of lung function parameters and clinical variables are poor predictors of bronchial provocation test outcome in RAN divers.

Introduction

The Royal Australian Navy's (RAN) minimum respiratory standard for entry requires all candidates at their time of application to have displayed no evidence of asthma within the preceding 3 years.¹

Prescribed medical standards for RAN divers stipulate there must be "No evidence of lung disease and, particular attention must be paid to any condition that might cause retention and trapping of expanding gas in any part of the lungs during decompression. Any past or present evidence of obstructive airways disease (e.g. asthma, chronic bronchitis, emphysema, allergic bronchospasm) are medical grounds for rejection from diving." The RAN also requires all divers and submariners to undergo pulmonary function testing as part of their periodic medical examination. A forced vital capacity (FVC) of less than 3.5 litres or a forced expiratory volume in one second (FEV₁)/FVC ratio of less than 75% at the initial medical examination are causes for rejection unless further pulmonary function testing reveals no abnormalities.²

The Australian Standard for Occupational Diving AS2299³ has similar guidelines stating "An FVC or FEV₁ of more than 20 % below predicted values or an FEV₁/FVC ratio of less than 75% may indicate increased risk of pulmonary barotrauma. If no other abnormality is present, a finding of fitness may be allowable if additional specialist pulmonary function tests and opinion do not find any fixed or intermittent outflow obstruction that might predispose to pulmonary barotrauma."

Diving/submarine branch candidates who fail to meet these standards are often referred for bronchial provocation testing despite minimal or absent clinical evidence of respiratory disease and many are subsequently passed fit to dive or fit for submarines. Bronchial provocation testing is a recognised technique for identifying bronchial hyperresponsiveness associated with asthma,⁴ however, the usefulness of bronchial provocation testing as part of a diving medical work-up in this population has not been substantiated.

Method

A retrospective analysis was undertaken of the Medical Health Documents of all RAN personnel attending Royal Prince Alfred and Concord Hospitals respiratory laboratories from June 1987 to January 1995. 178 subjects were identified from the laboratories' databases. Clinical histories were collected along with the results of lung function and bronchial provocation testing. Age, height, measured and predicted FEV₁ and FVC, FEV₁/FVC, peak expiratory flow rate (PEFR), peak expiratory flow from 25-75% of the vital capacity (PEF₂₅₋₇₅), measured and predicted total lung capacity (TLC), vital capacity (VC), inspiratory capacity, functional residual capacity (FRC) and residual volume (RV) were recorded. Clinical details such as the presence or absence of childhood wheeze, recent wheeze, exercise induced wheeze, family history of asthma, smoking history and history of atopy were noted. Details of whether histamine or methacholine or saline bronchial provocation or a combination were performed was recorded with the test result.

Results

Five of the 46 saline challenge tests were positive as were 75 of the 130 histamine and 3 methacholine challenge tests.

Logistic regression analysis was used to model the multivariate association between the various physical measurements, clinical history variables and outcome of histamine or saline testing.

No significant predictors of saline test results were found. There were only 46 saline tests so that tests of association lacked power. However if the results for FEV₁/FVC in the observed proportions hold true for larger data sets FEV₁/FVC would be a moderately significant predictor of positive or negative result.

There were 130 histamine tests. A number of variables were found to be jointly significantly associated with a positive histamine test. These were height, FEV₁/FVC <75% and a clinical presentation suggestive of asthma,

but the predictive power of this model was relatively poor. Vital capacity was significantly associated with a positive test result but had a high proportion of unmeasured values. Height was associated with VC and probably acts as a proxy for VC in the regression model (but does not have the high missing value rate). This "best" model for histamine test positive result had the optimal sensitivity and specificity values of 83% and 69% respectively.

Variables such as PEF, TLC and RV were not significantly associated with the test result. Clinical variables such as childhood wheeze, exercise induced wheeze and family history of asthma similarly showed no significant association with test outcome.

Discussion

These results support the hypothesis that physical measurements of lung function and clinical history variables are poor predictors of the results of bronchial provocation testing in the RAN population.

The retrospective nature, absence of complete sets of data on all participants and the small number of saline tests are identified as problems with this study, however important conclusions can be drawn from the data and provide a basis for further study. A FEV₁/FVC ratio of less than 75% at initial examination is used by many practitioners as the sole screening tool of lung function for potential divers. Brooks et al⁵ in a prospective study of Royal Navy Submarine Squadron candidates has shown that FEV₁ and FEV₁/FVC do not predict the likelihood of pulmonary barotrauma with the only good predictor in their study being a low FVC by itself. Our figures show there is an association of FEV₁/FVC <75% and a positive histamine test, however the predictive power is low.

Histamine and methacholine challenges have a high sensitivity and negative predictive value but a low specificity and positive predictive value of less than 30%.⁶ Up to 30% of people can have a positive result to inhaled histamine but have no symptoms or clinical history of asthma. The absence of any good predictor for test outcome, either measured or clinical, further reduces the value of histamine or methacholine challenge.

Saline provocation is a highly specific challenge for identifying persons with current asthma and is readily recognisable by diving candidates as having relevance to their potential sport. However, our data suggests that in the RAN our criteria for testing have a low predictive value.

Our results reveal that no measured lung function value alone or in combination stands out as having strong properties for predicting a positive test result. The combination of height, FEV₁/FVC <75% and a clinical history suggestive of asthma, while being better than

tossing a coin in predicting a positive result, is by no means a sensitive or specific model. This suggests we could refer everyone for bronchial provocation without performing any lung function tests or collating medical history and still obtain the same results.

To obtain the absolute predictive value for provocation testing we will need to submit a large number of RAN members who pass the screening tests for diving or submarine selection to bronchial challenge and compare the results with those of the group described here.

Conventional measurements and clinical history in this population are poor predictors of bronchial provocation testing outcome which implies we must continue the search for positive predictors in order to prevent candidates from being exposed to unnecessary physical or financial insults.

References

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