Evaluation of Asthmatics' Fitness to Dive

Samuel Shelanski

A. Introduction

For many years Asthma was considered an absolute contraindication to scuba diving. This was due to several deaths from Arterial Gas Embolism (AGE) that occurred during military submarine escape training and were attributed to bronchospasm and subsequent air trapping.

In 1994, an article in the Annals of Allergy suggested that while asthmatics may indeed be at increased risk from diving, this risk was largely confined to a subgroup of asthmatics whose bronchospasm is stimulated by exercise or cold, and that the was majority of asthmatics could safely enjoy the sport. This study based upon retrospective analysis of diving accident reports, and it showed that while asthmatics are twice as likely to suffer certain types of scuba related injuries, this risk is still minuscule and should not lead to their being banned from participation.

With this, and another similar, study in hand, the Undersea and Hyperbaric Medical Society held a meeting at the start of theirannual meeting in 1995 and issued a consensus statement that asthmatics with normal spirometry before and after provocative testing were suitable candidates for diving.

However, what has still not been addressed, in a prospectivemanner, is whether the conditions associated with scuba diving place asthmatics at increased risk of bronchospasm, and whether those, with a history of exercise or cold induced asthma are at greater risk than those with asthma of another etiology.

B. Study Design

This study is designed to be a dynamic evaluation of the pulmonary function of asthmatics under conditions similar to those encountered during an average warm water dive of 30 minutes or longer.

The study will include an initial phase under room air conditions to ensure that the study is utilizing a reasonable exercise level. The second phase will examine duration of exercise while breathing compressed air. The data to be collected includes time in minutes to bronchospasm, respiratory rate, air consumption, and~ peak flow. In addition a questionnaire at the beginning will collect information on what stimulants usually trigger the subjects asthma, and the subjects will be separated into two groups. One comprising those with a history of exercise or cold induced asthma, and the other with asthmatics of all other etiologies. The questions to be addressed with this data include:

1) What percentage of asthmatics are at risk of bronchospasm, from exercising under - these conditions for one hour?
2) Are asthmatics with a history of exercise or cold induced asthma at higher risk of 6i6nchospasm than other asthmatics?
3) Is there an identifiable average decrease in functional vital capacity, measured by volume per breath, at which point asthmatics feel bronchospastic? How does this correlate With peak flow measurements?
4) Is there a correlation between pre-exercise peak flow and duration' of exercise achieved?

The data will. be analyzed using the Kaplan-Meir Product-Link Estimate of Survival to compare the two arms of the study (exercise and cold induced asthma versus other). Multivariate analysis to assess potential contributions or predictive values of other variables will be performed using Cox!s Proportional Hazards Model.

C. Study Procedures

The study will involve an initial trial phase during which 20 participants will be evaluated for subjective complaints of bronchospasm. while exercising on a treadmill at 0 degree incline at a speed of 7

mph. This has been shown to consume a similar number of calories per hour as a dive in 80 degree water and minimal current. This initial phase will determine whether the planned design is feasible. If the room air phase induces bronchospasm. in greater than 10% of the subjects at 30 minutes, then the level of exercise will have to be decreased for the main study, and this decrease taken into consideration in any final comment on the fitness of asthmatics to dive.

The primary study will involve 20 subjects performing exercise, at the level determined in the initial phase, while breathing dry, compressed air. The participants will wear full face mask regulators during the study to minimize the potential confounding factors of nasal breathing or breathing around a mouthpiece. The subjects breathing rate and liter per minute (LPM) gas consumption will be monitored on a minute-bye-minute basis using a Dive-Trak computer mounted upon the regulator first stage. This will enable the calculation of the volume per breath on an ongoing basis during the trial.

The subjects will be asked to exercise until they subjectively feel bronchospastic, or for one hour, whichever is shorter. The primary measurement will be minutes of exercise until sensation of bronchospasm, respiratory rate at that time, and LPM consumption. Additional measurements will include peak flow measurements prior, and subsequent, to exercise.

D. Inclusion-exclusion criteria

Study subjects would be men and women, age 18 and older, who have a history of asthma. Subjects would be recruited from Columbia-Presbyterian employees and students.

Exclusion criteria include chronic steroid use, either oral or inhaled, or any contraindication to scuba diving as determined by the Diver's Alert Network (DAN) guidelines covering fitness to dive. This would include, but not be limited to, those with: history of spontaneous pneurnothorax, significant coronary artery disease, pregnant women, history of seizures within 5 years, and diabetics with hypoglycernic episode within one year.

In addition on the day of the study, participant's would be asked if they had utilized bronchodilators, or had symptoms of bronchospasm within the past 24 hours. If they had then they would be asked to return at a later date.

E. Study Questionnaire

All subjects would be required to complete a study questionnaire prior to participation. This would include an initial segment with questions pertaining to their medical history, and would be involved in determining suitability for inclusion in the study.

The second section would involve questions about their asthma history such as frequency of bronchospastic attacks, frequency of bronchodilator use, if they had ever been intubated, and what the subject has identified as common triggers.

The final section would include questions on life style including smoking history, and exercise history (frequency, intensity, duration.)

F. Location of Study

The study would be performed in the exercise physiology labs on the 9th floor of the PH building.

G. Risks and Benefits

As the test involves the subjects exercising, potentially, to the point of bronchospasm, there is some risk being incurred by the participants. This risk will be minimized in the following ways:

A physician will be present at all times during the testing, and each subject will remain under a physician's observation for 20 minutes following completion of exercise.

A nebulizer will be available for all those patients requiring proventil, or atrovent therapy to relieve their symptoms.

Epinephrine and terbutaline will also be on hand in case of severe bronchospastic events. Any subject requiring either of these medications, or receiving more than 3 nebulizer treatments without resolution of their bronchospasm would be transferred to the emergency room for further management.

H. Compensation and costs

The subjects would incur no costs associated with the study, and would be compensated $50 for the 1-1 1/2 hours required for their participation in the protocol.