Providence HEALTH CARE	**RESPIRATORY SERVICES**	DATE CREATED: January 2010 DATE REVIEWED/REVISED: **October 2015**
PROCEDURE	TITLE: Pulmonary Diagnostics: Eucapnic Voluntary Hyperventilation (EVH) (Respiratory Therapy) NUMBER: B-00-12-12126	RELATED DOCUMENTS:

SITE APPLICABILITY:

ST. PAUL'S HOSPITAL

GENERAL INFORMATION:

In May 2001, the IOC Medical Commission convened a workshop to examine asthma, beta-agonists and the Olympic Games. The workshop concluded that any athlete notifying the IOC of the need to use a beta-2 agonist will now require one or more of the following:

- A positive methacholine challenge test
- Evidence of a 12% or greater improvement in FEV_1 following beta-2 agonist
- Bronchial provocation with a Eucapnic Voluntary Hyperventilation (EVH) test
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After an EVH test, airway hyper-responsiveness (AHR) is confirmed if there is a fall of 10% or more in FEV_1 in the post challenge period. *(Anderson et al 2001, Br J Sports Med 35:344-347).*

EQUIPMENT:

- Sensormedics Vmax Metabolic Cart
- Hans-Rudolf Valve with two silicone connectors
- Silicone mouthpiece
- Microgard Filter
- Noseclip
- Reservoir bag with hose
- H-cylinder of Gas Mixture 5% CO_2, 21% O_2 and balance Nitrogen
- EVH worksheet
- Bronchodilator MDI with spacer

PROCEDURE:

1. Power on the Vmax Metabolic cart, and laptop computer.
2. Open both calibration tanks then calibrate the flow sensor and gas analyzers.
3. From the main menu, choose **New Study** to enter patient information (new patient) or choose **Find Patient** to search for patient information (old patient). Press **F3** to save.
4. From the main menu, choose **Pulmonary Function**, and have patient perform Flow Volume Loops as per ATS guidelines. (Refer to procedure RTD7300). Choose the best FEV_1 and press **F3** to save. The best FEV_1 will be used to calculate ventilation targets and threshold values (EVH worksheet).

5. Fill gas reservoir bag with 5% Carbon Dioxide mixture.
6. On a small table, prepare the Hans-Rudolph valve, mouthpiece and flow sensor as per **Exhibit A**. The Vmax flow sensor will connect to the exhalation side of the Hans-Rudolph valve to allow monitoring of the patient's spontaneous breathing parameters.
7. Prepare the patient to **hyperventilate** at a target range of (25 – 30) x FEV_1 = VE for **6 minutes**.
8. From the main menu, choose **Exercise/Metabolic Test**. Once in the Metabolic Study screen, choose **F10** to enter the Metabolic Protocol Setup screen.
9. From the Metabolic Protocol Setup screen under the heading **Bike**, choose **External Treadmill**. Under the heading **Text**, choose **EVH Test**. Press **F3** to save changes.
10. Press **Start Test** from the Metabolic Study screen and place the mouthpiece into patient's mouth with nose clips on.
11. Press **F3** again to begin data collection.
12. The patient's breathing should activate the scrolling of the tabular results. In the upper left-hand corner of the screen, click on **Events** and choose **Tech Notes**. In the lower right-hand corner of the screen, choose the **Breath Reject** box to remove the checkmark. This will help decrease the number of breaths rejected by the Vmax during testing. Press **F3** to save changes.
13. Have the patient begin hyperventilation as you toggle into exercise phase at the bottom right-hand corner of the screen. This will begin a counter at the top of the screen. The patient should hyperventilate for 6 minutes. Monitor patient's VE (minute ventilation) to keep it within the calculated target range, giving verbal encouragement as necessary.
14. Adjust flowrate of gas mixture from the H-cylinder to the reservoir bag to keep the bag inflated throughout the 6 minutes of hyperventilation, taking care not to under-fill or over-fill the bag.
15. After 6 minutes of hyperventilation, re-enter **Pulmonary Function** to perform spirometry, and toggle into **Post test**. Perform FEV_1 maneuver at 1, 3, 5, 7, 10, 15, and 20 minutes post hyperventilation.
16. Complete the EVH worksheet and calculate the total percent change achieved.
17. Administer a bronchodilator and re-test until patient returns to their baseline spirometry.

EXHIBIT A

REFERENCES:

1. S D Anderson, G J Argyros, H Magnussen, *et al*. Provocation by eucapnic voluntary hyperpnoea to identify exercise induced bronchconstriction. *British Journal of Sports Medicine* 2001 35: 344-347

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