

# The Safety of Cardiopulmonary Exercise Testing in Children with Pulmonary Hypertension

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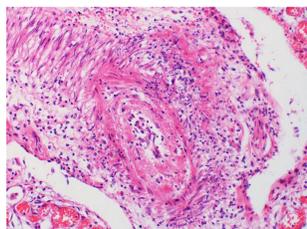
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## Background

Cardiopulmonary exercise testing (CPET) is a valuable tool to objectively measure exercise capacity.

Evidence supports its role as a prognostic tool and to guide treatment

However its use in children with PH is extremely limited, partly because of concerns regarding its safety.



## Results

- **98 patients, 45 with PH associated with congenital heart disease (CHD) and 35 with idiopathic PH had 167 CPETs.**
- **Median age was 14 years (10-15).**
- **Mean peak oxygen uptake (VO<sub>2</sub>) was 19.7±7.3 mL/kg/min, (51.6±18.3% of predicted value).**
- **Mean peak respiratory quotient was 1.08±0.16.**
- **All tests were maximal, except two, being terminated prematurely for clinical reasons.**
- **Five children (3.0%) experienced dizziness** (two with significant desaturation, and one requiring test termination).
- **Five children (3.0%) experienced chest pain** (two with significant desaturation, and one requiring test termination).
- **No significant arrhythmias or ECG changes were observed.**
- **Mean baseline saturation (SaO<sub>2</sub>) was 93.31±8.4% (23.5% of children had a baseline SaO<sub>2</sub><90%).**
- **Average SaO<sub>2</sub> at peak exercise was 81.2±19.5%.**
- **A drop of SaO<sub>2</sub><5% was observed in 38.6% of patients, 23.5% of patients had a decrease >20%.**

## Objectives

1. To assess the safety profile of CPET in a large cohort of paediatric PH patients.
2. To understand if specific features, i.e PH diagnostic groups, are associated with an increased risk of events during CPET.

## Materials and methods

Retrospective data from all consecutive patients undergoing CPET at a single center between March 2004 and November 2013.

### Exclusion criteria for CPET were:

- Height <120cm
- WHO class IV
- History of syncope or significant ischemia/arrhythmias during exercise.



### Significant events recorded included were:

- Symptoms reported by patients
- Arrhythmias
- Abnormalities detected on ECG
- Abnormal responses of arterial O<sub>2</sub> saturation (SaO<sub>2</sub>).

Variable	All Patients
Number of tests	167
Age (years)	14.0 (10-15.0)
Height (cm)	151±16.1
Weight (kg)	45.3±16.4
Rest HR (beats/minute)	93.7±16.1
Peak HR (beats/minute)	154.7±23.3
Percentage of predicted peak HR (%)	84.0±12.6
Rest SaO <sub>2</sub> (%)	93.3.5±8.8
Peak SaO <sub>2</sub> (%)	81.2±19.5
Absolute SaO <sub>2</sub> change (%)	12.1±14.3
Resting systolic BP (mmHg)	103.8±16.1
Peak systolic BP (mmHg)	120±30.7
Peak respiratory quotient	1.07.7±0.16
Peak VO <sub>2</sub> (mL/kg/min)	20.4±7.28
Peak VO <sub>2</sub> (% of predicted)	51.8±18.3
Peak workload (Watts)	69.5±37.85

CPET demographics and test for all patients and presented as mean±SD

Adverse Event	All patients (n=167)	Idiopathic PH (n=59)	PH associated with CHD (n=76)	Group 2 (n=6)	Group 3 (n=19)	Other (n=7)	p value
Dizziness, n (%)	5(3.0)	2 (3.4)	1 (1.3)	1 (16.7)	1 (5.3)	0 (0)	<0.0001
Chest Pain, n (%)	5 (3.0)	1 (1.7)	4 (5.3)	0 (0)	0 (0)	0 (0)	0.634
SaO <sub>2</sub> drop >5%, n (%)	94 (56.6)	23 (42.4)	48 (63.2)	1 (16.7)	18 (89.5)	4 (71.4)	0.0004
Ventricular ectopic beats, n (%)	21 (12.6)	8 (13.6)	4 (5.3)	1 (16.7)	8 (42.1)	0 (0)	0.0003
ST depression, n (%)	8 (4.8)	2 (3.4)	6 (7.9)	0 (0)	0 (0)	0 (0)	0.502
T wave changes, n (%)	5 (3.0)	3 (5.1)	1 (1.3)	0 (0)	1 (5.3)	0 (0)	0.0003
Other events, n (%)	12 (7.2)	2 (3.4)	6 (8.0)	2 (33.3)	0 (0)	2 (28.6)	0.016
No events, n (%)	57 (34.1)	24 (40.6)	26 (34.2)	3 (50)	1 (14.3)	1 (14.3)	0.407

### Frequency of complications observed in different PH diagnostic groups.

SaO <sub>2</sub> change (%)	All (n=166)	Idiopathic PH (n=59)	PH associated with CHD (n=76)	Group 2 (n=6)	Group 3 (n=19)	Other (n=6)	p value
≤5%	72 (43.4%)	36 (61.0%)	28 (36.8%)	5 (83.3%)	1 (5.2%)	2 (33.3%)	0.0004
5.1-10%	26 (15.7%)	11 (18.6%)	9 (11.8%)	0 (0%)	3 (15.8%)	3 (50%)	0.0035
10.1-15%	13 (7.8%)	1 (1.7%)	6 (7.8%)	0 (0%)	5 (26.3%)	1 (16.7%)	0.1796
15.1-20%	16 (9.6%)	6 (10.2%)	6 (7.8%)	1 (16.6%)	3 (15.8%)	0 (0%)	0.9967
>20%	39 (23.5%)	5 (8.5%)	27 (35.5%)	0 (0%)	7 (36.8%)	0 (0%)	0.0002

Extent and frequencies of SaO<sub>2</sub> changes from rest to peak exercise for patients with measurable peak exercise SaO<sub>2</sub> values (n=166). NB: For one patient pulse oximetry data was unavailable and so has not been included in this table.

### Association between diagnostic group and side effects during CPET

- Ventricular ectopics were more common in group 3 PH, than idiopathic PH (**p<0.05**) and PH associated with CHD patients (**p<0.001**).
- A drop in SaO<sub>2</sub>(>5%) was more common in group 3 PH compared with idiopathic PH (**p<0.05**) and those with CHD than left heart disease (**p<0.05**) or lung disease (**p<0.01**).
- No specific diagnostic group had a greater risk of side effects than any other.

### Association of medication and side effects during CPET

- Children were divided in 3 groups based on PH medication status: 0, 1, >1.
- Ventricular ectopics were more likely in those on one medication (**17/82**) than no medication (**1/21**) **p<0.05**.
- There were no differences in the incidence of cyanosis, dizziness, chest pain or ECG changes.

## Conclusions

- CPET in mild to moderately symptomatic children with PH is safe in a controlled environment and with an experienced team.
- Arterial O<sub>2</sub> desaturation is common but asymptomatic in the majority of patients.
- No side effects of the test were serious and all resolved promptly when the test was terminated.
- Adverse events were less likely in those children who were not receiving any regular PH medication.

## Clinical Perspective

This work advocates a more liberal use of CPET in paediatric PH, particularly to fully harness its utility as a tool to guide and monitor treatment.

## Limitations

Our cohort was largely idiopathic and CHD related PH. Those with less common causes of PH need to be represented in larger quantity in future studies.

## References

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## Further Information

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