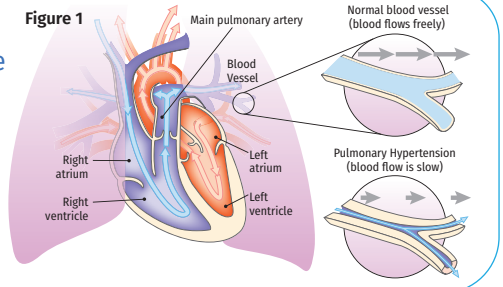


Pulmonary Hypertension in Children

Part 1: Causes and Symptoms

Pulmonary Hypertension (PH) is a rare but serious disease that can develop in children or adults at any age. PH causes high blood pressure in the blood vessels of the lungs. This leads to problems including difficulty getting enough oxygen to the body and strain on the heart. This fact sheet talks about Pulmonary Hypertension in children. Information about PH in Adults and Part 2 : Diagnosis and treatment of PH in children can be found found at www.thoracic.org/patients.



What is Pulmonary Hypertension?

In a structurally normal heart, there are two “sides” (see Figure 1). The left side pushes oxygen-rich blood out to the body so the body and brain have oxygen for energy. When the body has used up the oxygen, the blood collects into veins and returns to the top of the right side of the heart (the right atrium). The blood then flows into the lower chamber (the right ventricle). The right ventricle’s job is to pump this blood through the pulmonary artery and into the lungs. In the lungs, the blood receives the oxygen that is breathed in, so the blood can carry that oxygen back to the left side of the heart and be sent back out to the body again.

In Pulmonary Hypertension (PH), there is high pressure in the blood vessels of the lungs. The increased pressure makes the right ventricle work harder to pump blood through the lungs. When the right ventricle works harder, the muscle gets thicker over time and the right ventricle begins to stretch or dilate. As PH worsens and the pressure in the lungs rises, it gets more and more difficult for the right ventricle to pump blood to the lungs. Over time, the muscle of the right ventricle can tire out and fail, a condition known as right heart or right ventricular failure. Right ventricular failure is a very high-risk condition for death in patients with PH. It is important for children with PH to have close monitoring and treatment with specific PH-directed therapies. Patients should seek advanced care at specialized centers, which can provide options for other intensive treatments too, such as surgical interventions and lung transplant.

What are the Causes of Pediatric Pulmonary Hypertension?

Although, the general or umbrella term “PH” is used to refer to all types of pulmonary hypertension, not all PH is the same. There are two main types of PH in children: pulmonary arterial hypertension (PAH) and associated PH. There are differences between these types of pulmonary hypertension at the microscopic level, differences in treatment approaches and differences in outcomes. The severity and the clinical course of these types of PH can vary widely also, making it difficult to draw generalized conclusions about pediatric PH as a disease.

Pulmonary arterial hypertension (PAH)

PAH is caused by narrowing of the blood vessel walls, usually due to abnormal structure, and scarring. The narrowing makes it more difficult for the blood to pass through the blood vessels. This leads to increased blood pressure in these vessels and stress on the right ventricle. PAH is a progressive disease, which means that it worsens over time, is not reversible, and carries a risk for early death.

PAH may occur without a clear reason or may be inherited, and genetic mutations can affect multiple family members. In heritable PAH, the medical team may recommend checking other members in the family for symptoms of PAH. One of the most common genetic mutations associated with heritable PAH occurs in the *BMPR2* gene. Genetic testing for PAH typically includes *BMPR2* in addition to more than ten other known genetic mutations.

Another condition associated with PAH is congenital heart disease. This can lead to increased blood flow through the blood vessels of the lungs, causing damage and scarring to them over time. This results in elevated pulmonary pressures and PAH conditions.

Pulmonary Hypertension Associated with Other Medical Conditions

Many medical conditions may be associated with PH such as:

- Developmental lung diseases (for example, bronchopulmonary dysplasia or congenital diaphragmatic hernia)
- Clotting disorders
- Autoimmune diseases (for example, lupus, scleroderma)
- Genetic or developmental disorders (for example, Trisomy 21)
- Medication side effects (for example, diazoxide)
- Infection with schistosomiasis

Each of these diseases causes changes in the blood vessels of the lungs that lead to PH. Many of these cases of PH will improve when the main disease is treated and well controlled. However, many of these patients still need PH-directed therapy. PH associated with another condition may improve or worsen with time, often depending on the underlying cause. Attention must be given to treating the cause of the

PH, as this often affects clinical course, severity and outcome. Therefore, the prognosis for PH associated with another condition is different from PAH.

In children, bronchopulmonary dysplasia (BPD) is a common cause of PH. BPD is a condition of abnormal lung development related to premature birth (see ATS Patient Information fact sheet on BPD). The lungs and airways are not as well developed and do not function as well as normal. The blood vessels in the lungs with BPD are often not well developed, so their ability to tolerate blood flow is decreased. PH in the BPD infant can be a very worrisome problem and should be addressed by a specialist with expertise in this condition. Fortunately, in most cases of PH associated with BPD, as the child gets older and the lungs mature, the PH naturally improves and may resolve completely.

Who gets Pulmonary Hypertension?

PAH is a rare disease that can occur in children and adults of any age. Estimates of disease diagnosis vary. It is estimated that there are 0.47 to 2 per million children diagnosed with PAH per year. At any given time, it is believed that there are about 2.1-4.4 cases per million children living with PAH in the community. PAH or heritable PAH may present at different times throughout childhood, but it is most commonly diagnosed between ages 6-8 years. Likely due to hormone effects, females are more likely to have PAH than males.

Estimates for secondary or associated PH are often inaccurate because diagnosis is affected so heavily by the underlying disease process and there is often a lack of PH recognition. The cause of PH varies by age group and underlying disease. Infants diagnosed with PH are likely to have PH associated with underlying developmental lung disease or congenital heart disease.

Changes in the Body Due to Pulmonary Hypertension

As the pressure increases in the blood vessels of the lungs, the right ventricle must pump harder than usual. This causes the right ventricle to weaken over time. Blood can then backup into the right ventricle, right atrium and finally, into the veins of the head, neck, and belly. Blood flow through the lungs is decreased, which leads to less blood flow to the body's organs. This can lead to changes in the function of these organs. The heart may sound different to a doctor from a normal heart when examined. A murmur or loud second heart sound might be heard. The child may develop bulging neck veins, belly pain, nausea with vomiting and/ or liver abnormalities. The lack of blood flow and oxygen to the brain can lead to seizures, fainting, or dizziness. Other changes may include poor weight gain, decreased activity, and blue spells with activity.

In the most severe cases, the blood pressure in the lungs can rise so high that the right ventricle can no longer pump blood through the lungs. This can be from a sudden rise in the blood pressure in the lung, or it can be from the right ventricle muscle failing after a long period of pumping against high pressure. This is called a pulmonary hypertensive crisis and is life threatening.

Symptoms of Pulmonary Hypertension in Children

Due to changes in the heart and the lungs, children may not tolerate activity as well. They may complain of chest pain, shortness of breath and/or dizziness. Sometimes, children will look very pale or bluish and faint (pass out) with activity too.

The child's appetite may decrease and he/she may have nausea and vomiting with eating. The child with PH can also look swollen, in the face, arms and legs. In the young child, poor weight can be seen whereas the older child may gain weight, due to swelling and inactivity.

Prognosis

PH in children is made up of many different types and can be from many causes. PAH is a serious, life-threatening, and life-shortening disease. With early diagnosis and specialized treatments, survival can be extended. When PH occurs due to another disease, the other disease typically affects PH disease course and outcome.

For children, diagnosis may be delayed because of lack of awareness of this disease and the shortage of PH specialists. If possible, patients should get care in a pediatric PH center. The Pulmonary Hypertension Association has a process for accreditation of centers as PHA Care Centers. These are centers recognized for their expertise in the care of children with pulmonary hypertension and which have been reviewed carefully by the PHA. A list of those accredited centers can be found here: <https://phassociation.org/phcarecenters/accredited-centers/>

Action Steps:

- ✓ If your child has trouble breathing with exercise or fainting spells that are not improving with treatment or getting worse, ask your healthcare provider about checking for pulmonary hypertension.
- ✓ If your child has been diagnosed with Pulmonary Hypertension, seek care from a PH specialist at an experienced center.
- ✓ Take all medications as prescribed and call right away with any change in symptoms.
- ✓ Talk with your child's PH specialist about what activities your child can safely do.

Healthcare Provider's Contact Number:

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Resources

American Thoracic Society

- www.thoracic.org/patients
 - Pulmonary Hypertension in Children, Part 2

Pulmonary Hypertension Association (PHA)

- <https://www.phassociation.org/Parents>

PHAware Global Association

- <https://www.phaware.global/>

The Pediatric Pulmonary Hypertension Network

- www.PPHNet.org

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