Pulse Oximetry

Congenital Heart Disease (CHD) is the commonest group of congenital malformations and affects 7-8/1000 live born newborns. It contributes to 3% of all infant mortality and 46% of deaths from congenital malformations with most deaths occurring in the first year of life. Could having a pulse oximetry within 72 hours of being born prevent this?

What is PULSE OX testing ?

Pulse oximetry is a non-invasive diagnostic test used for detecting the percentage of **haemoglobin (Hb)** that is saturated with oxygen. This oxygen saturation is a measure of how much oxygen the blood is carrying as a percentage of the maximum it could carry. A normal pulse ox test would be 98 too 100. Anything under 95 is to low and kids with CHD have low pulse ox because their hearts do not get enough oxygen in to the blood

How is Pulse Oximetry performed?

A **pulse oximeter** is the device used for performing the test. It has a probe or rather a special light clip that is placed to the patient's finger or ear lobe (picture on left). The probe/clip is attached to the pulse oximeter, which is a computerised unit, by a cable. The unit displays the percentage of Hb saturated with oxygen. In some pulse oximeter models, the heart rate and blood flow can also be monitored. The oximeter can detect **hypoxia** before a patient becomes **cyanotic**.

Testing: The testing is non-invasive and does not cause pain, nor is it considered a "risky" procedure. Pulse oximetry can be performed at rest, during activity or even during sleep.

How does a Pulse Oximeter work?

A source of light originates from the probe/clip at two wavelengths of (650nm and 805nm) otherwise known and red and infrared. The two light wavelengths pass through the skin to measure the amount of oxygen in the blood, basically the light is partly absorbed by haemoglobin, by amounts, which differ depending on whether it is **saturated or desaturated with oxygen**. By calculating the absorption at the two wavelengths the processor can compute the proportion of haemoglobin which is oxygenated. The oximeter is dependant on a pulsatile flow and produces a graph of the quality of flow - in other words, the oximeter detects the slight change in colour of the arterial blood caused by the beat of the heart when blood is pushed into the finger (or earlobe or toe). Because the change in colour is so minute, it is imperative to ensure a strong pulse during testing. Where flow is sluggish (e.g. hypovolaemia or vasoconstriction) the pulse oximeter may be unable to function. When the pulse is weak, the results may be inaccurate. The computer within the oximeter is capable of distinguishing pulsatile flow from other more static signals (such as tissue or venous signals) to display only the arterial flow.

Pulse Oximetry Test Results on a fit and healthy adult

Pulse oximeter results must be accompanied by the percentage of oxygen the person is breathing, and their respiratory rate, for the results to be meaningful.

A fit, healthy person should have an oxygen saturation between 95%

and 99%. Results lower than 90% may be caused by excessive bleeding, lung problems, cigarette smoking, blood vessel problems, lung diseases such as COPD. Percentages above 99% may indicate that the testing was performed outside the pulse oximeter's limitations; re-testing may be needed.

What the Results Mean

One Hb molecule has the ability to carry up to four oxygen molecules. Therefore, one hundred haemoglobin molecules could carry a maximum of 400 oxygen molecules. If during testing, the haemoglobin molecules were carrying 380 oxygen molecules, the percentage of saturation would be 95% ((380/400) x 100 = 95%).

Definition of Medical words mentioned in this brochure:

What is Haemoglobin (Hb)?

Haemoglobin is a protein in red blood cells that carries oxygen. A blood test can tell how much haemoglobin you have in your blood.

What is Hypoxia?

Hypoxia / hypoxemia is a condition in which there is an inadequate supply of oxygen in the blood. Hypoxia is caused by:

- A reduction in partial pressure of oxygen
- Inadequate oxygen transport
- The inability of the tissues to use oxygen

What is Cyanotic?

Cyanosis is a condition in which the skin, lips and nails become bluish or purplish in colour. It occurs when there is an insufficient amount of oxygen in the blood.

What is saturated oxygen?

The red blood cells must carry sufficient oxygen through the arteries to all internal organs to keep a person alive. Normally, when red blood cells pass through the lungs, 95%-100% of them are loaded, or "saturated," with oxygen to carry.

What is hypovolaemia?

This is when severe blood and fluid loss makes it difficult for the heart to pump enough blood to the body. It causes low blood pressure, rapid pulse and low body temperature.

What is vasoconstriction?

Vasoconstriction is the narrowing (constriction) of blood vessels. When blood vessels constrict, the flow of blood is restricted or slowed.

Other information

In the UK there is a current newborn screening policy that comprises of a clinical examination at birth and 6 weeks, with specific cardiac investigations for specified high-risk children.

Conclusion

Early detection through newborn screening potentially can improve the outcome of congenital heart defects.
Pulse oximetry is a promising alternative newborn screening strategy but further evaluation is needed to obtain more precise estimates of test performance and to inform optimal timing, diagnostic and management strategies. Although screening echocardiography is associated with the highest detection rate, it is the most costly strategy and has a 5% false-positive rate.

For more information visit www.congenital-heart-defects.co.uk

For nurses:

This paragraph was taken directly from:
http://www.ncchta.org/minisumm/min944.htm
In a population of 100,000 live-born infants, the model predicts 121 infants with life-threatening congenital heart defects undiagnosed at screening, of whom 82 (68%) and 83 (69%) are detected by pulse oximetry and screening echocardiography, respectively, but only 39 (32%) by clinical examination alone. Of these, 71, 71 and 34, respectively, receive a timely diagnosis. The model predicts 46 (0.5%) false-positive screening diagnoses per 100,000 infants with clinical examination, 1168 (1.3%) with pulse oximetry and 4857 (5.4%) with screening echocardiography. The latter includes infants with clinically non-significant defects. Total programme costs are predicted of £300,000 for clinical examination, £480,000 for pulse oximetry and £3.54 million for screening echocardiography. The additional cost per additional timely diagnosis of life-threatening congenital heart defects ranges from £4900 for pulse oximetry to £4.5 million for screening echocardiography. Including clinically significant congenital heart defects gives an additional cost per additional diagnosis of £1500 for pulse oximetry and £36,000 for screening echocardiography. Key determinants for cost-effectiveness are detection rates for pulse oximetry and screening echocardiography. Parents and health professionals place similar values on the quality of life outcomes of children with congenital heart defects and both are more averse to neurological than to cardiac disability. Adverse psychosocial effects for parents are focused around poor management and/or false test results.