Infant respiratory distress syndrome (IRDS)

Synonym: hyaline membrane disease

What is infant respiratory distress syndrome?

Infant respiratory distress syndrome (IRDS) is caused by the inadequate production of surfactant in the lungs. Surfactant is normally produced by type II pneumocytes and has the property of lowering surface tension.

Most alveolar surfactant is produced after 30 weeks of gestation.[1] Inadequate surfactant production causes air sacs to collapse on expiration and greatly increases the energy required for breathing.

The development of interstitial oedema makes the lung even less compliant. This leads to hypoxia and retention of carbon dioxide. Right-to-left shunting may be severe and occurs through collapsed lung (intrapulmonary) or, if pulmonary hypertension is severe, across the ductus arteriosus and the foramen ovale (extrapulmonary).

IRDS epidemiology

- The incidence and severity are related inversely to the gestational age of the infant; a 2012 study showed 98% of babies born at 24 weeks had IRDS, while at 34 weeks, the incidence was 5%, and at 37 weeks was less than 1%.[2]
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- The incidence of IRDS decreases with:
    - The use of antenatal steroids. However, there are uncertainties over the efficacy for some groups such as the very early preterm babies, late preterm babies and multiple gestations.[3]
    - Pregnancy-induced or chronic maternal hypertension.
    - Prolonged rupture of membranes.

Risk factors[4]

- Premature delivery.
- Male infants.
- Infants delivered via caesarean section without maternal labour.
- Hypothermia.
- Perinatal asphyxia.
- Maternal diabetes.
- Family history of infant respiratory distress syndrome.

Secondary surfactant deficiency may occur in infants as a result of:[5]

- Intrapartum asphyxia.
- Pulmonary infection - eg group B beta-haemolytic streptococcal pneumonia.
- Pulmonary haemorrhage.
- Meconium aspiration pneumonia.
- Oxygen toxicity along with pressure or volume trauma to the lungs.
- Congenital diaphragmatic hernia and pulmonary hypoplasia.

Infant respiratory distress syndrome symptoms

- Usually preterm delivery.

- Presents with respiratory distress - usually immediately or within minutes after birth, but it may take hours to develop the typical signs: [6] tachypnoea, expiratory grunting, subcostal and intercostal retractions, diminished breath sounds, cyanosis and nasal flaring.
- May rapidly worsen over the following 48 hours to fatigue, apnoea and hypoxia.

Differential diagnosisof IRDS [6]

Other causes of respiratory distress in neonates:

- Pulmonary air leaks (eg, pneumothorax, interstitial emphysema, pneumomediastinum, pneumopericardium). In premature infants, these may occur from excessive positive pressure ventilation, or they may be spontaneous.
- Any infection may cause respiratory distress and may co-exist with IRDS; rapid diagnosis and treatment of any infection are essential.
- Pneumonia is often due to group B beta-haemolytic streptococci and often co-exists with IRDS.
- Aspiration of amniotic fluid, blood, or meconium may occur. It is usually seen in term or post-mature infants.
- Transient tachypnoea of the newborn usually occurs in term or near-term infants and usually after caesarean delivery.
- Congenital anomalies of the lungs (eg, diaphragmatic hernia, chylothorax, lobar emphysema, bronchogenic cyst, pulmonary sequestration).
- Congenital heart anomalies.
- Primary persistent pulmonary hypertension of the newborn (persistent fetal circulation).
- Metabolic problems (eg, hypothermia, hypoglycaemia).
- Haematological problems (eg, anaemia, polycythaemia).

Investigations

- Blood gases: respiratory and metabolic acidosis along with hypoxia. Metabolic acidosis results from poor tissue perfusion.
- Pulse oximetry is used as a non-invasive tool to monitor oxygen saturation, which should be maintained at 91-95%.[7]
- CXR or lung ultrasound (has been shown to have high sensitivity but may miss comorbid air-leak syndromes).[8]
- Monitor FBC, electrolytes, glucose, renal and liver function.
- Echocardiogram: diagnosing patent ductus arteriosus (PDA), determine the direction and degree of shunting, making the diagnosis of pulmonary hypertension and excluding structural heart disease.
- Cultures to rule out sepsis.

IRDS treatment and management

Surfactant replacement therapy[9]
This is given via an endotracheal tube:

- Prophylactic intratracheal administration of protein-free synthetic surfactant to infants at risk of developing infant respiratory distress syndrome has been demonstrated to improve clinical outcome.[10]
- Infants who receive prophylactic protein-free synthetic surfactant have a decreased risk of pneumothorax, a decreased risk of pulmonary interstitial emphysema and a decreased risk of neonatal mortality.
- Infants who receive prophylactic protein-free synthetic surfactant have an increased risk of developing PDA and pulmonary haemorrhage.
- However, a 2012 (most recent) Cochrane review has shown less risk of chronic lung disease or death when using early stabilisation on continuous positive airway pressure (CPAP) with selective surfactant administration to infants requiring intubation.[11]

- Minimally invasive surfactant administration (via thin catheter) is also an option.[12]

Oxygen[13]

- In babies receiving oxygen, saturation should be maintained between 91% and 95%.[7]
- Oxygen via a hood is still used for treating infants with mild IRDS.
- Intermittent positive pressure ventilation (IPPV) with surfactant is the standard treatment but it is invasive, potentially resulting in airway and lung injury.
- Continuous distending pressure (CDP) keeps the alveoli open at the end of expiration and has been used for the prevention and treatment of IRDS, as well as for weaning from IPPV. Its use in the treatment of IRDS might reduce the need for IPPV and its sequelae.
- Interventions for CDP include CPAP by mask, nasal prong, nasopharyngeal tube or endotracheal tube, or continuous negative pressure (CNP) via a chamber.
- In preterm infants with nfant respiratory distress syndrome, the application of CDP as CPAP or CNP is associated with reduced respiratory failure and mortality and an increased rate of pneumothorax.
- Studies have found that early nasal intermittent positive pressure ventilation (NIPPV) compared with nasal continuous positive airway pressure (nCPAP) decreases the requirement for endotracheal ventilation in preterm and term infants with IRDS.[14] [15]

Supportive therapy for IRDS

This includes the following:

- Gentle and minimal handling.
- Temperature regulation: prevent hypothermia.
- Fluids, metabolism and nutrition: closely monitor and maintain blood glucose, electrolytes, acid balance, calcium, phosphorous, renal function and hydration.

- Once the infant is stable, intravenous nutrition with amino acids and lipid.
- After the respiratory status is stable, initiate small-volume gastric feeds (preferably breast milk) via a tube initially to stimulate gut development.
- Circulation and anaemia: monitor heart rate, peripheral perfusion and blood pressure. Blood or volume expanders may be required.
- Antibiotics: start antibiotics in all infants who present with respiratory distress at birth, after obtaining blood cultures. Discontinue antibiotics after three to five days if cultures are negative.
- Support of parents and family: keep the parents well informed. Encourage parents to visit frequently and stay with their baby.

IRDS complications

Acute complications
These include the following:

- Complications related to procedures - eg, trauma to vocal cords from tracheal intubation; infection, embolism or thrombosis from venous or arterial catheterisation.
- Alveolar rupture: pneumothorax, pneumomediastinum, pneumopericardium, interstitial emphysema.
- Intracranial haemorrhage: the risk is increased in those who require mechanical ventilation.
- PDA, with increasing left-to-right shunt, especially in infants weaned rapidly after surfactant therapy.
- Persistent pulmonary hypertension.
- Occurrence of pulmonary haemorrhage increases in very premature infants, especially following surfactant therapy.
- Hospital-acquired infection.
- Necrotising enterocolitis and/or gastrointestinal perforation.

- Apnoea of prematurity is common in immature infants; its incidence has increased with surfactant therapy, possibly due to early extubation.

Chronic complications
These include the following:

- Chronic lung disease (bronchopulmonary dysplasia) is defined either as oxygen requirement at a corrected gestational age of 36 weeks or beyond the 28th day of life. It is due to lung injury from mechanical ventilation and the risk increases with decreasing gestational age, small for dates, severity of respiratory distress syndrome and duration of mechanical ventilation [16] .
- Retinopathy of prematurity: infants with infant respiratory distress syndrome and PaO_2 greater than 100 mm Hg are at a greater risk.
- Neurological impairment is related to the gestational age, the extent of intracranial pathology, the presence of hypoxia, the presence of infectionsand the length of time on mechanical ventilation. This correlates with increased rates of both cerebral palsy and neurodevelopmental delay. [17] They may develop a specific learning disability and behavioural problems.
- Hearing impairment and visual handicap may further compromise development.

Prognosis

- The outcome has improved in recent years with the increased use of antenatal steroids to improve pulmonary maturity, early postnatal surfactant therapy to replace surfactant deficiency and gentler techniques of ventilation to minimise damage to the immature lungs.
- Mortality may be less than 10%, with some studies showing survival rates of up to 98% with advanced care. [6] Increased survival in developed countries is in stark comparison to babies who received no intervention in low-income countries, where the mortality rate for premature infants with RDS is significantly higher, at times close to 100%.
- The prognosis is much better for babies weighing over 1500 g.

IRDS prevention

- Antenatal corticosteroids (dexamethasone) accelerate fetal surfactant production and lung maturation. They have been shown to reduce nfant respiratory distress syndrome, intraventricular haemorrhage and mortality by 40%.[18]
- Delaying premature birth. Tocolytics - eg, atosiban, nifedipine or ritodrine - may delay delivery by 48 hours and therefore enable time for antenatal corticosteroids to be given.
- Good control of maternal diabetes.
- Avoid hypothermia in the neonate.

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