MECONIUM ASPIRATION SYNDROME (MAS)

Respiratory distress in the presence of meconium liquor with patchy opacification and hyperexpanded lung fields on CXR.

EPIDEMIOLOGY

- Meconium stained liquor occurs in ~10-26% of all deliveries.
- Before 37 weeks gestation, the risk is < 2%.
- After 42 weeks the risk is ~40%.
- Thick meconium in the liquor increases the risk of fetal acidosis and is related to adverse outcome. There is no correlation between consistency of fetal meconium and asphyxia, and markers of acute intrauterine asphyxia. Thick meconium, fetal tachycardia or absent response to contractions may identify an infant at high risk.
- MAS often occurs in the post-mature infant or in the presence of other placental insufficiency syndromes.

PATHOPHYSIOLOGY

There is often a history of fetal distress and meconium in the liquor. Intra-uterine distress (at any time in gestation) may initiate gasping in utero. This may result in amniotic fluid and particulate matter to be inhaled into large airways, which then causes obstruction at delivery.

The meconium causes a ball-valve effect in the airways, resulting in areas of collapse and areas of overexpansion due to gas trapping. Air leak is common. Chemical inflammation from the meconium leads to a pneumonitis.

Meconium also inhibits endogenous surfactant. Secondary persistent pulmonary hypertension is present as a result of the atelectasis, hypoventilation, and intra-pulmonary shunting.

CLINICAL PRESENTATION

The infant with MAS is cyanosed, tachypneic, with a hyperinflated chest. They may have marked swings in oxygen saturation due to intra and extra-pulmonary shunting. Poor perfusion may result from impaired cardiac function.

INVESTIGATIONS

- Pre and post-ductal oxygen saturations should be measured to ascertain the degree of shunting.
- A hyperoxia test should be performed to try to eliminate the possibility of cyanotic heart disease. This involves administering 100% oxygen to the infant for 15 minutes and observing the pre and post ductal oxygen saturation. The saturations should not increase in cyanotic heart disease. In a critically sick neonate with MAS, the oxygen saturation may not increase. In this case an arterial blood gas should be performed. In cyanotic heart disease, the PaCO₂ will be normal to low, where as in meconium aspiration syndrome, it is invariably high.
- Once transported to the NICU, any infant with MAS who is requiring FiO\textsubscript{2} > 0.8 should have an echocardiogram to exclude cyanotic heart disease.
- Chest X-ray shows patchy opacifications with areas of atelectasis and other areas of hyperinflation.

**MANAGEMENT**

The pre-ductal saturation indicates how much oxygen is supplying the brain and ventilator changes should be made on pre-ductal gases where possible. Early stabilisation is the most important management strategy. Management should be similar to that of treating for pulmonary hypertension:

1. Treat with antibiotics until sepsis excluded
2. Temperature / glucose regulation.
3. Systemic arterial blood pressure should be greater that pulmonary arterial blood pressure. Aim for a mean blood pressure 55-60 mmHg. The pulmonary arterial blood pressure is invariably supra-systemic, therefore high systemic blood pressures are needed to overcome the pulmonary pressure and allow blood flow into the lung. This should be achieved with inotrope support:- dopamine, and adrenaline infusions as required.
4. Sedation will decrease pulmonary arterial pressure. Morphine or midazolam with a muscle relaxant is the rule in critically sick infants with pulmonary hypertension. Vecuronium is preferred to pancuronium in infants with cardiovascular instability because it has no effect on the heart.
5. Inhaled nitric oxide is a selective pulmonary vasodilator and hence will decrease pulmonary arterial pressure if it is able to get into the airways effectively. Infants ventilated and receiving inhaled nitric oxide should be handled minimally and only if necessary. Routine turning and suctioning should be avoided. Turning should only be performed after discussion with the consultant. Endotracheal suctioning should be performed only if tube obstruction is suspected. 
   **Other vasodilator drugs:** prostacyclin, sodium nitroprusside, and tolazoline, are systemic vasodilators and will drop systemic blood pressure. Newer drugs such as Milrinone (phosphodiesterase inhibitor) may be of benefit as it is a vasodilator as well as a mild inotrope.
6. Volume: Because the right ventricle is overloaded and the left ventricle is working inefficiently, volume loading is often required to improve pre-load on the heart. Additional volume may be needed when the infant is on HFV because a high mean airway pressure will impede venous return to the heart.
7. Surfactant: Meconium inactivates endogenous surfactant in the piglet model. Surfactant improves gas exchange, decreases the oxygenation index, and is more effective the earlier it is given. The need for ECMO has significantly reduced since iNO and surfactant have been administrated to infants with severe MAS. Exogenous surfactant is given every 6 hours to replace the inactivated surfactant. The dose may be repeated as many times as is needed to stabilise the infant. Surfactant should be given to any infant who is ventilated and in > than 50\% oxygen. For infants that are in >80\% oxygen, consideration should be given to administration of surfactant at the referring hospital during a WANTS transport (discuss with consultant). Surfactant should be given slowly in case of deterioration. If the oxygen saturation decreases below 80\% and does not improve after a considerable time, consider suction and treat the episode as a “surfactant lavage”. High volume, dilute surfactant lavage remains an experimental treatment and should not be considered outside of a randomised controlled trial.
8. High Frequency Oscillation Ventilation (HFOV) / iNO: HFOV can assist in opening up the lung to improve administration of iNO, and improve oxygenation and CO\textsubscript{2} removal. Because neonates may already have hyperinflated lungs with MAS, volume optimisation must be
achieved with care due to potential for air leak. Start the infant on a MAP equal to that on the conventional ventilator and gradually increase it. See HFOV / iNO for detailed management.

9. Weaning an infant off therapy needs to be a slow process and attempted only after discussion with a consultant.

10. The prognosis of infants with meconium aspiration syndrome is dependent on the degree of severity of the pulmonary hypertension and other end-organ involvement. With the dramatic recent reduction in incidence of air leak, the mortality has dropped to 0.15%.