# Management of meconium aspiration syndrome

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## Abstract

Meconium aspiration syndrome (MAS) mainly affects term and post-term infants. It ranges from mild respiratory distress to life-threatening cardiorespiratory failure. Prevention and treatment strategies are evolving. Amnioinfusion is no longer recommended for women with meconium staining of the amniotic fluid (MSAF). Pharyngeal suction prior to delivery of the fetal shoulders and tracheal suction of vigorous infants after birth do not prevent MAS and may be harmful. Tracheal suction is recommended for non-vigorous infants with MSAF but has not been studied prospectively. Bolus surfactant therapy, high frequency oscillatory ventilation and inhaled nitric oxide may be beneficial in severe cases. Surfactant lavage reduces the combined risk of death or requirement for extracorporeal membrane oxygenation (ECMO) when compared with no surfactant treatment but its role in the routine management of MAS is uncertain and it should be compared with bolus surfactant in prospective studies. ECMO reduces the risk of mortality in severe cases so it is of paramount importance to discuss the transfer of severely ill infants to an ECMO centre.

**Keywords** extracorporeal membrane oxygenation; high frequency ventilation; infant; labour, induced; meconium aspiration syndrome; newborn; nitric oxide; persistent fetal circulation; pulmonary surfactant

## What's new?

- Amnioinfusion is no longer recommended for women with MSAF.
- Surfactant lavage has been shown to reduce the risk of death or requirement for ECMO. Larger trials, including comparison with bolus surfactant treatment are required to define its role.

## Introduction

Meconium aspiration syndrome (MAS) mainly affects term or post-term infants and can be defined as the presence of respiratory distress and chest X-ray changes, not explained by other pathology, where there has been meconium stained amniotic fluid prior to delivery.

Meconium staining of the amniotic fluid (MSAF) occurs in around 4% of deliveries before 37 weeks, 10–20% of term deliveries, and up to 30–40% of post-term deliveries. Around 5% of infants born through MSAF go on to develop meconium aspiration syndrome. In the developed world, 0.43–2.1 per 1000 live-born infants receive mechanical ventilation for MAS. Mortality rates for infants with meconium aspiration syndrome remain around 2.5–5%.

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### Pathophysiology

In most cases MSAF is not associated with identifiable fetal compromise and may simply reflect fetal gut maturation. However, meconium passage may follow fetal stress such as hypoxia-ischaemia, and this may also be associated with fetal gasping, leading meconium to be aspirated into the fetal airways. It is unclear to what extent meconium enters the distal airways in utero or after delivery with the onset of air breathing.

Meconium consists of gastrointestinal and pancreatic secretions, bile and bile acids, mucous, swallowed vernix, lanugo hair, blood and cellular debris. The pathophysiology of meconium aspiration syndrome is multi-factorial and reflects the direct effects of meconium in the airways, the resulting inflammatory response and any associated hypoxic-ischaemic insult. There is mechanical obstruction, chemical pneumonitis, surfactant dysfunction and pulmonary vasoconstriction. Mechanical obstruction, particularly in expiration leads to gas trapping, local or generalized hyperinflation and increased risk of air leaks. Chemical pneumonitis occurs, invoking a powerful inflammatory response through cytokines such as IL-8, pro-inflammatory enzymes such as phospholipase A2 and by activating complement. Surfactant dysfunction results from direct inhibition, toxicity to type II pneumocytes, displacement of surfactant from the surface of alveoli and reduction of surfactant proteins A and B. Pulmonary vasoconstriction due to release of vasoconstrictors such as endothelin and thromboxane, contributes to pulmonary hypertension. Meconium may also induce non-inflammatory cell death (apoptosis) in the lungs. Ventilation perfusion mismatch and intrapulmonary shunting, lead to hypoxaemia, hypercarbia and acidosis and in may progress to severe cardiorespiratory failure.

Respiratory distress, cyanosis and chest hyperinflation may be observed from soon after birth or develop over several hours. Typical X-ray changes are of hyperinflation and patchy interstitial shadowing (Figure 1). More uniform atelectasis is also seen in some cases. The X-ray changes and clinical severity do not always correlate.

## Management

### General supportive measures

Most infants born through MSAF do not require resuscitation at birth and remain well. In the absence of other concerns or risk factors they should receive routine postnatal care. Infants who develop signs of respiratory distress require further management

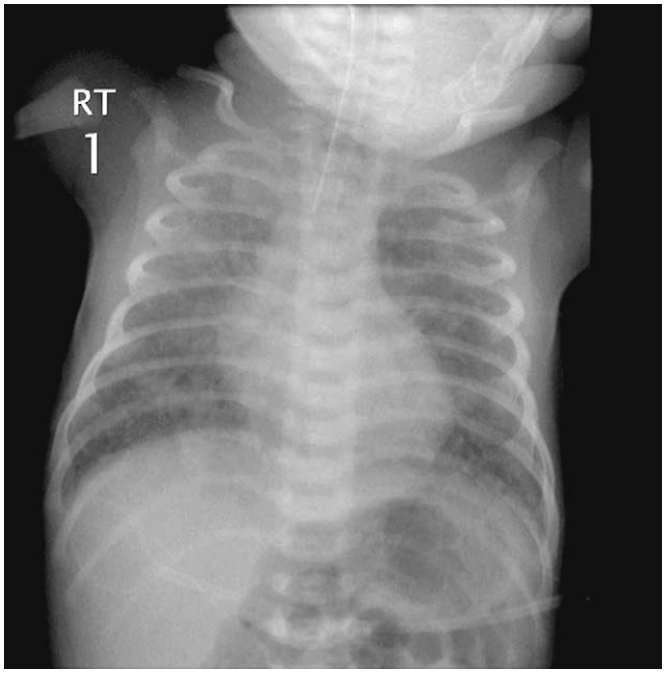


**Figure 1** Chest X-ray of a ventilated infant with meconium aspiration syndrome showing typical appearances of hyperinflation and patchy interstitial shadowing.

and admission to a neonatal unit. Although there is little objective evidence regarding the general management of infants with MAS, monitoring and treatment should include the following:

- Careful observation with monitoring of heart rate, respiratory rate and oxygen saturation.
- Minimal handling.
- Treatment with intravenous fluids, rather than enteral feeding, until respiratory signs subside.
- Oxygen therapy to maintain saturation in the upper 90s, aiming to minimize pulmonary hypertension.
- Blood gas and blood glucose monitoring to detect worsening respiratory acidosis or the development of hypoglycaemia.
- For ventilated infants, assessment of the need for analgesia, sedation and in some cases muscle relaxation to facilitate optimal ventilation.

It is usual practice for infants with respiratory distress of uncertain aetiology to be treated with antibiotics pending blood culture results. Meconium would usually be sterile prior rupture of the fetal membranes so its presence around delivery does not make a strong argument for routine antibiotic therapy. One small randomized controlled trial showed no evidence of reduction in neonatal sepsis or neonatal intensive care admission following maternal antibiotic prophylaxis in labour where there was MSAF but power was limited by sample size. Passage of meconium may be triggered by a fetal stress response and this could be due to infection. Given the potential devastating effects of neonatal sepsis, it is reasonable to perform blood cultures and give empirical treatment with penicillin and gentamicin for possible early onset sepsis until the results are available. Large studies would be required to answer the question definitively.

The clinical management of MAS can be considered in two phases: perinatal and postnatal management.

## Perinatal management

### Management of "post dates" pregnancy

MAS is clearly associated with advancing gestation, especially beyond 40 weeks. MAS is reduced after induction of labour post dates in comparison with expectant management. The relative risk of MAS at 41 weeks after induction compared with expectant management is 0.29 (95% CI 0.12—0.68). The relative risk at 42 weeks is 0.66 (CI 0.24—1.81) but this is not statistically significant. However, the absolute risk of MAS is small and this, in isolation, is not considered to be an indication for post dates induction of labour. Key goals of intrapartum care to minimize the risk of MAS include early detection and prompt management of fetal hypoxia.

### Amnioinfusion

Transcervical infusion of fluid during labour with MSAF was postulated potentially to reduce MAS by diluting thick meconium, reversing oligohydramnios or by providing support to the umbilical cord and thus reducing the risk of cord obstruction. A Cochrane review by Xu et al. concluded that amnioinfusion was not beneficial in terms of significant reduction of perinatal deaths or morbidity in infants with meconium staining of the liquor, except perhaps in resource poor settings with limited means of fetal monitoring. Amnioinfusion is not without risks, including cord prolapse and prolongation of labour. The UK National Institute of Health and Clinical Excellence (NICE) Guidelines, currently recommend against use of amnioinfusion in women with MSAF.

### Pharyngeal suction before delivery of the fetal shoulders

A large randomized multi-centre study by Vain et al., showed that the incidence of MAS, the need for mechanical ventilation and mortality rates were similar for infants whether or not they received intrapartum pharyngeal suction. Following this trial, intrapartum pharyngeal suction is no longer recommended.

## Postpartum management

### Tracheal suction

The value of attempting to suction meconium from the trachea remains unclear. Meta-analysis of four randomized controlled trials of tracheal suction of vigorous infants (good tone, spontaneous respirations and heart rate of over 100 beats per minute) does not support routine endotracheal suction of such infants. Laryngoscopy and tracheal suction are still recommended prior to commencement of positive pressure ventilation in infants who are not vigorous at delivery. The benefits and risks of this approach have not been evaluated in a prospective randomized study. Such a trial would be a valuable addition to the literature.

### Nasal continuous positive airway pressure (nCPAP)

Many neonatologist use nCPAP to support infants with respiratory dysfunction and its use in infants with MAS has been described. Others avoid using nCPAP in this condition because of the association between MAS, gas trapping and air leaks. There is no clear evidence of benefit or harm for nCPAP in this patient group as trials are lacking.