Meconium at resuscitation

Disagreement exists regarding appropriate delivery room management of the airway of meconium-stained infants. Anecdotal evidence led to the widespread practice of intrapartum suctioning of meconium-stained infants. In the light of recently published evidence, current guidelines for resuscitation of these infants are reviewed.

Elaine Foye
RGN, RM, Bsc Health Studies (Midwifery)
Advanced Neonatal Nurse Practitioner
Neonatal Transport Sister
West of Scotland Transport Team
Cuthbertson Building
Glasgow Royal Infirmary
Glasgow
elaine.foye@northglasgow.scot.nhs.uk

Keywords

resuscitation; airway management; guidelines; trained personnel; meconium

Key points

Foye, E. (2007) Meconium at resuscitation. *Infant* 3(3): 118-21.

1. Eleven percent of all pregnancies are complicated by passage of meconium.
2. Two percent of infants have some degree of aspiration syndrome.
3. Since 2005 the Resuscitation Council has no longer recommended suction of the oropharynx while the baby's head is at the perineum.
4. Only babies who are born through thick meconium and who are unresponsive should have oropharyngeal inspection.

Successful neonatal resuscitation requires more than the mechanical application of practised routines. It is dependent on the clear understanding of basic physiological principles and excellent assessment skills. It also requires essential equipment and practised teamwork[1].

According to the International Liaison Committee on Resuscitation (ILCOR)[2], approximately 10% of newborns require some assistance to begin breathing at birth, and about 1% require extensive resuscitation. Although the vast majority do not require intervention to make the transition from intrauterine to extrauterine life, the large number of births worldwide means that many infants require some resuscitation. Therefore, personnel trained in the basic skills of resuscitation should be in attendance at every delivery.

This is particularly important at a delivery of an infant born through meconium[1]. In these infants the potential exists for aspiration of meconium to occur, either *in utero* or at the time of the first breath[3].

The presence of meconium-stained amniotic fluid may indicate that an infant has been compromised at some point prior to delivery. Such infants are more susceptible to having reactive pulmonary vessels, which may constrict with hypoxia. They require careful initial evaluation and close observation to ensure that oxygenation is adequate, and to prevent the gradual development of hypoxia and consequent pulmonary vasoconstriction, which would set off the cycle that ultimately may result in persistent pulmonary hypertension of the newborn (PPHN).[1]

In Europe the incidence of meconium aspiration syndrome (MAS) is between 1:1000 and 1:5000, whereas in North America, rates of 2-5:1000 have been reported[4]. Approximately 11% of all pregnancies are complicated by passage of meconium, and 2% of infants have some degree of aspiration syndrome. The symptoms range from some minor initial tachypnoea to very severe meconium aspiration pneumonia with pulmonary hypertension[1]. Indeed 5% of these babies develop meconium aspiration syndrome (MAS)[4].

This article will examine the management of infants with meconium-stained liquor at delivery by reviewing current and past literature. There has been a significant change in practice over the years due to randomised controlled trials and this will be discussed.

Aetiology of MAS

Meconium is the thick black material that collects in the distal portion of the small intestine and colon of the fetus and consists of intestinal secretions, bile, desquamated cellular debris and amniotic fluid. Ninety-four per cent of newborns pass a meconium stool within 24 hours after birth[5].

Fetal respiratory activity is a normal physiologic process that causes lung fluid to move from within the tracheobronchial tree out into the amniotic fluid. This movement of fluid during each fetal 'breath' is minimal but consistent with a steady movement outward from the trachea. Fetal gasping allows amniotic fluid into the larger airways of the tracheobronchial tree[6].

Intrauterine distress can cause passage of meconium into the amniotic fluid. Factors that promote the passage *in utero* include placental insufficiency, maternal hypertension, pre-eclampsia, and maternal drug abuse, especially tobacco and cocaine[7].

The fetal passage of meconium may be due to a vagal reflex. As the fetus approaches term, the gastrointestinal tract matures and vagal stimulation from head or cord compression may cause peristalsis and relaxation of the rectal sphincter leading to meconium passage.

Recent data also support a role for motilin, a peptide which is produced mainly by the jejunum and stimulates peristalsis. Motilin is normally very low in preterm infants and non-asphyxiated infants, but is raised in asphyxiated infants who pass meconium interpartum[4].

Passage of meconium may also be a maturational event. MSAF is rarely noted in infants born before 37 weeks' gestation, but may occur in 35% or more of infants born at 42 weeks' gestation[8].

To develop MAS, an infant must pass meconium, inhale it, and inhaled material must damage the lungs. All these factors are inextricably interlinked with the presence of fetal asphyxia[4].

Once meconium is inhaled it migrates down the tracheobronchial tree, causing a variable degree of airway obstruction as it disperses into the distal sacs[9].

Meconium directly alters the amniotic fluid, reducing the antibacterial activity and subsequently increasing the risk of perinatal bacterial infection. The most severe complication of meconium passage *in utero* is aspiration of meconium-stained amniotic fluid before, during, and after birth. Aspiration induces three major pulmonary effects – airway obstruction, surfactant dysfunction and chemical pneumonitis[7].

FIGURE 1 A newborn baby has colour, tone, heart rate and breathing assessed.

Meconium aspiration syndrome

MAS occurs most frequently in term, or post term newborn infants who have passed meconium *in utero*. Affected infants often develop progressive respiratory failure with significant hypoxaemia during the first 2-3 days of life. Death rates as high as 28% have been reported for MAS[10].

MAS occurs in 2-22% of babies born through meconium stained amniotic fluid and carries significant mortality and morbidity. Appropriate intrapartum care with early detection and management of fetal hypoxia is important in minimising the risk from meconium staining of amniotic fluid[11] (**FIGURE 1**).

The respiratory failure and hypoxaemia seen in babies with MAS are due to stiff lungs, marked ventilation-perfusion imbalance and pulmonary hypertension precipitating extrapulmonary right to left shunts. Babies with MAS have a reduced compliance and tidal volume, and an increased airway resistance, but the tachypnoea increases the minute volume to twice normal. In the early stages of the disease, when the airways are plugged by meconium, there is marked ventilation-perfusion abnormality, which lessens as the lungs recover. In those babies who develop PPHN, the pulmonary artery pressure will be higher than the systemic, with right to left shunting through the ductus arteriosus and/or the foramen ovale[4].

Immediate complications may include being born in a profoundly depressed condition requiring aggressive resuscitation, intubation and mechanical ventilation for poor respiratory effort. Myocardial dysfunction can also occur resulting in poor cardiac output which may be associated with systemic hypotension, coagulopathy and hepatic and renal dysfunction. Specific neurological sequelae include those of acute encephalopathy with seizures and abnormalities of posture and tone[11].

Signs and symptoms of MAS

A baby with MAS is usually post mature, or mature with long fingernails and dry skin, which soon starts to flake. The skin, nails and umbilical cord are often stained greenish yellow. The baby is not usually febrile, unless secondarily infected[4].

Clinically, the baby may be quite depressed at birth, demonstrating pallor, cyanosis, tachypnoea, grunting and retractions. Due to gas trapping and alveolar overdistension, a barrel chest appearance may be observed. Rales and rhonchi may be ausculated on physical exam[6].

Treatment

There is no specific treatment for MAS. The main aim of treatment is supportive until the alveolar macrophages clear debris and lung function returns to normal.

Therapies instituted for MAS include[4]:

- Oxygen therapy
- Continuous positive airway pressure (CPAP)
- Intermittent positive pressure
- High frequency oscillatory ventilation
- Extra corporeal membrane oxygenation
- Pulmonary vasodilators
- Surfactant therapy
- Antibiotics
- Blood volume and blood pressure monitoring
- Physiotherapy
- Steroid administration

These babies require a unique ventilation strategy with a slow rate and longer inspiratory time. Nasal CPAP should be used with caution in these babies.

Practitioners must be aware of the risk of air leak and be prepared to insert a drain if there is sudden deterioration in respiratory status. Paralysis is often recommended. It is vital to maintain a good systemic blood pressure to minimise the right to left shunt and reduce PPHN.

Outcome

The severity of MAS and mortality have been shown to be related to the clinical stability of the infants at presentation[12].

Literature review

Provision of adequate ventilation is the cornerstone of resuscitation at birth; the means by which this is best achieved remains contentious[13].

After meconium is passed into the amniotic fluid, how does it find its way to the lungs? Based on the premise that meconium aspiration does not occur until the initiation of air breathing, a study was performed by Carson et al employing deep suctioning of the oropharynx and nasopharynx before the first breath, in an effort to remove meconium and prevent MAS[10]. However when significant amounts of meconium were present, 37% of infants had meconium below the cords despite early suction. This therefore does not support the conclusion that meconium aspiration occurs in the first few breaths[10].

The study by Carson et al was designed to compare the effectiveness in the prevention of MAS of this combined obstetric approach with the previous

approach of direct tracheal suctioning alone. In this study there was a significant reduction in the incidence and severity of MAS associated with the introduction of intrapartum suctioning. Their study performed over a six month period, showed that there was meconium staining of the amniotic fluid in 8.8% of 1,000 newly born infants. Interestingly, eight of those tested had meconium below the cords, but none in the mouth or larynx. However, the authors concluded that as the study was retrospective and non-randomised no robust conclusion could be made. On the basis that suctioning was not considered to be deleterious it was felt that prospective randomised studies were not justified. This would now appear not to be the case[10].

During pregnancy if a fetus becomes hypoxic, fetal breathing movements, involving movement of fluid in and out of the trachea, cease. This precedes deep intrauterine gasping, which places the fetus at risk for aspiration of meconium-stained liquor into the lungs. This suggests that MAS may not be an entirely postnatal occurrence as previously thought[14].

Several reports over the last decade have indicated that with the correct airway management the incidence of MAS can be greatly reduced. They suggested that as soon as the head was delivered, but before delivery of the shoulders, diligent suction of the oropharynx and nasopharynx should be performed. Following delivery, the trachea should be intubated and suctioned under direct vision, regardless of whether meconium was seen above or below the cords. Repetitive intubations with endotracheal suction should be performed, until the fluid returned was not meconium stained[15,16].

Furthermore it was once common practice to attempt to compress the chest post delivery to suppress respiratory effort. The trachea was then intubated and suction was performed until clear liquor obtained[14].

Limited anecdotal data lead to the widespread practice of intrapartum oropharyngeal and nasopharyngeal suctioning of meconium-stained infants[10], although not all data supports this approach[3]. Nonetheless, this procedure was practised worldwide for millions of deliveries. Additionally, prominent organisations such as the ILCOR, the American Academy of Pediatrics, and the American College of Obstetricians and Gynaecologists have recommended the procedure[17].

However, there is no evidence to support the widespread practice of routine pharyngeal suction and/or endotracheal intubation in these babies[11].

Timeline for resuscitation guidelines

Methods of resuscitation of neonates are generally based on expert opinions, intuition and relate to guidelines. Results of multicentre randomised trials have, however, exposed some commonly used methods as ineffective[18]. A number of organisations have been formed to provide advice and support regarding neonatal resuscitation (**TABLE 1**).

ILCOR was formed in 1992 to provide a forum for resuscitation. At this time management recommendations for infants born through meconium-stained amniotic fluid included suctioning of the mouth and hypopharynx before delivery of the shoulders. However, intrapartum oropharyngeal and nasopharyngeal suctioning have potential risks, such as apnoea and cardiac arrhythmias triggered by pharyngeal stimulation, worsening hypoxia, delay in resuscitation and damage to the upper airway. Thus if the procedure is to be justified, the benefits have to outweigh the risks.

Disagreement existed concerning the appropriate delivery room management of the airway of *vigorous* meconium-stained infants. Some suggested a universal approach to intubation and suctioning of the airway in all such neonates, whereas others advocated a selective approach. A multicentre, international collaborative trial of vigorous infants randomly assigned either to immediate tracheal suctioning or to expectant management alone was carried out by Wiswell et al[19].

This was a prospective, randomised, controlled trial in which 12 centres participated from 1995 till 1997; a total of 2094 infants were enrolled. There was a 'no informed consent' protocol. Due to the uniqueness of waiving informed consent, several invited ethicists and neonatologists were involved in the review process. In addition, the Steering Committee of the American Academy of Pediatrics/American Heart Association Neonatal Resuscitation Program wrote a supporting letter stating that investigation of this issue was required[19]. The results of this trial indicated that intubation does not decrease the incidence of MAS or other respiratory disorders in vigorous infants[19].

- Neonatal Resuscitation Program of the Academy of Pediatrics and the American Heart Association.
- United Kingdom Resuscitation Council.
- European Resuscitation Council.
- Heart and Stroke Foundation of Canada.
- Australian Resuscitation Council.
- Resuscitation Council of Southern Africa.
- Council of Latin America for Resuscitation.

TABLE 1 International organisations that deal with neonatal resuscitation.

In contrast, if the infant is born through meconium and has depressed respiratory drive, decreased tone, and a heart rate of less than 100 beats/min, direct suctioning of the trachea soon after delivery is indicated[19]. Moreover, endotracheal intubation and suctioning should still be performed in infants born through meconium-stained amniotic fluid if they are not vigorous, if they need positive pressure ventilation, or if they develop symptoms of respiratory distress subsequent to initial assessment[19].

Current recommendations

As a result of the two large multicentre, randomised controlled trials by Vain et al[17] and Wiswell et al[19], showing that attempts to aspirate meconium from the nose and mouth of the unborn baby while the head is still on the perineum do not prevent MAS, this practice is no longer recommended.

On the basis of evidence from non-randomised controlled studies, it has been recommended that all babies born through thick meconium should have their tracheas intubated so that suctioning of their airways can be performed. The aim is to reduce the incidence and severity of MAS. However, for babies who are vigorous at birth endotracheal intubation may be both difficult and unnecessary[21].

Current guidelines from the Resuscitation Council (UK)[2] are that if babies are born through thick meconium and are unresponsive (or 'not vigorous') at birth, the oropharynx should be inspected and cleared of meconium. If intubation skills are available then the larynx and trachea should also be cleared.

Ideally, all medical practice should be

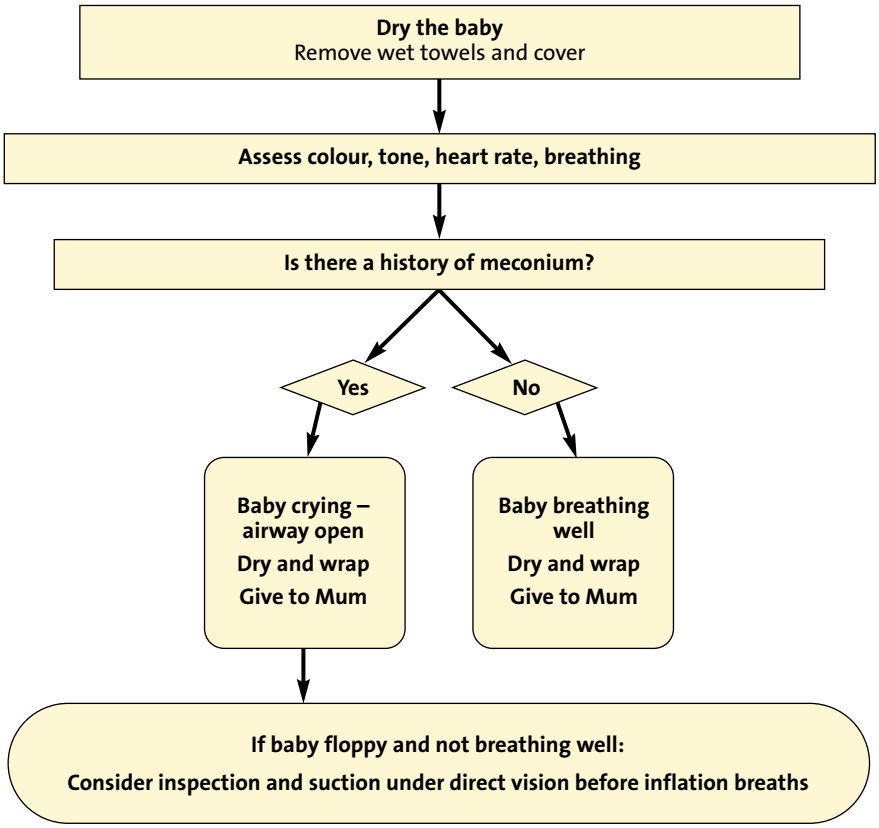

FIGURE 2 Flow chart of care of meconium at resuscitation. *Reproduced from Newborn Life Support, Second Edition (2006), Resuscitation Council (UK)*[20]

evidence based. The developments in the most recent Neonatal Resuscitation Program guidelines were an attempt to implement evidence-based medicine concerning resuscitation[22] (**FIGURE 2**).

Conclusion

Routine intrapartum oropharyngeal and nasopharyngeal suctioning of term-gestation, meconium stained infants does not prevent MAS or its complications[17]. Current guidelines have taken this into consideration and the Resuscitation Council (UK) as of December 2005 no longer recommends oral or nasal suction for neonates while the head is on the perineum[2].

Until further evidence is available routine intubation of vigorous term meconium-stained babies to aspirate the lungs should be avoided. Suctioning of the oropharynx may be beneficial but endotracheal intubation should be reserved for the non-vigorous infants[21].

The studies by Wiswell et al[19] and Vain et al[17] challenged recommendations and now new guidelines are in place.

Further research is needed to define a group of term babies with meconium staining who might benefit from intubation and airway aspiration. These studies should include unequivocal end points such as mortality and independently assessed radiograph reporting. However, it is clear that a study examining mortality as an outcome would need to be extremely large and with present knowledge may not be justifiable[21].

Over the past three decades, neonatal resuscitation has evolved from disparate, word-of-mouth teaching methods to organised programmes. The most widely used curriculum is the Neonatal Resuscitation Program, which is supported by the American Academy of Pediatrics and the American Heart Association. In this era of evidence-based medicine the most recent guidelines were developed to provide recommendations based on the best currently available science[22].

References

1. **Merrill T.D., Ballard R.A.** Resuscitation in the delivery room. Avery's Diseases of the Newborn. Pennsylvannia: Elsevier Saunders. 2005; **28**: 349-60.
2. **Resuscitation Council (UK).** Resuscitation Guidelines 2005; December.
3. **Falciglia H.S.** Failure to prevent meconium aspiration syndrome. *Obstet Gynaecol* 1988; **71**(3): 349-53.
4. **Rennie J.M.** Roberton's Textbook of Neonatology. 4th edition. Elsevier Churchill Livingstone. 2005; 502.
5. **Taeusch H.W., Ballard R.A., Gleason C.A.** Avery's Disease of the Newborn. Pennsylvannia: Elsevier Saunders. 2005; 712.
6. **Moore C.S.** Meconium aspiration syndrome. *Neonatal Network* 2000; **19**(4): 41-44.
7. **Clark D.A., Clark M.B.** Meconium Aspiration Syndrome.2004. http://www.emedicine.com/ped/topic768.htm (accessed March 2006).
8. **Donn S.M., Sinha S.K.** Manual of Neonatal Respiratory Care. 2nd edition. Phipadelphia: Elsevier Mosby. 2006; 325.
9. **Dargaville P.A., Mills J.F., Soll R.F.** Therapeutic lung lavage for meconium aspiration syndrome in newborn infants (Protocol) 2002. Cochrane Database. http://www.thecochranelibrary.com (accessed March 2006).
10. **Carson B.S., Losey R.W., Bowes Jr W.A., Simmons M.A.** Combined obstetric and pediatric approach to prevent meconium aspiration syndrome. *Am J Obstet Gynecol* 1976; **126**: 712-15.
11. **Ibrahim H., Subhedar N.V**. Management of meconium aspiration syndrome. *Current Paediatrics* 2005; **15**: 92-98.
12. **Bhutta Z.A., Jalil S.** Meconium aspiration syndrome: The role of resuscitation and tracheal suction in prevention. *Asia Oceania Obstet Gynaecol* 1992; **18**(1): 13-17.
13. **Allwood A.C.L., Madar R.J., Baumer J.H., Readdy L., Wright D.** Changes in resuscitation practice at birth. *Arch Dis Child Fetal Neonatal Ed* 2003; **88**: 375-79.
14. **Rossi E.M., Philipson E.H., Williams T.G., Kalhan M.B.** Meconium aspiration syndrome: Intrapartum and neonatal attributes. *Am J Obstet Gynecol* 1989; **161**: 1106-10.
15. **Gregory G.A., Gooding C.A., Phibbs R.H., Tooley W.H.** Meconium aspiration in neonates: A prospective study. *J Pediatrics* 1974; **85**(6): 848-52.
16. **Davis R.O., Philips III J.B., Harris Jr B.A., Wilson E.R., Huddleston J.F.** Fatal meconium aspiration syndrome occurring despite airway management considered appropriate. *Am J Obstet Gynecol* 1985; **151**: 731-36.
17. **Vain N.E., Szydl E.G., Prudent L.M., Wiswell T.E., Aguilar A.M., Vivas N.I.** Oropharyngeal and nasopharyngeal suctioning of meconium-stained neonates before delivery of their shoulders: Multicentre, randomised controlled trial. *Lancet* 2004; **364**: 597-602.
18. **Wiswell T.E., Gannon C.M., Jacob J., et al.** Delivery room management of the apparently vigorous meconium-stained neonate: Results of the multicentre, international collaborative trial. *Pediatrics* 2000; **105**(1): 1-7.
19. **Shah P.S.** Resuscitation of newborn infants. *Lancet* 2005; **365**(9460): 651-52.
20. **Resuscitation Council (UK).** Newborn Life Support. Second Ed. Resuscitation Council (UK). 2006.
21. **Halliday H.L., Sweet D.** Endotracheal intubation at birth for preventing morbidity and mortality in vigorous, meconium-stained infants born at term (Review). *Cochrane Database* 2006. http://www.thecochranelibrary.com (accessed March 2006).
22. **Wiswell T.E.** Neonatal resuscitation. *Respiratory Care* 2003; **48**(3): 288-95.

Acknowledgements

The author would like to thank Dr Charles Skeoch and Dr Lesley Jackson for their support and guidance with this article.