# Resuscitation at birth:

## Consensus and controversy

**Anthony D. Milner** MB, MD, FRCP, MRCS, LRCP, DCH, Professor of Neonatology, Guy's and St Thomas' Hospital

**Current methods of resuscitation have changed imperceptibly in recent years, despite the fact that there is little research to support the accepted procedures. Perhaps it is now time to question these tenets and investigate possible improvements which may lead to a few more babies being successfully resuscitated and a better prognosis for those babies subsequently developing brain damage?**

**Keywords:** *ventilation; oxygen; sodium bicarbonate; adrenaline; meconium aspiration syndrome; volume limited resuscitation*

The January 1999 edition of the Journal of Neonatal Nursing contained an excellent Step by Step guide to neonatal resuscitation. There is no doubt that following this approach will very often lead to a satisfactory outcome and that it represents the most cost effective form of treatment available to any health carers, apart from rehydration for acute diarrhoea in the developing world.

The aim of this article is to examine what evidence there is to support the approach to resuscitation outlined by Sister Harling and Dr Yoxall (1999), to try to identify how we have reached the current consensus, whether there are areas where research is required and whether changes should be introduced. It is very unlikely that modifications to the current policy will have dramatic effects on outcome for the large majority of babies, but it is possible that some babies currently dying or surviving with brain damage, could be helped.

## Historical contribution

The first documented case of neonatal resuscitation by intubation was as long ago as 1834. A French Accoucheur (19th century Obstetrician), Blundell described how he inserted a silver tube into the trachea of an apnoeic baby , using his finger as a guide, and then inflated the lungs by blowing down the tube (Dunn, 1982). This brought the baby to life and he states "had due care been taken, it would probably have been living still"! This technique, although now in use in some developing countries, did not catch on for over 100 years.

Our current methods of advanced resuscitation go back to 1928 when Flagg in North America first described intubation and positive pressure ventilation, using oxygen and pressures of 25 to 30 cm.$H_2O$. In the same year, Henderson (1928), also from the States, reported the use of a round face mask, an oxygen cylinder and a pressure limiting device (Fig.1) for resuscitation at birth, a system which only in the last 15 years has found favour as an alternative to bag and mask resuscitation.

## Pattern of ventilation

The pattern of ventilation in current use, utilising either T-piece systems or self inflating bag, has therefore largely been determined by historical precedence rather than research. Physiological studies have shown that pressures of 25 to 30cm $H_2O$, maintained for less than one second, rarely achieve good lung expansion. There have been studies examining how healthy babies manage to expand their lungs at birth. These have shown that babies often generate negative pressures of 50 cm $H_2O$, but only for approximately a third of a second. This is a pattern which can be achieved using a bag system connected to the endotracheal tube and has been shown to provide effective resuscitation in a small group of babies. Alternatively

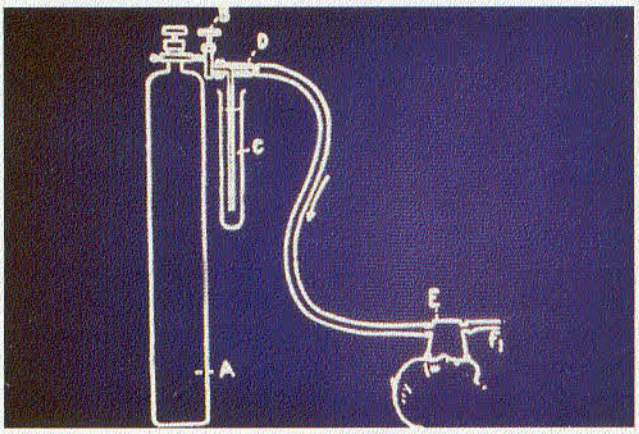


Figure 1. Diagram of face mask/T piece resuscitation system described by Henderson in 1928.

### Key points

**Milner, A.D.** (1999) Resuscitation at birth: Consensus and controversy. *Journal of Neonatal Nursing* **5**(6): 15,16,18.

1. There is little research to support the currently accepted approach to resuscitation.
2. Modifications to the current policy are unlikely to have dramatic effects on outcome, but may help some babies currently dying or suffering brain damage.
3. Procedures which need further research include the use of room air for resuscitation; the rationale for endotracheal toilet and the use of high inflation pressures.
4. Future developments will probably include more monitoring, the use of volume limited devices and CPAP.

good lung expansion can be achieved by using pressures of 25 to 30cm $H_2O$ for 2 to 3 seconds for the first few breaths. No clinical trials been carried out to see whether one technique is better than the other, or whether the immediate formation of an air reservoir is necessary.

## Use of oxygen

From the days of Flagg, oxygen has been used for both bag and T piece resuscitation. This is partly because oxygen has been used historically as the babies are cyanosed and obstetric units have access to compressed oxygen, but often not to compressed air. Recently there has been increasing interest in oxygen free radicals, poisons which are generated in the body by metabolic processes involving oxygen. These can destroy brain cells and are generated in large quantities during the reperfusion period, the time when oxygenated blood returns to the brain after a period of asphyxia. The level of oxygen free radicals is dependent on the concentration of oxygen present. This raises the possibility that using air for resuscitation might limit the degree of brain damage (Sangsted, 1998). Studies on animals and new born asphyxiated babies suggest that air is normally as effective as oxygen in resuscitating term infants. To test the hypothesis that air is less damaging would require a very large randomised trial, with a total delivery rate of greater than 400,000! It is possible that such a trial will be set up in the next few years. Meanwhile the latest generation of resuscitaires are marketed with oxygen/air mixing facilities. There is an increasing trend now to use a compromise oxygen concentration of 30 to 40%, but no research to support this approach.

## Use of sodium bicarbonate

Although still recommended for babies who fail to respond to positive pressure ventilation and adrenaline, sodium bicarbonate has largely been abandoned as a useful form of therapy in the treatment of cardiac arrest in adults. The reason for this is that although it is effective in improving the pH in the blood, carbon dioxide is given off which diffuses rapidly through into the cardiac muscle and the brain leading to a further fall in pH there. Anecdotal experience suggests that in the newborn situation, bicarbonate can be useful, but there are no physiological studies or clinical trials to indicate whether in the long term bicarbonate is useful or potentially harmful.

## Adrenaline

Although the current consensus is that adrenaline is useful, there remains considerable dispute on the most appropriate dose. This ranges from 0.1 to 1.0mL of 1/10,000 strength/ kg body weight. Some authorities recommend starting at the bottom end of the strength, but increasing to maximum dose if the baby remains asystolic. A further area in urgent need for research is the dose which should be given via the endotracheal tube. Adrenaline again anecdotally does sometimes seem to be effective when given by this route. This is surprising as even during effective cardiac massage, prior to the onset of respiration and the relaxation of pulmonary artery vasoconstriction, less than 20% of the cardiac output will pass through the lungs. In addition, the lungs will be fluid filled so that the adrenaline will be diluted before is has had a chance to work. It is recommended that higher doses should be given when this route is used in the resuscitation of adults. It may be that we should be following this example.

## Meconium aspiration syndrome

Aggressive oropharygeal suction after delivery of the head, and then repeated tracheal toilet was accepted as standard therapy for meconium staining of the liquor in the early 1970s. This approach came from North America where probably for a number of reasons meconium aspiration syndrome was far commoner than in Western Europe. Some units went to the extreme of introducing a policy of squeezing the chest immediately after delivery in an attempt to prevent the onset of respiration before the baby had been intubated and tracheal suction commenced. This was particularly inappropriate as it would not prevent the diaphragm descending and it is well established that squeezing the chest wall is a powerful stimulus to respiration and has now been abandoned.

The management of meconium staining of the liquor has now changed (Linder et al, 1988). Staining by thin, old meconium is no longer regarded as an indication for even summoning someone experienced in intubation to be present at delivery, if there are no other adverse factors such as fetal distress. There is increasing evidence that oropharyngeal suction while the baby's head is still on the perineum is not helpful. There is also increasing support for a less aggressive policy after delivery, only passing a laryngoscope in those who are apnoeic and not in those who are vigorous and have already started to breathe. There is still a consensus that those who are depressed and have meconium below the cords require repeated tracheal suction using a wide bore catheter or even an endotracheal tube, to remove as much of the thick meconium as possible, provided the heart rate remains above 60/min. Saline lavage which was also recommended in the 1970s has been abandoned as this is ineffective and unnecessary in a situation in which the lungs and airways are already fluid filled.

## Resuscitation of preterm babies

There is even less information on how preterm babies should be resuscitated. The consensus recommendation is that the same protocol should be followed, but that active intervention should be started earlier. Some authorities recommend that all babies of less than a particular gestational age, for example 28 weeks, should be intubated at birth. There may be local reasons for this: there may be a policy to give surfactant prophylaxis; there may be a long journey involving lifts from one floor to another.

There is one study which suggested that mortality is reduced by elective intubation of all less than 29 weeks gestation. However as only 3% of those in the selective arm of the study were intubated at birth, this study is really a comparison of elective against withholding intubation.

There is some dispute on the inflation pressures which should be used at the onset of resuscitation. On the one hand there are anxieties that the use of high pressures i.e in excess of 25cm $H_2O$ may increase the risk of pulmonary interstitial

emphysema. On the other, these babies are often surfactant deficient and require high pressures if adequate lung expansion is to be achieved. A compromise is to set the inflation pressure at 20-25cm $H_2O$ but be prepared to increase this if the tube is definitely in the trachea but chest wall movement remains poor (Milner, 1998). Particularly high pressures, sometimes exceeding 40cm $H_2O$, are likely to be needed if the preterm baby also has pulmonary hypoplasia. The outcome of babies born with birth asphyxia at a gestation of less than 26 weeks is so poor that some units have a policy of not using adrenaline for these. Although there is some data to support this approach, further research is needed.

Figure 2. Diagram of volume limited device for use with face mask or endotracheal tube.

## Other developments

Although most babies respond to resuscitation rapidly, those most severely affected and most likely to die or be left with brain damage should be receiving some monitoring after the first few minutes. The minimum requirement in the near future will be for heart rate and transcutaneous oxygen saturation measurements. Rapid carbon dioxide monitoring devices are also available which can be placed around the endotracheal tube. These do not increase the dead space and provide useful information on the effectiveness of the ventilation.

Studies on the onset of spontaneous breathing at birth have shown that the pressures used to expand the lungs vary very considerably from baby to baby, whereas we tend to use the same pressure for all. One possibility is to use a volume limited rather than pressure limited resuscitation system, set at perhaps 10mL/kg (Fig 2). This would ensure that the lungs are adequately expanded with the minimum of inflation pressure. More research is needed before this approach, which is already available in Canada, can be categorically recommended as a useful advance.

Currently, the standard T-piece resuscitation systems provide little if any positive end expiratory pressure (CPAP). This will not be of consequence to the mature, term baby but will limit the ability of the surfactant deficient preterm baby to maintain an adequately expanded lung. The provision of CPAP, both during active resuscitation and once the baby starts to breathe spontaneously is likely both to improve oxygenation and conserve what surfactant there is. Although this technology is already available, no studies have yet been published to establish whether or not this leads to a significantly better outcome.

## Conclusions

The consensus protocol for neonatal resuscitation leads to a satisfactory outcome on over 90% of occasions. It is supported by some physiological studies, but not tested in randomised controlled trials. A number of possible procedures warrant consideration and further investigation:

- It may be preferable to use 30 or even 21% oxygen rather than 100% .
- The place of sodium bicarbonate is controversial, and the optimal dose of adrenaline unknown.
- Endotracheal toilet is only indicated in apnoeic babies born with thick meconium – oro-pharyngeal suction on the perineum is not helpful.
- Preterm babies may need high inflation pressures.

Likely developments for the future include more monitoring, the use of volume limited devices and CPAP.

### References

**Dunn, P.M.** (1982) Perinatal lessons from the past: Dr James Blundell (1790-1878) and neonatal resuscitation. *Archives of Disease of Childhood* **64**: 494-95.

**Flagg, P.J.** (1928) The treatment of asphyxia in the newborn. *Journal of the American Medical Association* **91**: 788-791.

**Harling, E. and Yoxall, B.** (1999) Resuscitation of babies at birth. *Journal of Neonatal Nursing* **5**(1): centre insert.

**Henderson, Y.** (1928) The prevention and treatment of asphyxia in the newborn. *Journal of the American Medical Association* **90**: 583-86.

**Linder, N., Aranda, J.V., Tsur, M. et al** (1988) Need for endotracheal intubation and suction in meconium stained neonates. *Journal of Pediatrics* **112**: 613-15.

**Milner, A.D.** (1998) Resuscitation at birth. *European Journal of Pediatrics*.**157**: 524-27.

**Saugstad, O.D.** ( 1998) Resuscitation with room air or oxygen supplementation. *Clinics in Perinatology* **25**: 741-756.