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WHAT IS ILCOR?

The International Liaison Committee on Resuscitation (ILCOR) was founded in 1992 by representatives of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada and the Resuscitation Council of South Africa. They were later joined by the New Zealand Resuscitation Council and the Consejo Latino-Americano de Resuscitatión. As a group of organisations concerned with issuing resuscitation guidelines, they wished to establish a standing liaison committee to coordinate international efforts to refine knowledge and to develop internationally consistent guidelines for paediatric and adult emergency life support.

The paediatric working group of ILCOR established a neonatal subgroup in 1995. Since then two major international efforts have been made to update guidelines on neonatal resuscitation following collaborative examination of published evidence. The first of these resulted in an advisory statement on neonatal resuscitation in 1999 and in international guidelines the following year.[1 2] The second effort has resulted in publication of a document outlining an international consensus on science in 2005.[3] The primary aim of this document is to agree on an interpretation of the published science. It is therefore not a 'guidelines' document in the usual sense. However, where it was possible not only to agree on the science but also on a treatment recommendation then this treatment recommendation has also been included. This ILCOR document in turn has been used by various organisations as the basis for constructing national guidelines.[4–6]

PRINCIPLES OF NEONATAL RESUSCITATION

In 1897 JB De Lee, an American obstetrician, succinctly summarised the essence of resuscitation at birth in the following statement—''*there are three grand principles governing the treatment of asphyxia neonatorum: first, maintain the body heat; second, free the air passages from obstructions; third, stimulate respiration, or supply air to the lungs for oxygenation of the blood*.''.[7] Despite this clear exposition of advice which we would all now endorse, numerous fanciful methods of resuscitation at birth were strongly supported in various parts of the world for the next 70 years.

However, during a ten year period from 1957 work by a number of physiologists demonstrated the existence of a period of 'primary apnoea', from which spontaneous recovery was possible, as well as a later period of secondary or 'terminal' apnoea from which recovery really did depend on the nature of any intervention. This work was beautifully summarised by Geoffrey Dawes in an extraordinarily important book published in 1968.[8]

As a result of this work those methods of resuscitation whose 'useful' effects seemed only to be apparent in babies in primary apnoea, were dropped in favour of a concentration on lung aeration. One might therefore ask that if things really are as simple as De Lee and Dawes suggest, and they usually are, how is it that we still manage to find fuel for significant arguments forty years later? The answer is, of course, that most of these arguments are firmly at the margins.

ISSUES EXPLORED IN 2005

When preparing for the updating process in 2003 the group charged with updating the guidelines relating to resuscitation at birth were each asked to suggest a series of topics or questions for exploration. At a meeting of delegates in December 2003 a list of agreed topics was generated and each topic was then allotted to two members of the group each of whom then started the process by gathering all published evidence relating to the topic and completing an evidence evaluation worksheet. These worksheets were then compared, argued over, modified and refined over a number of meetings by both authors and the whole group until an agreed summary statement of what the science supported was arrived at during a five day meeting in January 2005. If there was sufficient agreement amongst the group as to how to convert the agreed science into a treatment recommendation then this was also added. Full details of the process have been published as part of the final document and the worksheets themselves can be examined on www.C2005.org.[9] Furthermore, most of the participants in this process have since contributed their evaluations of the literature concerning the questions they addressed to a special edition of Clinics in Perinatology.[10] I will briefly outline some of the more important issues below. Those who wish to delve deeper into the arguments behind these and other issues should consult references 9 and 10.

OXYGEN VS AIR

Over the past fifteen years or so a number of investigators have raised concerns about the safety of using 100% oxygen in resuscitation at birth and questioned the need to do so. A large number of studies in animals and a few studies in humans have been conducted but no clear answer has yet emerged. All of the 21 studies in animals can be criticised for using animals already adapted to extrauterine life, usually piglets a few days old. Important late fetal adaptations, such as the storage of glycogen within the tissues of the fetal heart, are rapidly dissipated within a few days of birth and use of animals as relatively mature as this may be a serious error. A more appropriate model would be full term fetal animals as used by the physiologists who first drew attention to the existence of primary and secondary (or terminal) apnoea.[11] The five studies in humans are also problematic in that the three larger studies, involving about 1100 of the 1252 infants so far studied, were not blinded nor truly randomised and there is very little data on the outcome beyond 28 days.

Despite the difficulties with the evidence the ILCOR group felt able to be more permissive of the use of alternatives to 100% oxygen in 2005 than previously. One of the difficulties with making blanket recommendations in neonatal resuscitation is that Geoffrey Dawes was right when he said that ''*very few babies which are apnoeic on delivery are in secondary apnoea*''.[8] This group clearly don't need to be given 100% oxygen. However, if one is thinking of a longer term outcome, that may not be so easily decided for those who need more extensive resuscitation from terminal apnoea.

The treatment recommendation produced by ILCOR (*with my interpretive comments*) reads as follows: ''There is currently insufficient evidence to specify the concentration of oxygen to be used at initiation of resuscitation. (*You can start*

with air or 100% oxygen or any mixture between). After initial steps at birth, (*drying, assessment etc*.) if respiratory efforts are absent or inadequate, lung inflation/ventilation should be the priority. Once adequate ventilation is established, if the heart rate remains low, there is no evidence to support or refute a change in the oxygen concentration that was initiated (*if successful lung inflation with say air does not result in an increase in a low heart rate then there is no evidence that changing the oxygen concentration at this point would be an advantage…*). Rather the priority should be to support cardiac output with chest compressions and coordinated ventilations (*…you should get on with chest compressions*). Supplementary oxygen should be considered for babies with persistent central cyanosis (*once the baby has responded with a good heart rate consider giving more oxygen if the baby is centrally cyanosed—which usually implies a saturation of less than 80%*). Some have advocated adjusting the oxygen supply according to pulse oximetry measurements to avoid hyperoxia, but there is insufficient evidence to determine the appropriate oximetry goal because observations are confounded by the gradual increase in oxyhaemoglobin saturation that normally occurs following birth. Excessive tissue oxygen may cause oxidant injury and should be avoided, especially in the premature infant.''

MECONIUM

Arguments over the effectiveness of strategies designed to prevent meconium aspiration syndrome have dogged resuscitation at birth for decades. However, two large multi-centre international randomised trials have clarified the situation considerably.[12 13] The subject now provides an object lesson in the effects of over-interpretation of data. In 1960 James suggested suctioning at birth to prevent meconium aspiration syndrome.[14] Fourteen years later a prospective study of 88 infants, concluded that nasopharyngeal suctioning before delivery followed by tracheal suctioning after delivery—ideally before the first breath- was advantageous despite the absence of a comparison group.[15] This was followed by a retrospective study of 125 infants born through meconium, which attempted to identify risk factors by examining the differences between symptomatic and asymptomatic babies, again without any comparison group.[16] A further prospective study of 273 meconium stained infants followed but this study used a retrospective comparison group.[17] These studies were interpreted as confirming the advisability of intrapartum or immediate postpartum suctioning of meconium.

Finally, in 2000, the question was addressed in a randomised controlled study recruiting 2094 infants in 12 centres. This study found that suctioning of vigorous infants at birth did not prevent meconium aspiration syndrome.[12] The further question as to whether or not it is advantageous to provide oropharyngeal suctioning 'on the perineum' has now been clarified in a second randomised controlled study involving 2514 infants in 11 centres which has found that such intrapartum suctioning does not affect the incidence or severity of any subsequent meconium aspiration syndrome.[13] One can only speculate on the vast number of man-hours of work that has been wasted on these ineffective interventions over the last 40 years not to mention the immense amount of money that has changed hands in court based on these erroneous instructions. The one group of babies where intervention remains to be studied is that group who are both unresponsive and emerging from liquor contaminated by thick meconium. For the present in this group suction clearing of the airways and, where possible, clearing of the trachea, is still advised.

VENTILATION STRATEGIES

Science supports the contention that, when properly performed, positive pressure ventilation alone is effective in the resuscitation of virtually all apnoeic or bradycardic infants at birth. Furthermore, the most important and fastest indicator of initial lung inflation is an improvement in the baby's heart rate. Though there is general agreement that pressures of 30–40 cm of water are virtually always effective and that pressures lower than this—say 20 cm of water—may also be effective. However, there have been few scientific attempts to define the most effective inflation pressures, inflation times and gas flow rates required to achieve lung inflation in the apnoeic newborn. As to devices used to apply gas pressure to the airways self-inflating bags, T-piece devices and flow-inflating bags have all been used successfully. Specific target pressures and inflation times are most easily and consistently delivered with T-piece devices though the clinical implications of this are unclear.

Little work has been done on initial ventilation strategies in preterm infants but animal work shows that it is easy to damage preterm lungs, preparing the way for bronchopulmonary dysplasia, with even a few large volume inflations at birth. Initial lung inflation in preterm infants should therefore be attempted with lower inflation pressures, say 20–25 cm of water, and only increased if they are not promptly effective in improving the heart rate. Also, though positive end expiratory pressure and continuous positive airway pressure have well established uses when providing respiratory support in the neonatal unit, their use in resuscitation has not been seriously explored and perhaps should be.

LARYNGEAL MASK AIRWAYS

These do show some promise but ILCOR found that there was insufficient evidence to recommend the Laryngeal mask airways (LMA) as the primary airway device during neonatal resuscitation. There were particular worries concerning use in settings complicated by meconium staining or a need for chest compressions. However, they acknowledge that case reports and a single small randomised controlled trial involving personnel experienced in LMA use suggest that the LMA can provide effective ventilation in the time-frame of a neonatal resuscitation.

DRUGS

Drugs are very rarely required in neonatal resuscitation. Those commonly used include adrenaline, fluids for volume expansion and, less commonly, sodium bicarbonate. In the past high dose adrenaline (100 microgram/kg intravenously) has been recommended if lower doses were ineffective but paediatric and animal data now suggest that this provides no benefit and may in fact reduce survival.[18 19] The latest recommendations therefore suggest that an intravenous dose of 10 μg/kg should be used initially and a dose of 30 μg/kg should not be exceeded intravenously.

Where any effect has been shown following tracheal administration it has only occurred following use of doses considerably higher than recommended hitherto. As a result, in the current guidelines if adrenaline appears to be required then the intravenous route is recommended. If the tracheal route has to be used then standard doses (10–30 μg/kg) are unlikely to be effective. If the tracheal route really is the only option one should consider giving a higher dose, perhaps as high as 100 microgram/kg, though the efficacy of such a dose has not been demonstrated, nor have its disadvantages been explored.

DISCONTINUATION OF RESUSCITATIVE EFFORTS

Having expressed the view that deciding not to start resuscitation and discontinuing life-sustaining treatment after or during resuscitation are ethically equivalent the ILCOR document suggests that their recommendations should be *'interpreted*

according to current regional outcomes and societal principles'. In other words, the resuscitation of extremely preterm infants, for example, should be guided, at least in part, by knowledge of the long term outcome of such infants within that society.

Another issue is the timing of a decision to stop resuscitation. ILCOR's view of the science is that infants who show no signs of life for a period of ten minutes after birth despite '*continuous and adequate*' resuscitation efforts are highly likely to die or, if they survive, to show severe neurodevelopmental disability. The ILCOR consensus on treatment arising from this is ''*If there are no signs of life after 10 minutes of continuous and adequate resuscitative efforts, it may be justifiable to stop resuscitation*.'' How this advice is to be incorporated into individual hospital guidelines is presumably for local decision.

TEMPERATURE

The two most important issues here concern the maintenance of normal body temperature during stabilisation of the very small preterm infant and the therapeutic possibilities of intentional mild hypothermia in limiting neurological damage following asphyxia.

Sufficient evidence now supports the contention that plastic bags or plastic wrapping *in combination with overhead radiant heat* is more effective than the conventional drying and wrapping approach in the maintenance of body temperature in very low birth weight babies during initial stabilisation at delivery.[20]

However, therapeutic hypothermia remains contentious, not because anyone doubts that it can have an effect, but because a number of significant questions remain to be elucidated. The evaluation of encephalopathy before initiating treatment has not been standardised, the severity at which the risk benefit ratio favours hypothermia is undefined, the best method of cooling needs further study, the optimal timing of the intervention and maximum postnatal age at which hypothermia might still offer neuroprotection is unclear and the number of studies reporting follow up beyond 18 months is very limited. These and a number of other questions still preclude recommending this form of treatment outside randomised controlled trials.[21 22]

THE FUTURE

The ILCOR process has focussed attention once again on neonatal resuscitation and provides an international mechanism for critical evaluation of relevant scientific evidence. In addition, many countries have developed networks for the rapid distribution of such knowledge to appropriate personnel by means of training courses such as the Newborn Life Support course developed in the UK, and the Neonatal Resuscitation Program developed in the USA.[23 24]

One of the reasons for ILCOR's existence is to draw attention to gaps in the knowledge underlying resuscitation topics in the hope that research will address these gaps in the future. The process which led up to the 2005 guidelines will be repeated over the next few years with the intention of issuing a further update in 2010. A preliminary meeting of the neonatal group took place in December 2006 prior to the Hot Topics meeting in Washington, USA. The object of this meeting was to discuss which topics in neonatal resuscitation would merit the ''worksheet approach'' leading up to the next guidelines revision planned for 2010.

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Competing interests: The author was the co-chair of the neonatal section of ILCOR and was a member of the editorial board responsible for the ILCOR consensus document. He is also chair of the UK Resuscitation Council's Newborn Life Support (NLS) course and editor of its manual.[23]

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