Early Human Development xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

When should resuscitation at birth cease?

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ARTICLE INFO

Available online xxxx

Keywords:
Infant, newborn
Resuscitation
Medical ethics
Hypoxia-ischemia, brain
Apgar score

ABSTRACT

It is rare for newborn infants to require prolonged resuscitation at birth. While there are detailed national and international guidelines on when and how to provide resuscitation to newborns, there is little existing guidance on when newborn resuscitation should be stopped.
In this paper we review current guidance surrounding adult, paediatric and neonatal resuscitation as well as recent evidence of outcome for newborn infants requiring prolonged resuscitation. We discuss the ethical principles that can potentially guide decisions surrounding resuscitation and post-resuscitation care. We also propose a structured approach to stopping resuscitation.

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1. Introduction

A term newborn infant is unexpectedly born in very poor condition following normal vaginal delivery and apparently uncomplicated labour. The infant is pulseless and has no respiratory effort. Midwives start mask ventilation and urgently call the neonatal team who arrive at a few

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http://dx.doi.org/10.1016/j.earlhumdev.2016.09.005
0378-3782/

minutes of age. Neonatal resuscitation is commenced, the infant is intubated, umbilical lines are inserted and resuscitation drugs are given. However there is no response: the infant remains pulseless and apneic.

The majority of newborn infants require little active support during their natural fetal-to-neonatal transition; [1] only approximately one in 10 infants require some form of intervention at birth. Fewer, about 1 per 100 newborns, require intermittent positive pressure ventilation, while approximately one in 1000 newborn infants receives full cardiopulmonary resuscitation (CPR) [2,3]. The majority of these cases will respond to resuscitative measures, however a small proportion will not. In the stressful and challenging situation of an apparently stillborn infant, like the one described above, clinicians frequently wonder how long to continue resuscitative efforts. While there is ample training and detailed national and international guidelines on when and how to provide resuscitation to newborns, there is little existing guidance on when newborn resuscitation should be stopped [4].

2. Guidelines

2.1. Newborns

Current international neonatal resuscitation guidelines uniformly suggest stopping resuscitation after a period of 10 min of effective resuscitation (defined as the provision of adequate chest inflation and a sufficient chest compression technique, including use of medication), without Return of Spontaneous Circulation (ROSC). This is based upon evidence of poor outcome in infants with prolonged low Apgar scores.

The Apgar score is universally used as a measure of newborn adaptation. It encompasses objective and surrogate measures of vital signs (heart rate, colour, breathing, neurologic assessment) at 1, 5 and 10 min after birth. Scores of zero, one and two points are given for a total of five components of the score which ideally sums up to a score of ten at each time point but could be as low as zero in a completely unresponsive baby. The International Liaison Committee on Resuscitation (ILCOR) 2015 guidelines note that the outcome of infants with Apgar of zero at 10 min was 'almost universally poor' and supported the cessation of resuscitation at 10 min of no detectable heart beat [3]. Both the European Resuscitation Council's (ERC) recommendation for newborn resuscitation [5] and their Neonatal Life Support (NLS) courses [6] follow this recommendation, however ILCOR, ERC and NLS also state that "The decision to continue resuscitation efforts when the heart rate has been undetectable for longer than 10 min is often complex and may be influenced by issues such as the presumed aetiology, the gestation of the baby, the potential reversibility of the situation, the availability of therapeutic hypothermia and the parents' previous expressed feelings about acceptable risk of morbidity". The American Heart Association (AHA) similarly suggests a time period of 10 min before resuscitation is discontinued: "… in infants with an Apgar score of 0 after 10 min of resuscitation, if the heart rate remains undetectable, it may be reasonable to stop assisted ventilation; however, the decision to continue or discontinue resuscitative efforts must be individualized." [7].

2.2. Adults

In adult medicine, the important decision to continue or to terminate resuscitative efforts usually lies with the most senior attending physician. While several factors are potentially taken into account, the most significant prognostic factor associated with poor outcome is duration of resuscitation [8]. The likelihood of discharge from hospital alive and neurologically intact decreases with the time taken for ROSC. Globally, many resuscitation guidelines suggest that, after taking into account pre-existing morbidities and other specifics of the situation, it is reasonable to terminate resuscitative efforts if asystole persists after 20 min of adequate CPR in the absence of reversible factors [9]. A recent population study from Japan suggested survival rates of approximately 5% and survival with favourable neurological outcome of 2% in the setting of out of hospital cardiac arrest and resuscitation of 20 min or more without ROSC [10].

2.3. Children

For paediatric resuscitation, international resuscitation guidelines are less prescriptive about the duration of recommended CPR; recent guidelines note that there are no reliable predictive factors of outcome, and therefore do not provide clear guidance on when to stop [11]. In a recent study from 328 US and Canadian hospitals, children suffering an in-hospital cardiac arrest received a median of 19 min of resuscitation [12].

3. Evidence

The guidance for discontinuing resuscitation of newborn infants is based on previously published retrospective data [13,14]. A systematic review, published in 2007, identified 85 cases in 8 studies. Studies describe high mortality, and in survivors, severe levels of neurodisability [14]. This formed the basis of the opinion that resuscitation beyond 10 min would not usually be justified in neonates.

Recent evidence, however, suggests that the outcome of infants may have improved through the availability of more refined resuscitation and post-resuscitation care, particularly including therapeutic hypothermia for term or near term born babies. Table 1 summarizes the most recent available data. It includes the outcomes of infants with an Apgar score of zero at 10 min who had been treated with therapeutic hypothermia. Of the infants, 49% (39/79) survived, while 54% (21/39) of survivors were not severely impaired at follow-up. Overall, 27% of cooled infants (27/100) survived without severe disability.

It is important to interpret these figures cautiously. The studies may have overestimated survival, since they include only infants admitted to the neonatal unit who received therapeutic hypothermia. The most gravely ill infants are likely to have been excluded. Nevertheless, it appears that in the current era, infants who make it to the neonatal unit following prolonged resuscitation may not necessarily have a dismal outcome.

The cause of the improved outcome is not clear. It might reflect the influence of therapeutic hypothermia. It might also be the result of greater use of prognostic tests (e.g. amplitude-integrated electroencephalography, magnetic resonance imaging) for infants with hypoxic-ischaemic encephalopathy to aid decision-making in the neonatal intensive care unit (NICU).

However, outcome for preterm infants born in a compromised state may be significantly worse than term infants. A recent population-based study examined the outcomes of 2262 extremely preterm infants (<28 weeks) who had been given an Apgar score of zero at 1 min of life, between 1998–2011 [22]. Despite attempted resuscitation, the vast majority of these infants died. Only 13 survived to be admitted to NICU, of whom 2 survived to discharge. Importantly, no infants in this cohort with an Apgar score of zero at 5 min survived.

4. Ethics

There are several ethical principles that might be drawn on to aid decisions about when to stop resuscitation for newborn infants.

4.1. Best interests

Treatment decisions should be guided by the best interests of the child [23]. In neonatal units across the world, if a child's life would be severely limited in quality or quantity, and treatment would do more harm than good, it is generally considered ethical to withhold or withdraw life-sustaining treatment [24].

Please cite this article as: J.S. McGrath, et al., When should resuscitation at birth cease?, Early Hum Dev (2016), http://dx.doi.org/10.1016/j.earlhumdev.2016.09.005