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REVIEW

Clinical practice: neonatal resuscitation. A Dutch consensus

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Abstract The updated Dutch guidelines on Neonatal Resuscitation assimilate the latest evidence in neonatal resuscitation. Important changes with regard to the 2004 guidelines and controversial issues concerning neonatal resuscitation are reviewed, and recommendations for daily practice are provided and argued in the context of the ILCOR 2005 consensus.

Keywords Dutch guidelines · Neonatal resuscitation

Introduction

Recently, the Pediatric Association of the Netherlands (NVK) has published the evidence-based guidelines on Neonatal Resuscitation at http://www.pedianet.nl (published in Dutch). The new guidelines are an update of the first Dutch guidelines on Neonatal Resuscitation published in 2004 and are mainly based on the ILCOR 2005 Consensus on Resuscitation Science and Treatment Recommendations [1], supplemented with the latest evidence and adapted to local practices. In The Netherlands, unlike in other Western countries, it is common to deliver at home (23% of deliveries) or in the context of a short stay in a hospital (10% of deliveries) under the care of a midwife or general practitioner [21]. Based on risk estimates for mother and child it is decided whether the mother can deliver under the supervision of a midwife or general practitioner, or has to be referred to an obstetrician in secondary care. Data from The Netherlands Perinatal Registry shows that in 0.1% of home deliveries some form of neonatal resuscitation (at least mask ventilation) is needed versus in 1–2% of hospital deliveries [2]. This means that several disciplines are involved in perinatal care and all should be skilled in basic neonatal resuscitation. The algorithm of the Dutch guidelines on Neonatal Resuscitation, which is designed for all disciplines involved in neonatal resuscitation, is presented in Fig. 1. The most important changes with regard to the 2004 guidelines are: (1) using 21% of oxygen when initiating resuscitation, (2) occlusive plastic wrapping without drying in infants <28 weeks' gestation, and (3) preference for the intravenous route for epinephrine. In this review article we will address notable changes in the updated Dutch guidelines, focus on controversial issues concerning neonatal resuscitation, and provide recommendations for daily practice. Where different from the ILCOR guidelines, issues will be discussed in the context of the latest evidence.

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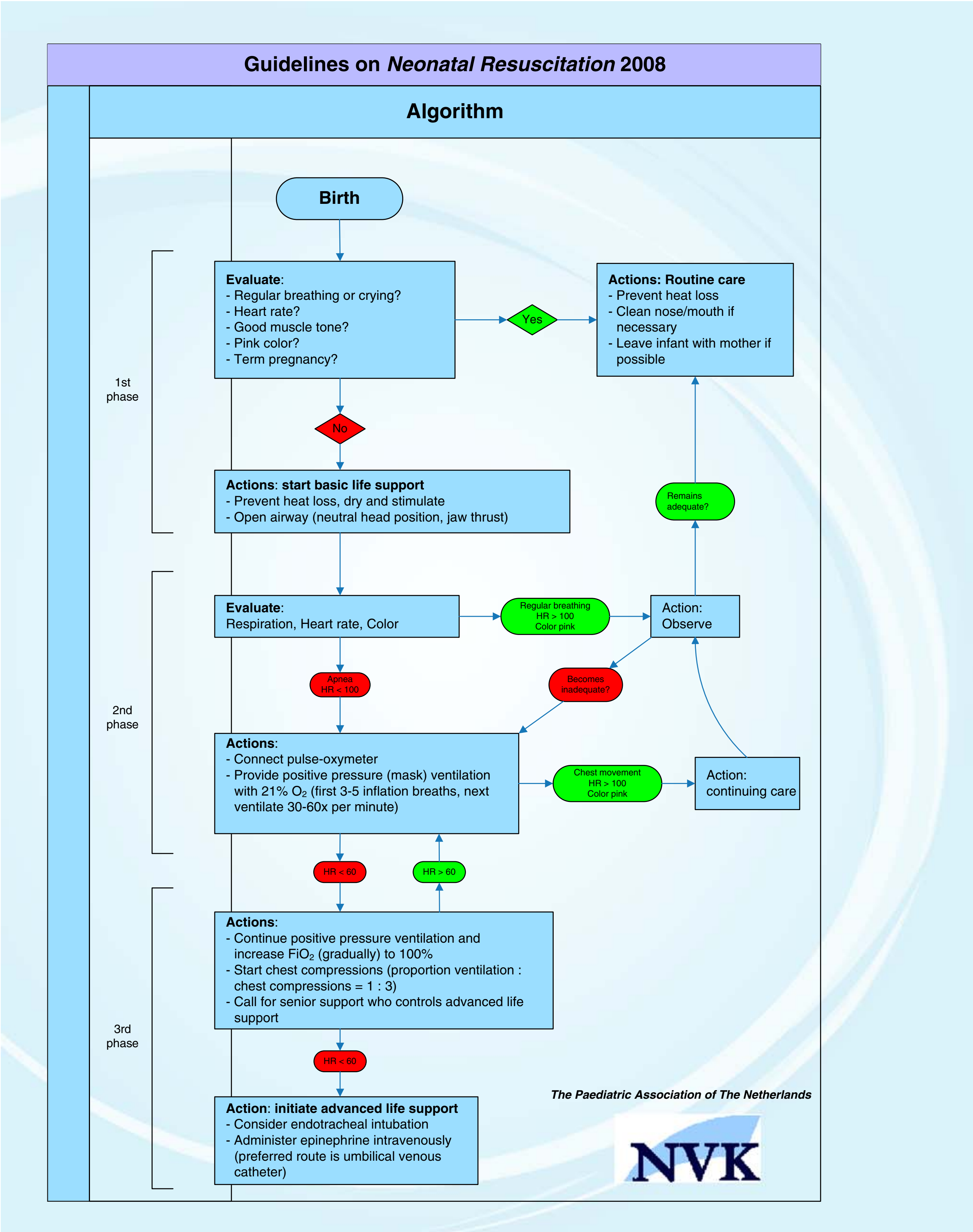

Fig. 1 Guidelines on neonatal resuscitation

Initial actions

Evaluation

The decision to initiate or continue resuscitation is based on repeated assessment of three vital signs: heart rate, color, and respiration. Although the heart rate is often assessed by palpation of umbilical cord pulsations, this method appears to be difficult for quick assessment and to underestimate the heart rate frequently [26]. If the heart rate is undetectable by cord palpation within 30 s or the heart rate is <100 bpm, auscultation of the praecordium with a stethoscope should be performed. In addition, heart rate determined by auscultation has also been shown to underestimate the heart rate compared to electrocardiography [17]. Therefore, it is advised to use monitoring of the heart rate in case of an extended resuscitation.

Clinical assessment of the color of the patient is subjective and shows a high inter-observer variability [25]. When available, pulse oximetry should be used to assess the transcutaneous oxygen saturation of the infant. Healthy term newborns reach preductal oxygen saturations between 79% and 91% 5 min after birth [16, 29].

The three vital signs: heart rate, color, and respiration are used for guiding the resuscitation. Although the ILCOR 2005 guidelines do not mention the Apgar score, it is widely used for scoring the condition of the baby and the reaction to resuscitation. Uniformity in scoring, irrespective of three or five items are scored, is essential [20]. Therefore, we emphasize that an apnoeic infant should score ‘0’, even if the infant is ventilated. Abnormal respiratory efforts, such as irregular, shallow, or dyspnoeic breathing should score ‘1’, also if the infant is ventilated. The premature infant that is hypotonic scores ‘1’ for muscle tone, although this may be physiologic for the gestational age [4, 5, 20]. Furthermore, it is important to take care of precise documentation of the clinical condition of the infant, the necessary resuscitation steps and the response of the patient. The use of an expanded Apgar score form, like the one developed by the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists, can provide this information [3].

Body temperature control

Several observational studies have shown an association between hypothermia and increased mortality in newborns [10, 22, 24]. For the full-term newborn both standard thermal care (removing wet blankets, promptly drying, and wrapping the infant in a warm blanket) and placing the dried infant under a radiant heater are effective in maintaining normal body temperature [11]. A draft-free delivery room at a minimum temperature of 25°C is advised, although this may be difficult to achieve [13]. For preterm infants however, these actions are often insufficient to prevent hypothermia [10]. Several randomized controlled trials have shown that, in addition to radiant heating, covering premature infants up to the neck in a transparent heat-resistant plastic wrapping without previous drying, results in a higher body temperature of the newborn at admission, especially in infants <28 weeks’ gestation [8, 19, 37, 38]. Only the head is dried and covered with a cap. Currently, there is no evidence that this procedure improves mortality or long-term outcome. Monitoring of body temperature should be considered, especially when resuscitation is prolonged, to avoid the small risk for inducing hyperthermia [19, 38]. All resuscitation interventions, including intubation, chest compressions, and insertion of (central) lines, can be performed with the plastic cover in place. In the ILCOR guidelines, occlusive wrapping is generally applied to very low birthweight infants, whereas in the Dutch guidelines rather a gestational age of 28 weeks or less is used as a criterion for occlusive wrapping, because occlusive wrapping is most effective in newborns below 28 weeks of gestation, and gestational age is nearly always available at the time of delivery.

Airway and breathing

Airway

If the newborn is not responding to the initial actions, the first step in Newborn Life Support is opening of the airway. The newborn is placed in neutral position/slight sniffing position. Chin lift or jaw thrust maneuver might be helpful in opening the airway. Routine oropharyngeal suction is not recommended.

Breathing

Establishing gas exchange is the most important step in newborn resuscitation in order to correct hypoxemia and bradycardia. If the newborn is not breathing sufficiently inflation breaths are started followed by ventilation breaths 30–60 per minute.

Inflation breaths

Inflation breaths are used in newborn resuscitation to facilitate the aeration of the fluid-filled lungs by applying a higher airway pressure for a prolonged period of time. When a pressure of 30 cm H_2O is applied for the duration of 5 s a higher lung volume is achieved than in conventional 1-s inflations [39]. In addition, one randomized controlled trial in preterm newborns shows that sustained initial inflations through a nasopharyngeal tube followed by nasal CPAP reduces the need for intubation and the risk for BPD [33]. Although the evidence is based on a few studies, inflation breaths may have a positive effect on postnatal adaptation for newborns in need of resuscitation. However, as stated in the ILCOR guidelines 2005, the optimum pressure, inflation time, and flow required to establish an effective FRC has not yet been determined.

LMA

Although laryngeal masks are regularly used in infants by anesthesiologists, they are rarely used in newborn resuscitation. Several case reports and case series describe the successful use of laryngeal masks in newborns, even in preterm newborns [34]. One randomized controlled trial shows more successful ventilation with the use of laryngeal mask compared to face mask [31]. Most pediatricians are trained in endotracheal intubation, however maintenance of this skill might be difficult to achieve. In case of non-successful mask ventilation and endotracheal intubation is not possible or problematic a laryngeal mask should be considered as a good alternative. Training of pediatricians in LMA placement is therefore recommended.

The use of oxygen for the resuscitation of newborns

In the last years growing evidence from both experimental and clinical studies shows that the routine use of 100% oxygen for the resuscitation of newborns has no advantage above the use of room air and may even be harmful. In a meta-analysis in 2005, Tan et al. concluded that the routine use of oxygen in neonatal resuscitation increases mortality with a number needed to harm of 20 [32]. However, the implementation of this result in resuscitation guidelines was complicated by the fact that the majority of the children included in this meta-analysis were born in developing countries with perinatal care and perinatal mortality rates different from that in Western European countries. In addition, some studies included in the meta-analysis raised methodological concerns about the randomization and blinding. Recently, a new meta-analysis was published including ten studies under which six randomized controlled trials in European countries (Spain and Romania) [30]. A subgroup analysis of these European studies showed a reduction in mortality from 3.9% to 1.1% with a number needed to harm of 36. These recent data support the decision not to follow the ILCOR 2005 guidelines and to recommend the initial use of room air for resuscitation of newborns instead of 100% of oxygen. The ILCOR 2005 guideline opened already the possibility to start with lower oxygen fractions down to 21%. Nevertheless, a subgroup of newborns will likely benefit from oxygen at some moment of resuscitation e.g. newborns with PPHN. No scientific guidelines are available for the use of oxygen in newborns not responding to the initial steps of newborn resuscitation. Therefore it seems reasonable to start the supply of additional oxygen whenever a newborn is not responding despite adequate ventilation with room air. Monitoring of oxygen saturation by pulse oximetry makes it possible to adjust the fraction of inspired oxygen to achieve more or less physiologic levels of oxygen saturation. Healthy term newborns reach preductal oxygen saturations between 79% and 91% 5 min after birth [16, 29]. Newborns delivered by caesarean section and preterms reach average preductal oxygen saturations of 90% 2 min later compared to healthy term newborns [16, 29]. In the Dutch guidelines, as in the ILCOR 2005, the approach of initial oxygen fraction is the same for full-term and preterm infants. After publication of the Dutch guidelines two small randomized studies reported that preterm infants need additional oxygen in most cases [12, 40]. For preterm infants a higher initial oxygen fraction may be needed, although evidence is currently not sufficient to recommend an optimal initial oxygen fraction.

Exhaled CO_2 detection

Exhaled CO_2 detection is useful as a quick confirmation of accurate position of the endotracheal tube, especially when clinical judgement is uncertain [6, 9]. However, in the case of circulatory arrest and absent or low pulmonary blood flow, end tidal CO_2 detection may be false negative. False positive results are not reported in literature. In the case of a negative result in circulatory arrest tube position should be checked visually before removing the tube.

Circulation

Chest compressions—1/3 of the anteroposterior diameter of the chest—should be provided if the heart rate is absent or remains <60 bpm despite adequate assisted ventilation for 30 s. The main goal of chest compressions is to achieve or sustain adequate diastolic blood pressure in order to improve coronary perfusion and restore effective myocardial function. The two-thumb method, which is generally considered more effective for optimal coronary perfusion than the two-finger method, is performed by placing both thumbs on the lower third of the sternum, gripping the chest with the hands and supporting the back with the fingers [15, 23]. Although there are no data that support the superiority of any ratio in newborn infants, general consensus is that chest compressions should be coordinated with ventilation at a ratio of 3:1 and a rate of 120 “events” per minute to achieve approximately 90 compressions and 30 breaths per minute [42]. However, chest compressions are only effective if the lungs have first been successfully aerated, making the quality of the breaths and compressions more important than the rate.

Drugs

Epinephrine

Epinephrine is rarely needed in neonatal resuscitation and used only when the heart rate remains <60 bpm despite adequate ventilation and chest compressions. Although randomized controlled trials on effect and outcome of endotracheally versus intravenously administered epinephrine are lacking, the intravenous route is recommended because there is evidence from animal studies that intravenously administered epinephrine is effective [18] and because the intravenous route in neonates can easily be achieved by inserting an umbilical venous catheter. However, when the intravenous route cannot be obtained, the endotracheal route remains the alternative. For the endotracheal route higher dosages (0.03–0.1 mg/kg) of epinephrine might be necessary to have the desired effect [7]. The safety, however, of the use of these higher endotracheal dosages, has not been studied. Randomized studies of high (>0.03 mg/kg) versus standard (0.01–0.03 mg/kg) intravenous dosages of epinephrine are not available. Observational studies in children and animals show no better outcome when high intravenous dosages are used [27, 28]. In addition, high intravenous dosages may increase the risk for intraventricular hemorrhage in preterm infants. Therefore, epinephrine is recommended via the intravenous route (preferably via the umbilical venous catheter) and the dosage should be 0.01–0.03 mg/kg. The dosage can be repeated every 1–3 min.

Ethics

There is strong evidence for withholding or discontinuing further resuscitation if there is no recovery of spontaneous circulation after 10 min of continuous and adequate resuscitative efforts. Recently, a systematic review showed data of 94 newborns without any sign of life (Apgar score 0) during the first 10 min after birth [14]. Ninety-four percent of these newborns died or had severe neurological handicaps. Two percent of the newborns had moderate or minor handicaps. Follow-up data on 3% were missing, however, the first newborn had a cerebral palsy, the second newborn had a hypoxic ischaemic encephalopathy (H.I.E.) and several intestinal perforations, and the third newborn had H.I.E. and chronic lung disease. The outcome is therefore almost universally poor. Withholding further resuscitation in case of absence of signs of life during the first 10 min after birth despite continuous and adequate resuscitative efforts is justifiable.

Special cases

Meconium

In the case of meconium-stained amniotic fluid, 2–9% of the newborn infants will develop a meconium aspiration syndrome (MAS) [36]. Intrapartum oro-nasopharyngeal suctioning of meconium has shown not to reduce the incidence of MAS, the need for mechanical ventilation or mortality [35] and is not recommended anymore. In the case of meconium-stained amniotic fluid and a non-vigorous newborn (absent or depressed respirations, decreased muscle tone) endotracheal suction by brief intubation or suction under direct vision is advised. If the infant is vigorous, endotracheal suction is not recommended because it may cause harm and does not improve the outcome [41].

Home delivery

In the majority of situations of planned home delivery the leading professional is the midwife. In 2005 the Dutch society of midwives (KNOV) published their own guidelines on neonatal resuscitation at http://www.knov.nl (guidelines in Dutch). The resuscitation of the newborn at home now follows the same algorithm as presented in the figure. The lead practitioner in the home delivery is expected to be able to perform the basic life support of the newborn in need of resuscitation. Special attention should be paid to maintaining normal temperature of the baby by turning up the heater, close the windows to prevent draughts, use of warm, dry towels and use of hats and skin-to-skin contacts. A transparent plastic wrapping is useful for unexpected premature home delivery. Although not separately described in the Dutch guidelines, special equipment for resuscitation in a home delivery should at least include a self-inflating bag 500 ml with a blow off valve, suitable face masks (size 00/01), oxygen cylinder with appropriate delivery tubing, oropharyngeal airways (size 0, 00, and 000), stethoscope, laryngoscope with one large, and one small disposable straight blade or a spatula with a light for inspection of the oropharynx, a suction device, and a watch or clock. Telephone numbers of hospital and ambulance should be quickly available.

Conclusion

The updated Dutch guidelines on neonatal resuscitation assimilate the latest evidence in neonatal resuscitation and may contribute to a better care of newly born infants. However, still many questions on important issues concerning neonatal resuscitation, have to be answered. To our opinion, the following topics should have further attention in future research: the effect of endotracheal suction in case of meconium-stained amniotic fluid in a non-vigorous newborn, the outcome of preterm infants treated with occlusive plastic wrapping immediately after birth, the effect of inflation breaths in combination with positive end-expiratory pressure on postnatal adaptation for newborns in need of resuscitation, the percentage and timing of additional oxygen in newborns not responding to the initial steps of newborn resuscitation, the use of continuous positive airway pressure during neonatal resuscitation, and the most efficacious intravenous dose of epinephrine with the least possible harmful side effects in newborns with an asystole. In addition, implementation and training of the new guidelines in Neonatal Life Support programs will further contribute to improvement of the care for newborn infants.

Conflicts of interest None.

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