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Laryngeal Mask Airway – an Alternate Option for All Phases of Neonatal Resuscitation

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Globally, a quarter of all neonatal deaths (estimated at 2.5 million annually) die from birth asphyxia, which remains the leading cause of neonatal morbidity in low and middle-income countries (LMICs). Early initiation of positive pressure ventilation (PPV) by face-mask has shown to result in survival of >90% of newborns.[1] In the rare circumstances when non-invasive PPV is unsuccessful and the newborn remains severely bradycardic (heart rate <60 beats per minute), the International Liaison Committee on Resuscitation (ILCOR) suggests endotracheal tube (ETT) intubation prior to initiation of chest compressions.[2] Intubation is a difficult skill to practice. Developing proficiency at newborn intubation requires a significant amount of experience[3] and simulation-based training has not shown to prepare towards successful neonatal intubations.[4]

The laryngeal mask airway (LMA) was designed in 1981 by British anesthesiologist, Archie Brain, as a more practical tool compared to face-mask ventilation and less invasive than ETT intubation (figure 1). The LMA has been used in neonatal resuscitation for many years and owing to its ease of insertion and reliability in ventilation has been suggested as an optimal alternative to the ETT.[5] Simulation studies using manikins have demonstrated that an LMA can be successfully inserted in a median time of five seconds after a fifteen-minute educational session.[6] Clinically, LMA insertion was achieved on the first attempt within ten seconds and followed by successful resuscitation in 95% (20/21) of newborns.[7]

At the turn of the century, the American Heart Association (AHA) and American Academy of Pediatrics (AAP) introduced the LMA in their guidelines, and currently ILCOR suggests the LMA as an alternative to ETT intubation in infants >34 weeks' gestational age and/or birth weight >2,000 grams when face-mask ventilation or intubation is unsuccessful or not feasible.[2] Several different types of neonatal LMAs are manufactured by various companies,[8] but there are no clinical studies that have compared the different available products.

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Programs focusing on neonatal resuscitation in LMICs such as Helping Babies Breathe (HBB) have focused on establishing ventilation at birth.[9] A small number of babies that do not respond to PPV alone require circulatory support and medications. Placement of an advanced airway, such as an ETT is preferred during chest compressions. However, developing expertise in tracheal intubation might not be feasible in some settings in LMIC. The LMA may, however, be a reasonable alternative to both face-mask ventilation during initial PPV and ETT intubation during advanced resuscitation.

To date, there have been no studies assessing the feasibility and efficacy of LMA during chest compressions in neonates. In the current issue of *Pediatric Research*, Mani et al. present very interesting and novel data from a randomized study comparing LMA vs. ETT during neonatal resuscitation requiring chest compressions in a well-established perinatal asphyxiated cardiac-arrest lamb model that closely mimics the transitioning physiology of the human newborn in the delivery room.[10] Continuous measurement of hemodynamic parameters and frequent blood draws for arterial blood gas analysis are particular strengths of this study. The authors demonstrate that LMA is non-inferior to ETT during cardiopulmonary resuscitation with a similar incidence of return of spontaneous circulation between the groups. Furthermore, LMA ventilation was shown to be as effective as ETT ventilation when comparing respiratory pressures, tidal volumes, and arterial tension of oxygen and carbon dioxide (figure 2). Finally, the two methods had similar hemodynamic parameters (pulmonary and carotid blood flows, blood pressure) throughout the study period. The study by Mani et al. highlights the versatility of the LMA and how its use in the delivery room may improve resuscitation success, including instances when chest compressions are needed.

Provision of adequate breaths using face-mask ventilation can be hampered by incorrect mask placement or poor seal, movement of the head or profuse oropharyngeal secretions. Excessive pressure on the face can also cause apnea and bradycardia by compressing the trigeminal nerve (figure 1). Inadequate ventilation is the main cause of persistent neonatal bradycardia. Maintaining adequate ventilation by face-mask during chest compressions is likely more difficult, which is why ILCOR encourages establishing an alternate airway prior to initiating chest compressions. More studies are needed to validate the findings reported by Mani et al. and to determine if the LMA can lead to improved outcomes in newborns who require chest compressions.

A recent large randomized study in a LMIC demonstrated that PPV using an LMA compared to face-mask ventilation did not decrease neonatal encephalopathy (NE).[11] The enrolled infants were sick with 61% having meconium-stained or foul-smelling amniotic fluid and 15% died in the first 24 hours. The combined primary outcome of early neonatal death (day 0–7) and NICU admission with moderate to severe NE between day 1–5 was similar in both groups (figure 3). However, crossover was allowed and 3.5% of infants assigned to LMA were switched to face-mask with only 10% incidence of avoiding the combined primary outcome of dealth/NE. In contrast, 10.9% of infants assigned to face-mask switched to LMA and 32% of these switched infants avoided the primary outcome. The aforementioned study was conducted at a high volume hospital in Uganda by experienced midwives who were familiar with face-mask ventilation, and it would be

interesting to know whether LMA ventilation may be superior to face-mask ventilation in the hands of less experienced healthcare providers. Correspondingly, better awareness of the LMA and quicker adoption of LMA ventilation where the resources or the expertise to intubate are lacking may yield better resuscitation success in developed countries.

A recent survey at a large regional NICU in the United States reported that only 12% of neonatal resuscitation program certified providers had placed an LMA in a live newborn and that as many as 56% had a lack of awareness using this device as an alternative to ETT.[12] Simulation studies using high-fidelity neonatal manikins evaluating resuscitation during chest compressions using an LMA compared to an ETT to assess respiratory parameters, chest compression effectiveness, as well as providers' performance, mindset and attitudes are urgently needed. Companies also need to consider manufacturing smaller LMAs, which could be used in premature infants who are more likely to require positive pressure ventilation at birth.

Mani et al. have demonstrated that the LMA can be effective during chest compressions in a lamb model and have provided one more piece of evidence that advanced resuscitation is not a limitation for LMA use. The time has come for neonatal providers to recognize the limitations of face-mask ventilation and give more credence to the laryngeal mask airway.

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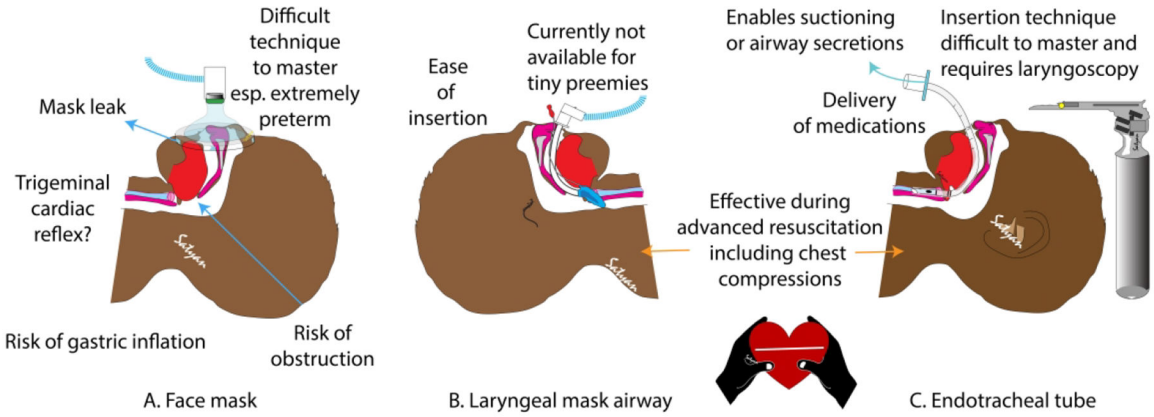

Figure 1.

A comparison of advantages and disadvantages of three devices for positive pressure ventilation (PPV) in neonates – A. face mask, B. laryngeal mask airway (LMA) and C. endotracheal tube (ETT). LMA can be an effective tool for initial PPV similar to a face-mask and also for advanced resuscitation similar to an ETT. Copyright Satyan Lakshminrusimha

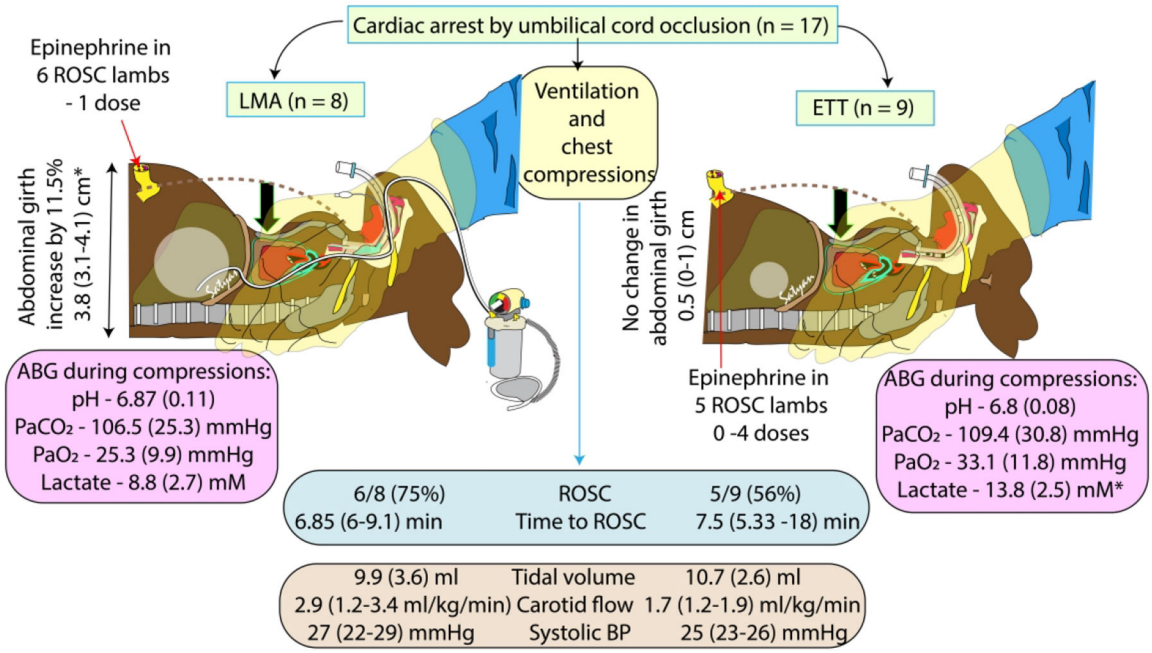

Figure 2.

Graphic abstract of Mani et al (Reference 10) – 17 fetal lambs with cardiac arrest induced by umbilical cord occlusion and randomized to laryngeal mask airway (LMA) with a device with an esophageal drain or endotracheal tube (ETT) with a cuff. Statistical significance between the two groups is designated by an asterisk (*). Lambs in the LMA group had increased abdominal girth and lower lactate compared to ETT group. Copyright Satyan Lakshminrusimha

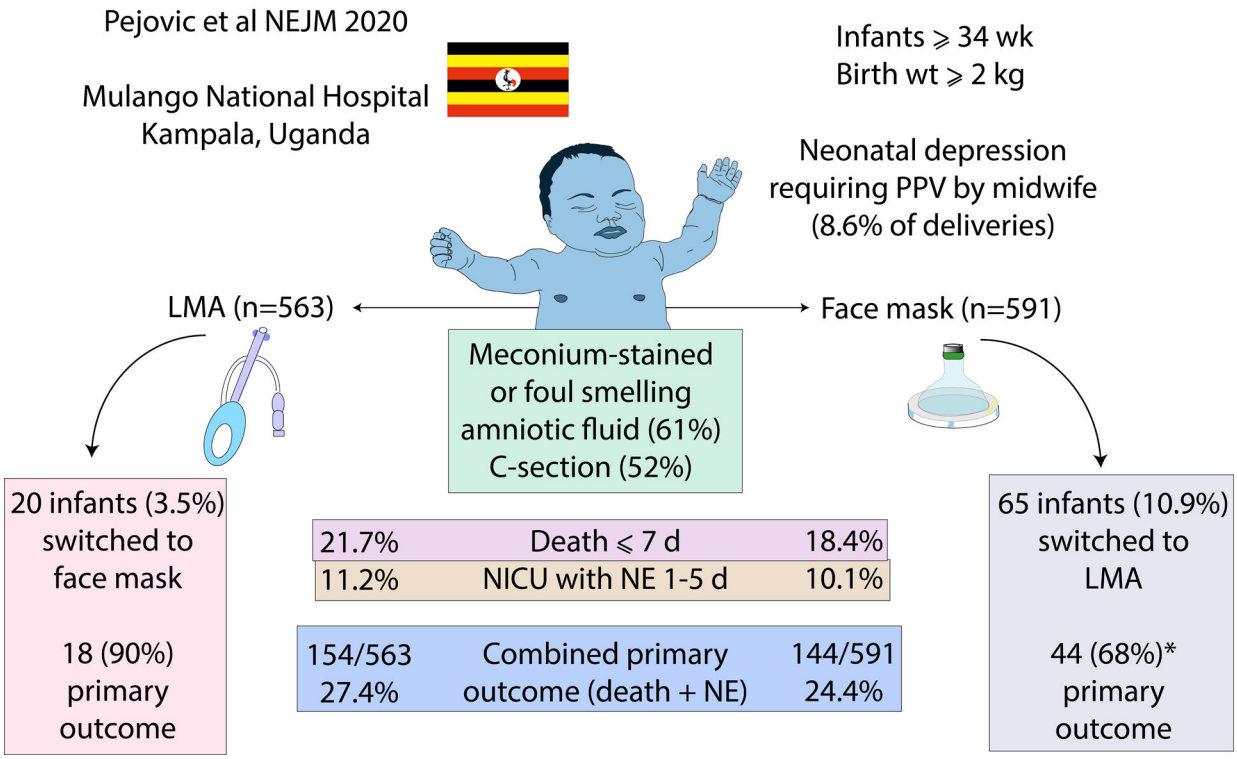

Figure 3.

Graphic abstract of Pejovic et al (Reference 11) – 1171 infants ≥ 34 weeks and ≥ 2000 grams in need of positive pressure ventilation (PPV) were randomized to laryngeal mask ventilation (LMA) or face-mask by midwife providers. No differences were observed in the primary combined outcome of early neonatal death ≤ 7 days or neonatal intensive care unit (NICU) admission between day 1 to 5 with moderate to severe neonatal encephalopathy (NE). Crossover to the other device occurred more often with face-mask. Among the neonates who underwent crossover, the percent who avoided the primary outcome was higher (32% vs. 10%) in infants who were rescued with LMA following face-mask failure. Copyright Satyan Lakshminrusimha.