

# **Engineering World Health**

2021 Design Competition



## **Newborn Resuscitation Device**

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# 1 Problem Definition

In low-resource communities around the world, birth asphyxia is a significant cause of neonatal deaths. In under-resourced countries, lack of training and equipment contribute to disproportionately high numbers of birth asphyxia-related deaths. In National Service Provision Assessments in 6 African countries, only 2%–12% of personnel conducting births in facilities had been trained in neonatal resuscitation, and only 8%–22% of facilities had the necessary equipment for neonatal respiratory support [1]. Due to a lack of preparation for cases of birth asphyxia, there is a significant need for a solution to improve neonatal resuscitation practices in preventing these avoidable deaths.

Birth asphyxia is the condition in which oxygen deprivation lasts for a long enough period of time to cause neuronal damage. The condition first causes immediate damage due to hypoxia, which leads to the rupture of neuronal cells. Secondly, blood flow from damaged areas contributes to the spread of toxic neurotransmitters [2], [3]. These released toxins can lead to a wide range of debilitating conditions such as cerebral palsy, motor disorders, and speech delays in those infants that are able to be resuscitated [2]. However, most infants with birth asphyxia in developing countries do not survive the condition. Birth asphyxia is often misdiagnosed as stillbirth resulting in an estimated death of 1.2 million newborns every year [4]. Its misdiagnosis also leads to difficulty estimating this figure, which may in reality be much higher. While developed countries are relatively unaffected by birth asphyxia, there is a vital need for a solution in low-resource communities.

Thus the primary issues we seek to address are **(i)** a lack of sufficient medical education regarding birth asphyxia and newborn resuscitation, and **(ii)** an unavailability of practical, low-cost equipment to assist in newborn resuscitation.

The design solution used to address **(i)** includes a training website, with downloadable resources, designed to educate medical staff to successfully identify birth asphyxia and how to apply adequate response procedures to resuscitate the newborn.

To address **(ii)**, a lack of equipment can be compensated for with a bag valve mask (BVM) that includes a feedback device, which monitors the quality of the applied positive pressure ventilation. Such a pressure monitor would have a simple LED light visual display to indicate whether or not resuscitation measures are sufficient.

The debilitating effects of birth asphyxia, which may be worsened with a lack of proper resuscitation, can be mitigated with the use of such a resuscitation monitoring device. As a result, our proposed design aims to provide accessible feedback on resuscitation in order to reduce the number of neonatal deaths due to birth asphyxia.

## 2 Impact on the Developing World

Southeast Asia is estimated to have approximately 200,000 annual neonatal deaths, according to the Association of Southeast Asian Nations. This puts the infant mortality rate at 1 to 30 per 1,000 live births, in this region [7]. Furthermore, India shows a significant number of deaths due to birth asphyxia, accounting for a total of 20% of their neonatal deaths [4]. The disproportionately large number of newborn deaths in India can be primarily explained by a lack of birth attendant training and misdiagnosis of birth asphyxia as stillborn cases [4]. In some communities, miscategorizing asphyxiated neonates may be due to cultural or religious factors that influence response. With proper training that highlights the value and need of newborn resuscitation, neonatal deaths in these under-resourced communities should decrease.

For this proposed design, the community of interest is Vemavaram, India. In Vemavaram, the nearest hospital to the village is a couple hours away, so it is generally common for midwives to assist in home births. However, due to COVID, most births currently take place at home with no midwives and very limited proper equipment or medical knowledge. In Vemavaram, there is limited internet access, nevertheless some of the people residing in the village have access to mobile phones with internet capabilities [5]. Considering this, a BVM monitor and website offers the community a practical solution to birth asphyxia in the long term.

Currently, there are some existing solutions to help train and enable health professionals to be more equipped to handle birth asphyxia. These solutions include BVM ventilation training programs such as Helping Babies Breathe [8] and an online app called the Neonatal Resuscitation Program [9], both of which are hosted by the American Academy of Pediatrics and implemented in developing countries. While these programs are productive in helping introduce health care workers to the proper way of handling birth asphyxia, they both struggle when it comes to the retention rate of the techniques taught in training once training ceases. This leads to an eventual loss in birth attendants trained in birth newborn resuscitation measures. A translated and simplified website design, accessible both online and offline, is capable of solving both of these issues. Existing resuscitation monitoring devices such as the Augmented Infant Resuscitator (AIR) work well in providing feedback on whether resuscitation is effective or not, even offering illustrations that indicate the cause of inadequate applied breaths. The device has been deployed for use in Uganda in conjunction with training programs to help better prepare birth attendants for the proper steps and procedures in newborn resuscitation. This device is effective in providing information on leakages and blockages during resuscitation, but lacks feedback on the frequency of positive pressure ventilation. Furthermore, a lack of reliable long term training instructions may prevent its continued use over time. For the purposes of our design, we will focus on a low-cost, simplified version that is both easy to use and highly portable. The design will primarily focus on providing birth attendants the tools and references they need to perform resuscitation, but it will also monitor and support resuscitation efforts.