Understanding Barriers to Neonatal Resuscitation in a Hospital in Haiti

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UNDERSTANDING BARRIERS TO NEONATAL RESUSCITATION

AT A HOSPITAL IN HAITI

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A Thesis Submitted to the Faculty of
Harvard Medical School
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Understanding Barriers to Neonatal Resuscitation at a Hospital in Haiti

Abstract

BACKGROUND: Neonatal mortality is a major problem in developing countries, accounting for 41% of mortality in children under five. Approximately one quarter of these deaths are attributed to birth asphyxia. Although it is estimated that 99% of asphyxia-related deaths can be prevented with neonatal resuscitation, in many settings, interventions to improve neonatal resuscitation have not led to decreases in mortality (AAP, 2011).

OBJECTIVES: This study aimed to develop an understanding of neonatal resuscitation practices at Hôpital Saint Thérèse d’Hinche. Specific objectives were: 1) to identify current resuscitation practices in the hospital at the time of delivery; 2) to characterize provider experiences with newborn care and resuscitation at the time of delivery; and 3) to identify perceived barriers to providers performing effective resuscitations.

METHODS: This was a mixed methods study. The quantitative phase involved the observation of newborn care at 155 deliveries. The qualitative phase comprised 22 semi-structured individual interviews with providers of newborn care.

RESULTS: Fifty-one (32.9%) of the 155 newborns in this study were not breathing at the time of birth. Of these, 45 (88.2%) were successfully resuscitated, 11.8% by drying and stimulation, 19.6% by stimulation and airway clearing, 39.2% by a combination of drying, stimulation, and airway clearing, and 17.6% by bag-mask ventilation with or without chest
compressions. Six of the newborns (11.8%) died. The average time to newborn assessment for all deliveries was 16 seconds, and to bag-mask ventilation was 3.2 minutes.

Through content analysis of the interviews with health care providers, three themes emerged: training and competency, barriers to neonatal resuscitation, and sources of resilience. Most providers described feeling competent to perform resuscitation, although bag-mask ventilation technique was considered challenging. The most salient barriers to resuscitation included personnel shortages, resource shortages, inadequate space, and poorly organized communication systems. Despite these challenges, providers described feeling pride in their work.

**CONCLUSIONS:** This investigation found a considerably higher proportion of newborns in need of resuscitation than global estimates currently suggest. The systemic nature of the barriers to neonatal resuscitation highlighted by this study suggest that addressing the need for personnel, equipment, space, and solid communication systems will be essential to making improvements in neonatal resuscitation and consequently reducing neonatal morbidity and mortality. Training, particularly training that is embedded in a system of ongoing mentorship, is also important, but given the extent to which systemic barriers prevent providers from putting into practice the skills they already have, further training alone will be insufficient to overcome the barriers revealed in this study.
## Table of contents

List of Figures with Captions.................................................................vii
List of Tables with Captions................................................................vi
Acknowledgments ............................................................................. ix

Introduction .........................................................................................1
  Neonatal mortality trends worldwide..............................................1
  Neonatal mortality and intrapartum-related hypoxia in Haiti..........2
  Intrapartum-related hypoxia and the need for neonatal resuscitation...3
  Interventions to improve neonatal resuscitation in resource-poor settings.................6
  Of history and health systems: Underlying causes of neonatal mortality in Haiti.........9

Study objectives.................................................................................12

Methods............................................................................................13
  Setting.........................................................................................13
  Design.......................................................................................16
  Quantitative phase.................................................................16
    Quantitative participant selection.........................................16
    Quantitative data collection..................................................17
    Quantitative data analysis....................................................20
  Qualitative phase.................................................................21
    Qualitative participant selection.........................................21
    Qualitative data collection..................................................21
    Qualitative data analysis....................................................21

Participant-Observation...............................................................22
List of Figures with Captions

Figure 1. Worldwide under-five and neonatal mortality trends, 1965-2015..........................1
Figure 2. Neonatal mortality trends in Haiti according to DHS data, 1975-2012.........................3
Figure 3. Pathway of intrapartum-related hypoxia and appropriate interventions to avoid fetal injury and prevent perinatal morbidity and mortality.........................................................5
Figure 4. Estimates of global numbers of babies needing resuscitation at birth.......................6
Figure 5. Helping Babies Breathe (HBB) neonatal resuscitation algorithm..............................8
Figure 6. Overview of participant recruitment in Phases 1 & 2..................................................17
Figure 7. Delivery observation checklist..................................................................................19
Figure 8. Global estimates of numbers of babies undergoing neonatal resuscitation, as compared with the findings of this study..........................................................45
List of Tables with Captions

Table 1. Summary of newborn and maternal characteristics........................................20
Table 2. Neonatal resuscitation success rates, by step.....................................................23
Table 3. Provider achievement of technique criteria for airway clearing.......................25
Table 4. Provider achievement of technique for bag-mask ventilation..........................26
Table 5. Number and percent of newborns exposed to meconium whose airways were cleared immediately after birth.................................................................26
Table 6. Breakdown of who provides newborn care at birth............................................27
Table 7. Percent of deliveries at which supplies were available and/or prepared by the provider in advance of the delivery.................................................................28
Table 8. Self-rated competency of providers in resuscitation.........................................29
Acknowledgments

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Introduction

Neonatal mortality trends worldwide

Worldwide, there are 2.9 to 3.6 million neonatal deaths each year, ninety-nine percent of which occur in developing countries (Ersdal & Singhal, 2013; Black et al., 2010; Rajaratnam et al., 2010). While mortality in children who have survived the neonatal period (the first 28 days of life) has declined in these settings over the past several decades, neonatal mortality rates have remained relatively stagnant, and early neonatal mortality (death within the first seven days) has been particularly stubborn (Figure 1). Neonatal deaths now account for approximately 41% of all deaths in children under the age of five (Black et al., 2010; Rajaratnam et al., 2010).

Figure 1. Worldwide under-five and neonatal mortality trends, 1965-2015. Early neonatal mortality refers to death within the first seven days of life. Late neonatal mortality refers to deaths occurring at 8-28 days. Source: Lawn, Cousens, Zupan, & Lancet Neonatal Survival Steering Team, 2005.

Within the neonatal period, it is the first day, and more specifically, the first hour of life that carries the greatest mortality risk. Estimates indicate that anywhere from 25% to 70% of neonatal deaths occur within the first twenty-four hours (Lawn et al., 2005; Ersdal et al., 2013). A critical cause of death during this period is intrapartum-related hypoxia (previously referred to as ‘birth asphyxia’). It is the cause of approximately 814,000 neonatal deaths and one million
stillbirths each year (Lee et al., 2011; Lawn et al., 2009; Lawn, Shibuya, & Stein, 2005). Among those newborns who survive intrapartum-related hypoxia, one million experience long-term morbidity, such as cerebral palsy (World Health Organization, 2005). Other major causes of neonatal mortality around the world include preterm birth and sepsis.

**Neonatal mortality and intrapartum-related hypoxia in Haiti**

According to the latest Demographic Health Survey (DHS) data, neonatal mortality in Haiti is 31 per 1,000 live births (Cayemittes et al., 2013). Although the 1970s and 1980s witnessed a decline in neonatal deaths, this rate has remained relatively unchanged over the past twenty-five years, mirroring trends in low-income countries worldwide, (Figure 2). In the context of improving post-neonatal mortality rates, deaths during the first month of life now account for approximately 35% of all deaths in Haitian children under five. Stillbirths currently add an additional 15 deaths per 1,000 to this figure, an unknown proportion of which are likely misclassified newborn deaths (World Health Organization, 2012).

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1 According to the 1994/95 DHS, neonatal mortality declined by over 50% between 1975 and 1990 (Cayemittes, et al., 1995). Similarly steep declines were experienced in the United States during this period, which has been attributed to advances in neonatal medicine and the development of surfactant (Centers for Disease Control, 1999). It is unclear to what extent such factors played a role in the decline in neonatal mortality in Haiti over the same period.

The number of neonatal deaths secondary to intrapartum-related hypoxia is unknown. The only data related to this specific cause of death come from a retrospective study of 144 under-five deaths in the catchment area of Albert Schweitzer Hospital in the Artibonite Department from 1995 to 1999. This study found that 27% of neonatal deaths had reportedly occurred on the first day of life (Perry, Allen, Fernand, 2005). Given the timing, it is possible that a number of these deaths were related to intrapartum-related hypoxia, but an accurate estimate is indiscernible.

**Intrapartum-related hypoxia and the need for neonatal resuscitation**

Intrapartum-related hypoxia refers to an abnormality of blood flow or oxygen delivery to the fetus during labor or delivery through the birth canal. In settings with advanced technology, diagnosis is made on the basis of clinical and laboratory data, including poor APGAR scores and acidemia. Severe intrapartum-related hypoxia can lead to hypoxic-ischemic encephalopathy
(HIE), a form of acute brain injury related to the hypoxic intrapartum event. In low resource settings, however, the failure to initiate respirations at birth may be the only evidence that intrapartum-related hypoxia has occurred. As such, definitions in these settings tend to focus on outcomes, with many studies defining birth asphyxia merely as the failure to initiate or maintain regular breathing at birth and/or a five-minute APGAR score < 7.2

The majority of infants who do not breathe at birth are in primary apnea and can be expected to initiate respirations in response to prompt stimulation, a first step in neonatal resuscitation. Non-breathing newborns in primary apnea who do not receive early intervention progress into secondary apnea, a state that requires more intensive intervention and is harder to reverse. These infants must receive positive-pressure ventilation (see Figure 3) (American Academy of Pediatrics, 2011). Evidence suggests that every 30-second delay in initiation of bag-mask ventilation for apneic infants yields an increased risk of morbidity and mortality of 16% (Ersdal & Singhal, 2013). Failure to identify that a newborn is in primary or secondary apnea can yield to misidentification of a live newborn as a stillbirth.

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2 In Basic Newborn Resuscitation: a practical guide, published by the WHO in 1997, birth asphyxia was defined as the failure to initiate or maintain regular breathing at birth. However, it is worth noting that the failure to breathe at birth can be caused by problems other than intrapartum-related hypoxia, one reason for which such a definition has been problematic.
Figure 3. Pathway of intrapartum-related hypoxia and appropriate interventions to avoid fetal injury and prevent perinatal morbidity and mortality. FSB=fresh stillbirth (stillbirth with skin still intact, implying death within twelve hours before delivery); FHR=fetal heart rate; FMV=face-mask ventilation. Source: Ersdal & Singhal, 2013.

It has been estimated that approximately 10% of all newborns are born with poor or absent respiratory effort and thus require some level of neonatal resuscitation at the time of delivery (American Academy of Pediatrics, 2011; Wall, et al., 2009). According to the American Academy of Pediatrics (AAP), 99% of these infants will respond to basic neonatal resuscitation (see Figure 4). Neonatal resuscitation is series of sequential interventions performed to help a newborn establish breathing and circulation at the time of birth, progressing from drying and stimulation to airway clearing, positive-pressure ventilation, and in rare cases, to chest compressions, intubation, and administration of medication.
Interventions to improve neonatal resuscitation in resource-poor settings

Recently, there has been a considerable push to expand implementation of neonatal resuscitation in resource-poor settings. In 2010, the AAP launched Helping Babies Breathe (HBB), a neonatal resuscitation education program and algorithm for birth attendants in resource-poor settings (See Figure 5). HBB is an example of a vertical, or ‘disease’-specific program with a narrow, targeted goal: the reduction of neonatal mortality secondary to intrapartum-related hypoxia through effective neonatal resuscitation. HBB aims to achieve this through the program’s specific objective of ensuring that at least one health care provider skilled in neonatal resuscitation is present at the birth of every baby around the world (AAP, 2011).

The HBB neonatal resuscitation algorithm is typically taught to health care providers through a one- or two-day course that combines didactic instruction and simulated practice scenarios using “simple, low-cost training materials,” including mannequins and visual aids (AAP, 2011). In contrast to the AAP’s Neonatal Resuscitation Program (NRP) that is used
routinely in US hospitals, HBB does not teach advanced resuscitation techniques based on the premise that such interventions are needed in less than 1% of cases and require additional resources that are infrequently available in resource-poor settings.

For programs interested in conducting a Helping Babies Breathe training, a ready-made curriculum and training materials are available for purchase through HBB. To provide a sense of the price of these items, in 2013, six equipment packages and facilitator materials were purchased by the non-governmental organization (NGO) Partners In Health for $1180. In addition to instructional aids, there are pre- and post-test materials that make it straightforward for programs to measure knowledge and skill acquisition (as defined by provider performance on a multiple-choice questionnaire and Objective Structured Clinical Examination), although there is no material offered to measure practice change or clinical outcome. For many global health practitioners and funders, HBB’s training methodology may be appealing for the fact that it is simple to teach and low-cost relative to more systems-level interventions. At the time of writing, 607 HBB courses have been implemented around the world, including twenty-three in Haiti (HBB website, accessed 4/10/15).
Figure 5. Helping Babies Breathe (HBB) neonatal resuscitation algorithm. Source: AAP, 2011.
HBB trainings have been conducted in numerous countries with mixed results. Early evaluations in Kenya and Pakistan found that only 15-17% of trainees were able to demonstrate mastery of bag-mask ventilation after one to two days of training (Singhal et al., 2012). Following refinement of the training program, studies showed greater improvements in knowledge and in resuscitation technique in simulation scenarios (Shivaprasad et al., 2013; Singal et al., 2012; Musafili, Essén, Baribwira, & Rukundo, Persson, 2013; Ersdal et al., 2013). However, delivery room management did not change, and skill retention even in simulated scenarios was quite poor (Ersdal et al., 2013; Musafili et al., 2013). These failures to translate knowledge gains into clinical practice are not uncommon after one-time trainings and call into question the notion that such trainings are an effective method of achieving behavior change in the absence of linkages to implementation and systems support. Two exceptions to these underwhelming results are a study from Tanzania that found a 47% reduction in early neonatal mortality following implementation of HBB (Msemo et al., 2013) and one from India showing a reduction in the fresh stillbirth rate (OR 0.54, 95% CI 0.37-0.78, p≤0.001; Shivaprasad et al., 2013). The term fresh stillbirth is defined as a baby born without signs of skin degradation or maceration, suggesting fetal demise within the twelve hours preceding delivery.

Of history and health systems: Underlying causes of neonatal mortality in Haiti

The problem of neonatal mortality in Haiti has both proximal and distal causes. The proximal causes are those typically focused on in the medical and public health literature: preterm birth, sepsis, and intrapartum-related hypoxia. Arguably more important are the underlying lying causes that increase a newborn’s risk for developing and dying from any of
these conditions.\(^3\) In Haiti, entrenched poverty and a weak public health system are major contributing factors to the country’s high rate of neonatal mortality.

The last century has witnessed an uncoupling of neonatal mortality between rich and poor countries. As technological advances, social programs, and investment in robust health care systems have led to steep declines in infant mortality in high-income countries like the United States, the gains of poor countries around the world have been more modest (MacDorman & Mathews, 2009; Guyer, Freedman, Strobino, & Sondik, 2000; Wertz & Wertz, 1989; Centers for Disease Control, 1999). Whereas these rates were once relatively uniform around the world, today, neonatal mortality is nearly ten times higher in Haiti than in the United States, and twice as high as in the neighboring Dominican Republic (World Bank, 2015).

In Haiti, the poverty that is responsible for placing so many newborns at risk of morbidity and mortality has deep historical roots that reach back to the slave trade, colonialism, imperialism, dictatorship, and neoliberalism—to name but a few of the social processes and events seldom discussed in medicine or public health. These forces have paved the way for entrenched poverty, and relatedly, to the development of a health care system that is woefully underequipped to provide high quality, universally accessible health care to the Haitian people.

To offer up but one example of how large-scale sociopolitical forces have established the structures that maintain poverty and a weak state, the experience of Haiti’s foreign debt is illustrative. Following Haiti’s defeat of Napoleon’s army in 1804 to achieve independence as the second free nation in the hemisphere, France demanded reparations from the Haitian government to pay for France’s loss of “property,” which included not just territory but what France had

\(^3\) In the *Lancet* Neonatal survival series, Lawn and colleagues emphasize two reasons why poverty is an important underlying cause of neonatal mortality—increases in the prevalence of risk factors and decreases in access to effective care (2005).
considered its human property, slaves. In modern currency, this debt is estimated to amount to $21 billion. British historian Alex von Tunzelmann describes the impact of this debt here:

For Haiti, this debt did not signify the beginning of freedom, but the end of hope. By 1900, it was spending 80% of its national budget on repayments. To manage the original reparations, further loans were taken out—mostly from the United States, Germany and France. Instead of developing its potential, this deformed state produced a parade of nefarious leaders, most of whom gave up the insurmountable task of trying to fix the country and looted it instead. (Cited in Alsan et al., 2011)

This experience is an exemplary illustration of how macro-level political and economic forces underlie poverty in Haiti and the financial constraints of the government health care system.4

If we are willing to “lift our eyes to look hard at history, political economy, and the powerful transnational institutions” that have shaped Haiti’s development over the past several hundred years, it becomes clear that the legacy of these social and historical forces continue to shape life in Haiti to this day (Farmer, 2008). For families, poverty contributes to neonatal mortality by reducing women’s access to health care leading up to, during, and after childbirth. Although delivering at a health facility is known to reduce risks of neonatal and maternal mortality, between 2007 and 2012, only 36% of births took place in a health facility in Haiti.5

This percentage dropped to 8.7% for women in the lowest economic quintile (Cayemittes et al., 2013). Similar trends are observed when analyzing access to prenatal and postpartum care. Inability to pay for care, lack of access to transport to a health facility, and fear are just some of the many reasons why poor women do not access the care they need at a time of critical risk for them and their babies.6

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4 This quotation is from Alex von Tunzelman’s 2009 article in the Sunday Times. She offers a more detailed discussion of the debt and its effect on Haiti in her book Red Heat: Conspiracy, Murder, and the Cold War in the Caribbean.
5 According to one large meta-analysis of studies in 17 low- and middle-income countries, health facility delivery can reduce neonatal mortality by 29% (Tura, Fantahun, & Worku, 2013).
6 See Barnes-Josiah, Myniti, & Augustin (1998) and Westoff (2006) for discussions of barriers to utilization of health care services in Haiti. A qualitative study conducted by White and colleagues (2006) examining women’s care-seeking behaviors during pregnancy found that the most common reason given for not obtaining medical care
For women who reach a health facility to give birth, these facilities often lack the human and physical resources to be able to provide timely, quality care to mother and baby. The absence of such resources is directly linked to the social and historical forces mentioned above, whose legacy is not just the impoverishment of Haitian families but also of the Haitian government. With a GDP currently estimated at $1,300 per capita, and national health budget of only $63 per capita in 2010-11, the government’s ability to provide quality health services to the Haitian population is severely constrained (Central Intelligence Agency, 2013; Ministère de la Santé Publique et de la Population, 2013). While a lack of strong management by the government is considered a major source of the public system’s failings, long-standing deficiencies in the public sector have only been exacerbated by years of disinvestment in this sector by international donors in favor of NGOs, many of them foreign (Prins, Kone, Nolan, & Thatte, 2008).7

Study objectives

This study examines the challenge of providing effective resuscitation of newborns in a resource-limited setting. Through direct observation of clinical practices and through interviews with frontline health care providers at a public hospital in Haiti, it aimed to develop an understanding of the current state of clinical practice with respect to neonatal resuscitation. Specific objectives were: 1) to identify current resuscitation practices in the hospital at the time of delivery; 2) to characterize provider experiences with resuscitation at the time of delivery; and 3) to identify barriers to providers performing effective resuscitations.

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7 The problem of disinvestment in the public sector is not limited to Haiti. In his forward to Global Surgery and Anesthesia Manual (2015), Farmer notes that divestment from public health systems has contributed to a “massive reversal” in public health gains in poor countries around the world (p. ix). See also Biehl & Petryna (2013).
Methods

Setting

This investigation was conducted at Hôpital Saint Thérèse d’Hinche (HSTH), the public referral hospital for the Central Department, one of Haiti’s ten departments. HSTH is located in the department capital of Hinche and serves the department’s predominantly rural population of over 700,000 inhabitants (Ministère de la Santé Publique et de la Population, 2013). Throughout Haiti, 78% of the population lives on less than $2 per day, and with 41% of its residents considered to be in the country’s bottom economic quintile, only Grande-Anse has a larger proportion of residents living in extreme poverty (Cayemittes, et al., 2013).

Although fecundity is on the decline, the most recent DHS shows that women in the Central Department still give birth more to more children than in any other department in Haiti (6.5 live births per woman, as compared the national average of 4.9), and are more likely to be pregnant (8.2% of women were pregnant at the time they were surveyed, versus the national average of 5.9%). However, between 2007 and 2012, only 25% of deliveries took place in a health facility, considerably less than the national average. These factors all contribute to the Central Department’s elevated neonatal mortality rate, which at 37 per 1,000 live births is the second highest rate of any department in Haiti (Cayemittes, et al., 2013).

The United States Government built HSTH in the 1920s during its occupation of Haiti, which lasted from 1915-1937. In the years preceding its construction, Hinche was the site of a number of violent uprisings against the occupying force, known as the “Cacos Insurrection.” One of the major reasons for these uprisings was the U.S. government’s conscription of forced laborers to participate in the construction of public works, such as roads and hospitals (Gaillard,
1982; Heinl & Heinl, 1978; Farmer, 1994; Coupeau, 2008). The U.S. Marines responded to the rebellions with force, killing a large but debated number of Haitians, ultimately including Charlemagne Péralte, the nationalist leader of the Cacos and an Hinche native.8

Administration of HSTH was eventually handed over to the Haitian government, and it is now run by the Haitian Ministry of Public Health and Population (Ministère de la Santé Publique et de la Population, MSPP). Since 2004, the hospital has received support from Zanmi Lasante (ZL), a Haitian NGO affiliated with Boston-based Partners In Health (PIH). ZL initially became involved with HSTH after the Minister of Health for the Central Department requested the organization’s help improving the hospital’s HIV/AIDS services (Pabo, Rhatigan, Ellner, & Lyon, 2011). Over the past decade, ZL’s support of HSTH has expanded in accordance with efforts to strengthen the public health sector’s ability to provide quality care to patients in the Central Department, and ZL now supports a diverse array of services and departments at HSTH, in addition to those focused on HIV/AIDS. HSTH also receives support from Midwives For Haiti (MFH), an international NGO founded in 2006 that provides the maternity department with supplies, training, and short-term foreign volunteers, and Ohio State University (OSU), an academic partner supporting the hospital’s neonatology program since its launch in late 2013.

Currently, the labor ward at HSTH receives around two hundred deliveries per month. Between 7am-6pm, the delivery room is staffed by two providers (either two skilled birth attendants or one skilled birth attendant and one nurse-midwife), while three other birth attendants staff the antepartum, post-partum, and post-operative wards. On weekdays, one nurse-midwife is present to supervise the staff. Overnight, one skilled birth attendant staffs the delivery room, and another is responsible for the remaining three wards. The skilled birth attendants

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8 For a discussion of differing accounts of the death toll of the Cacos Insurrection, see Farmer’s The Uses of Haiti, pages 95-101.
perform most vaginal deliveries. There are sometimes foreign MFH volunteers (nurse-midwives, nurses, physicians, doulas) assisting on the labor ward, as well.

All skilled birth attendants employed by HSTH have completed training as either registered nurses or auxiliary nurses (*auxiliaires*), as well as a one-year accelerated midwifery training course offered by MFH.§ HBB training was provided to all nurse-midwives and skilled birth attendants working in the HSTH maternity department in 2013. However, three skilled birth attendants who participated in the individual interviews reported that they had not attended the training (one had not yet been hired by HSTH, and two were working with MFH at a separate site); these three individuals each reported some prior training in neonatal resuscitation.

Throughout the day and night, one obstetrician is assigned to be on call although not necessarily in-house, and not always immediately available. There is also an on call operating room team (nurse anesthetist, scrub technician, and circulating nurse) that is shared between the obstetricians and the surgeons. Of the three obstetricians employed by the hospital, each typically takes 24-hour call for five to ten days consecutively every month.

The HSTH pediatrics department consists of a pediatric emergency room, an inpatient pediatrics ward, and a malnutrition ward. At the end of 2013, a neonatology program was established at HSTH with support from Ohio State University (OSU) and a Greif Foundation grant. Through this program, seven new nursing positions were created at HSTH, with the express purpose that these nurses would be dedicated to newborn care, attending all deliveries taking place at the hospital. Each of the newly hired registered nurses completed a six-week training course in newborn care, including the NRP. This was followed by approximately one month of full-time, on-site mentorship with two American nurse practitioners from OSU’s

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§ Although Midwives For Haiti and many of the program’s graduates describe themselves as “midwives”, I use the term “skilled birth attendant” in keeping with the fact that MFH’s accelerated training program is not accredited by the Haitian government, and to distinguish these providers from the officially credentialed nurse-midwives.
Neonatal Intensive Care Unit (NICU). By the time delivery observations for this study began, the Haitian nurses were working independently but met with their nurse-mentors from OSU at least weekly. The registered nurses trained through this program are referred to as newborn care or neonatology nurses. They began attending deliveries in January 2014. From January to May 2014, the neonatology program was based out of the pediatric emergency room, with the newborn care nurses responsible for managing pediatric emergency room patients in addition to attending deliveries.

**Design**

This is a mixed methods study following an explanatory sequential design. Prior to initiation, there was a two-month period of participant-observation to acclimate to the context and establish relationships with the staff. The first phase of the study followed a descriptive observational methodology in order to identify current neonatal resuscitation practices and gaps. The second phase of the study used qualitative interviews with providers to enhance understanding of the barriers to systematic and effective implementation of this intervention.

**Quantitative phase**

*Quantitative participant selection*

In March 2014, all potential providers of newborn care in the delivery room and/or the operating room at HSTH were invited to participate in this investigation. This included obstetrician-gynecologists, newborn care nurses, nurse-midwives, skilled birth attendants (nurses or auxiliary nurses), and an auxiliary nurse working as a cleaner in the delivery room. Thirty-seven (97%) providers consented to be included (see Figure 6).
The women whose deliveries were observed and their newborns were considered secondary participants in the study. All women presenting to HSTH in labor were eligible to participate in the study. Consent was requested after a skilled birth attendant evaluated each woman. Two hundred thirteen women consented to participate in the study, but 38 of these women were not included because they were discharged prior to delivery or because a researcher was not present at the time of the delivery. One hundred seventy-five women and 178 newborns were ultimately included in the study.

**Quantitative data collection**

Delivery room observations were performed by a student researcher and a trained research assistant. The research assistant was a Haitian physician who had previously worked at
the hospital. Observations were conducted over a two-month period in March and April 2014. Delivery room coverage by researchers was 24 hours a day, six days a week, with the day off varied in order to include data from a mix of weekday and weekend shifts. The purpose of these observations was to characterize current neonatal resuscitation practices.

Observations were recorded using a checklist developed by the Zanmi Lasante pediatrics team to evaluate resuscitation practices following a Helping Babies Breathe training (see Figure 7). The checklist was based off of the neonatal resuscitation algorithm and technique taught in HBB.
<table>
<thead>
<tr>
<th>Item</th>
<th>Action taken?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baby cries or breathing well at birth?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Time to assessment of newborn</td>
<td></td>
</tr>
<tr>
<td>Was the baby dried with a cloth or towel immediately after delivery?</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>In the first minute after delivery, the provider:</strong></td>
<td></td>
</tr>
<tr>
<td>Assesses baby's breathing while drying?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Discards wet cloth?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Wraps baby in new dry cloth?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Transfers baby to a surface that is warm, clean and dry</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If baby did not breathe at birth:</strong> Did the baby breathe or cry after drying</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If the baby doesn’t breathe with drying:</strong> Was the baby’s airway suctioned?</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>In case of meconium:</strong> The baby’s airway was suctioned before drying and stimulation?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider positions baby's head so that it is slightly extended</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider suctions mouth first</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider introduces tube into mouth ≤5cm from lips</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider suctions on withdrawal</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider suctions nose second</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider introduces tube ≤3cm into each nostril</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider suctions on withdrawal</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider repeats suction maximum twice</td>
<td>Y/N</td>
</tr>
<tr>
<td>Suction process lasts less than 20 seconds</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If the baby received suctioning:</strong> Did the baby start breathing or crying?</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If the baby did not breathe after suctioning:</strong> Did the baby receive bag-mask ventilation?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider chooses correct size mask?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider places mask to cover chin mouth and nose?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Good seal formed?</td>
<td>Y/N</td>
</tr>
<tr>
<td>If smaller bag-mask, was bag squeezed 2-3 times with 2 fingers?</td>
<td>Y/N</td>
</tr>
<tr>
<td>If a larger bag-mask, was bag squeezed 2-3 times with whole hand?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider observes rise of chest while ventilating?</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If no chest rise:</strong></td>
<td></td>
</tr>
<tr>
<td>Provider repositions head?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Mask seal checked?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Bag squeezed slightly harder with whole hand?</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If good chest rise:</strong></td>
<td></td>
</tr>
<tr>
<td>Provider ventilates 40 squeezes/minute until newborn crying or spontaneous breathing?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider assesses baby by looking for chest in-drawing?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider assesses baby by counting breaths per minute?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Provider stops ventilation if breathing &gt; 30 breaths/min and no chest in-drawing?</td>
<td>Y/N</td>
</tr>
<tr>
<td><strong>If the baby received bag-mask ventilation:</strong> Did it breathe following this intervention?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Infant status at end of resuscitation period</td>
<td>Alive/dead</td>
</tr>
</tbody>
</table>

Figure 7. Delivery observation checklist
The availability of 12 items of resuscitation equipment was also noted for each delivery. Estimated gestational age, birth weight, time of delivery, complications, mode of delivery, and APGAR scores at one and five minutes were recorded from the hospital birth registry for each delivery (see Table 1). Data sheets from each delivery were reviewed by the student researcher at the end of each shift. In 23 cases, an intervention was performed by a clinician who was not a designated participant in the study (for example, a foreign volunteer or one of the researchers); any data collected from these cases were excluded post hoc from the study.

Table 1. Summary of newborn and maternal characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Breathing newborns</th>
<th>Non-breathing newborns</th>
<th>Total (breathing and non-breathing newborns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal delivery</td>
<td>87</td>
<td>38</td>
<td>125</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>17</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>Average birth weight (kg)</td>
<td>2.8 (1.7-3.7)</td>
<td>2.8 (1.2-4.2)</td>
<td>2.8 (1.2-4.2)</td>
</tr>
<tr>
<td>Average EGA (weeks)</td>
<td>39.5 (33-42.9)</td>
<td>38.4 (24-43.3)</td>
<td>39.2 (38.4-43.3)</td>
</tr>
<tr>
<td>Average APGAR – 1 min</td>
<td>7.6 (4-9)</td>
<td>5.0 (0-9)</td>
<td>6.8 (0-9)</td>
</tr>
<tr>
<td>Average APGAR – 5 min</td>
<td>9.0 (8-10)</td>
<td>6.5 (0-9)</td>
<td>8.2 (0-10)</td>
</tr>
</tbody>
</table>

Maternal complications\textsuperscript{10}
- Pre-eclampsia or eclampsia: 7 (6.7%) for breathing newborns, 9 (17.6%) for non-breathing newborns, and 16 (10.3%) for total newborns.
- Cephalopelvic disproportion: 9 (8.7%) for breathing newborns, 4 (7.8%) for non-breathing newborns, and 13 (8.4%) for total newborns.
- Premature rupture of membranes: 7 (6.7%) for breathing newborns, 7 (13.8%) for non-breathing newborns, and 14 (9.0%) for total newborns.
- Placenta previa: 0 for breathing newborns, 3 (5.9%) for non-breathing newborns, and 3 (1.9%) for total newborns.
- Placental abruption: 0 for breathing newborns, 2 (3.9%) for non-breathing newborns, and 2 (1.3%) for total newborns.
- Twin gestation: 3 (2.9%) for breathing newborns, 2 (3.9%) for non-breathing newborns, and 5 (3.2%) for total newborns.

\textit{Quantitative data analysis}

Descriptive statistics were used to analyze the observational data. Checklist responses of Yes or No were transformed into dichotomous variables.

\textsuperscript{10} Included in the table are the most common maternal complications recorded in the HSTH birth registry.
Qualitative phase

Qualitative participant selection

Following the completion of the quantitative data collection, health care providers who had participated in the quantitative phase of the study were invited to be interviewed about their experiences with newborn resuscitation. Those providers who had been recruited for the quantitative phase but who had never been observed providing direct newborn care were excluded from the interview phase. There were also two skilled birth attendants who left HSTH prior to completion of the study. Ultimately, 23 providers (92%) of the 25 eligible for Phase 2 consented to be interviewed.

Qualitative data collection

We conducted semi-structured individual interviews with 23 health care providers in April and May 2014. Interviews lasted 30-75 minutes. The interviews were conducted with the help of a Haitian Creole interpreter. The interviews were the transcribed by the student researcher who also provided a more formal translation of the interview responses into English.

Qualitative data analysis

Qualitative data analysis was performed according to an inductive, content-focused approach looking for common themes. The interview transcripts were coded and analyzed with the support of qualitative data analysis software.
**Participant-Observation**

The student researcher spent two months preceding the start of the study on the pediatrics and maternity wards. During this time, she was able to get to know the hospital setting, build relationships with staff, and develop her own sense of the barriers to neonatal resuscitation at HSTH. Throughout this period, as well as during the two-month period she spent performing delivery room observations, she took notes on her experiences, observations, and informal conversations.

**Ethical considerations**

This study was approved by the Institutional Review Board (IRB) of Harvard Medical School and the *Comité d’Éthique et Recherche* of Zanmi Lasante in Haiti. Written informed consent was obtained from providers prior to participation in each phase of the study. Verbal informed consent was obtained from the women whose deliveries were observed upon arrival to the hospital in labor. In six cases, consent was obtained post-partum because emergent intervention was required upon the patient’s arrival to the hospital. The determination to waive consent at the time of delivery was made by the health care provider responsible for that patient’s care.

**Results**

**Quantitative data**

**Resuscitation outcomes**

In the quantitative phase, the deliveries of 155 newborns were observed, of which 51 (32.9%) were not breathing at the time of birth. Forty-five (88.2%) of these newborns were
successfully resuscitated by providers at the time of delivery. Of these, six (11.8%) were successfully resuscitated with drying and stimulation alone. Ten (19.6%) newborns were successfully resuscitated by stimulation and airway clearing alone. Twenty (39.2%) were resuscitated by a combination of drying, stimulation, and airway clearing. Nine (17.6%) were successfully resuscitated by the preceding techniques combined with bag-mask ventilation with or without chest compressions. Six of the 51 newborns (12%) were not successfully resuscitated and died. This represents a mortality rate in the study group of four percent (3.9%).

Of note, it is possible that four of these deaths were actually fresh stillbirths. At the time of delivery, these were anticipated live births, and as such, a full resuscitation was attempted in each case. However, following the failure of these resuscitations, providers classified these four deliveries as stillbirths and recorded one- and five-minute APGAR scores of zero in the hospital birth registry.

**Table 2. Neonatal resuscitation success rates, by step.**

<table>
<thead>
<tr>
<th>Newborns successfully resuscitated</th>
<th>Drying + stimulation</th>
<th>Airway clearing + stimulation</th>
<th>Drying + airway clearing + stimulation</th>
<th>Drying + airway clearing + stimulation + BMV +/- chest compressions</th>
<th>All steps combined</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>All non-breathing newborns</td>
<td>6 (11.8%)</td>
<td>10 (19.6%)</td>
<td>20 (39.2%)</td>
<td>9 (17.6%)</td>
<td>45 (88.2%)</td>
<td>6 (11.8%)</td>
</tr>
<tr>
<td>Non-breathing newborns delivered vaginally</td>
<td>6 (11.8%)</td>
<td>-</td>
<td>11 (21.6%)</td>
<td>4 (7.8%)</td>
<td>21 (41.2%)</td>
<td>3 (5.9%)</td>
</tr>
<tr>
<td>Clear amniotic fluid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meconium-stained amniotic fluid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-breathing newborns delivered by cesarean section</td>
<td>-</td>
<td>6 (11.8%)</td>
<td>5 (9.8%)</td>
<td>2 (3.9%)</td>
<td>13 (25.5%)</td>
<td>-</td>
</tr>
</tbody>
</table>

**Intervention timing and ‘The Golden Minute’**

The average time from birth to newborn assessment and basic stimulation for all newborns was 16 seconds (12 seconds for vaginal deliveries, and 30 seconds for cesarean deliveries). The denominator used in these calculations is 51. This includes the 45 resuscitated newborns and the six newborns who died (including the four whose deaths may have been stillbirths).
sections). The average time to intervention was slightly longer for non-breathing newborns (18.6 seconds for vaginal births and 37.9 seconds for cesarean sections). The average time from birth to initiation of bag-mask ventilation was 3.2 minutes (range: 1-4.5 minutes).

**Resuscitation technique**

*Step 1: Drying and stimulation*

Of the 51 newborns not breathing at birth, 46 (90%) were dried immediately after birth. Eighteen (36%) of the total were dried immediately and effectively. Drying was considered effective if the provider met four technique criteria based on the HBB checklist: 1) observing the infant’s breathing while drying it, 2) discarding the first wet cloth used for drying the infant, 3) wrapping the infant in a second dry cloth, and 4) transferring the infant to a surface that was clean, warm, and dry. Providers met these criteria at rates of 94%, 49%, 46%, and 98%, respectively.

*Step 2: Stimulation and airway clearing*

Of the 31 infants who remained apneic after initial drying and stimulation, all (100%) had their airways cleared with a bulb suction device.\(^{12}\) Twelve (40%) were suctioned effectively.\(^{13}\) The provider’s suctioning technique was considered effective if the provider met the nine technique criteria from the HBB checklist (Table 3). At the end of this step, 15 (48%) newborns remained apneic.

\(^{12}\) This figure includes those infants who were suctioned for meconium exposure or following cesarean section prior to initiation of drying, as well as those whose airways had not previously been cleared.

\(^{13}\) One data sheet left the technique section blank, so this case was not included in the denominator.
Table 3. Provider achievement of technique criteria for airway clearing.

<table>
<thead>
<tr>
<th>Technique Criteria</th>
<th>Percent of providers performing correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positions baby's head in slight extension</td>
<td>33%</td>
</tr>
<tr>
<td>Suctions mouth first</td>
<td>100%</td>
</tr>
<tr>
<td>Introduces tube into mouth ≤5 cm from lips</td>
<td>100%</td>
</tr>
<tr>
<td>Suctions on withdrawal</td>
<td>96%</td>
</tr>
<tr>
<td>Suctions nose second</td>
<td>100%</td>
</tr>
<tr>
<td>Introduces tube ≤3 cm into each nostril</td>
<td>100%</td>
</tr>
<tr>
<td>Suctions on withdrawal</td>
<td>93%</td>
</tr>
<tr>
<td>Repeats suction maximum twice</td>
<td>81%</td>
</tr>
<tr>
<td>Suction process lasts &lt; 20 seconds</td>
<td>88%</td>
</tr>
</tbody>
</table>

**Step 3: Positive-pressure ventilation with a bag-mask device**

Of the 15 infants who remained apneic after drying, stimulation, and suctioning, all (100%) received ventilation with a bag-mask. The ventilation technique was effective in three (21%) of cases. The provider’s ventilation technique was considered effective if the provider met nine technique criteria from the HBB checklist (Table 4). In the event that a provider was unable to achieve chest rise, technique was additionally assessed based on whether the provider took the following three actions: 1) re-positioned the mask, 2) assessed the mask seal, and 3) squeezed the Ambu-bag harder. Providers were initially unable to elicit chest rise in 11 cases; in five of these, the provider was eventually able to establish effective ventilation. Of the 15 newborns who received ventilation in this study, nine (60%) were successfully resuscitated, and six (40%) died. Of the providers ventilating the six infants who died, none were able to achieve good chest rise.
**Table 4. Provider achievement of technique for bag-mask ventilation.**

<table>
<thead>
<tr>
<th>Technique Criteria</th>
<th>Percent of providers performing correctly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct size mask selected?</td>
<td>86%</td>
</tr>
<tr>
<td>Mask placed to cover chin, mouth, and nose?</td>
<td>93%</td>
</tr>
<tr>
<td>Good seal formed?</td>
<td>86%</td>
</tr>
<tr>
<td>If smaller bag-mask: Ambu-bag squeezed 2-3 times with 2 fingers?</td>
<td>71%</td>
</tr>
<tr>
<td>If a larger bag-mask: Ambu-bag squeezed 2-3 times with whole hand?</td>
<td>100%</td>
</tr>
<tr>
<td>Provider observes rise of chest while ventilating?</td>
<td>100%</td>
</tr>
<tr>
<td>If no chest rise:</td>
<td></td>
</tr>
<tr>
<td>Provider repositions head?</td>
<td>100%</td>
</tr>
<tr>
<td>Mask seal checked?</td>
<td>100%</td>
</tr>
<tr>
<td>Bag squeezed slightly harder with whole hand?</td>
<td>90%</td>
</tr>
<tr>
<td>If good chest rise:</td>
<td></td>
</tr>
<tr>
<td>Gives 40 breaths per minute until newborn crying or spontaneous breathing?</td>
<td>100%</td>
</tr>
<tr>
<td>Assesses baby by looking for chest in-drawing?</td>
<td>88%</td>
</tr>
<tr>
<td>Assesses baby by counting breaths per minute?</td>
<td>100%</td>
</tr>
<tr>
<td>Stops ventilation if breathing more than 30 breaths per minute and no chest in-drawing?</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Management of newborns exposed to meconium-stained amniotic fluid**

The HBB neonatal resuscitation algorithm for newborns exposed to meconium-stained amniotic fluid recommends immediate suctioning of the infant’s airway prior to all other interventions. In this way, management of these newborns differs slightly from those who are not exposed to meconium during the delivery process. Of the 26 (17%) newborns exposed to meconium-stained amniotic fluid, 18 (69%) received immediate suctioning after birth (Table 5).

**Table 5. Number and percent of newborns exposed to meconium whose airways were cleared immediately after birth**

<table>
<thead>
<tr>
<th>All newborns</th>
<th>Total</th>
<th>Number immediately suctioned at birth (% of newborns exposed to meconium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breathing newborns</td>
<td>26</td>
<td>18 (69%)</td>
</tr>
<tr>
<td>Non-breathing newborns</td>
<td>7</td>
<td>3 (43%)</td>
</tr>
<tr>
<td><strong>Vaginal births</strong></td>
<td>14</td>
<td>10 (71%)</td>
</tr>
<tr>
<td><strong>Cesarean section births</strong></td>
<td>5</td>
<td>5 (100%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>19</td>
<td>15 (79%)</td>
</tr>
</tbody>
</table>

26
Management of newborns delivered via cesarean section

Thirty (19%) of the newborns in this study were delivered via cesarean section. In all cases, the obstetrician suctioned the newborn’s airway prior to cutting the umbilical cord and handing the infant to the newborn care nurse. Resuscitation of newborns was then performed as needed by the newborn care nurse.

Delivery attendance

Of the 155 deliveries included in the summary data analysis, all but one (99.4%) was attended by a provider trained in neonatal resuscitation, including all deliveries of non-breathing newborns. The rate of attendance at the 23 excluded deliveries was lower at 87%. Combined, the rate of delivery attendance by a provider trained in neonatal resuscitation was 98% (174 of 178 deliveries). A newborn care nurse was present at 52% of the 178 observed deliveries.

Table 6. Breakdown of who provides newborn care at birth. This data only includes the 155 deliveries included in the major data analysis.

<table>
<thead>
<tr>
<th>Newborn care nurse</th>
<th>Skilled birth attendant</th>
<th>Midwife</th>
<th>Auxiliary nurse</th>
<th>Physician</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° provider</td>
<td>80 (52%)</td>
<td>73 (47%)</td>
<td>0 (0%)</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>2° provider</td>
<td>8 (5%)</td>
<td>92 (59%)</td>
<td>3 (2%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

Equipment availability

All equipment and supplies were available at 20% of deliveries. These supplies were prepared in advance of the delivery in 1% of cases. For supplies to be considered “prepared,” they needed to be in an easily accessible location known by the provider (e.g. on a bedside tray, on the counter where resuscitation took place); an item that remained in the supply closet or in the dirty supply bin until it was needed after the delivery was considered “available” but not
“prepared.” On average, 10 of 12 items were available. Of available supplies, these were prepared by the provider 75% of the time on average.

<table>
<thead>
<tr>
<th>Item</th>
<th>Available?</th>
<th>Prepared?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloves</td>
<td>100%</td>
<td>96%</td>
</tr>
<tr>
<td>Towels (2)</td>
<td>84%</td>
<td>73%</td>
</tr>
<tr>
<td>Baby hat</td>
<td>65%</td>
<td>46%</td>
</tr>
<tr>
<td>Scissors or razor blade</td>
<td>99%</td>
<td>91%</td>
</tr>
<tr>
<td>Umbilical clamps or ties</td>
<td>89%</td>
<td>76%</td>
</tr>
<tr>
<td>Bulb suction</td>
<td>99%</td>
<td>81%</td>
</tr>
<tr>
<td>Ambu-bag</td>
<td>98%</td>
<td>54%</td>
</tr>
<tr>
<td>Mask (large)</td>
<td>98%</td>
<td>45%</td>
</tr>
<tr>
<td>Mask (small)</td>
<td>92%</td>
<td>41%</td>
</tr>
<tr>
<td>Clock or watch</td>
<td>53%</td>
<td>50%</td>
</tr>
<tr>
<td>Stethoscope</td>
<td>88%</td>
<td>74%</td>
</tr>
<tr>
<td>Warming lamp or warming blanket</td>
<td>56%</td>
<td>16%</td>
</tr>
</tbody>
</table>

**Table 7. Percent of deliveries at which supplies were available and/or prepared by the provider in advance of the delivery.**

Qualitative results

Training impact and perceived competency

Both skilled birth attendants and newborn care nurses explained that they valued the training they had received in neonatal resuscitation and believed it to have contributed to their ability to respond to babies not breathing at birth. Some described the benefits of training in general terms. For instance, one birth attendant stated: “The training I had on the fake babies was good. When I had a real baby, I knew how to do everything.” Another stated: “I really appreciated [the training] because, before learning how to resuscitate a baby, a baby born with a breathing problem might even die. But after learning how to help him breathe, the baby breathes and lives.” Other providers described specific instances in which they felt that their training had enabled them to save a baby’s life. Reflecting on one successful resuscitation she had performed, a newborn care nurse remarked: “I felt comfortable because, when I saw the baby breathing, I knew that it was truly because of the training that I had succeeded.” One of her colleagues
similarly commented: “Our studying has started to lead to results. At the majority of deliveries that we assist, the resuscitations we do are successful.”

All but two providers interviewed described an experience in which she provided bag-mask ventilation to resuscitate a newborn; the two who had not ever performed this task included an auxiliary nurse employed as a cleaner in the delivery room (she occasionally assisted with deliveries but had not had any training on resuscitation) and one birth attendant who had “never encountered a baby in distress that needs resuscitation.”

Among providers with experience providing both stimulation and bag-mask ventilation, confidence in one’s ability to resuscitate neonates was high. When asked to rate their competence on a scale of one to five (1=not competent at all, 3=competent, 5=very competent), the average score provided by respondents was 4.1 (Table 8). “We’re good at resuscitation” and “I know what to do” were common justifications. Providers frequently justified high scores on the basis of positive outcomes, pointing to successful resuscitations as evidence of their skill.

<table>
<thead>
<tr>
<th>Score</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3.5</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>4.75</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>n/a</td>
<td>3</td>
</tr>
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While most providers were confident in their resuscitation skills, they were eager for further training. “Learning never ends” was a common refrain, with both newborn care nurses and skilled birth attendants suggesting that refresher trainings on resuscitation be integrated into
continuing medical education.

Of note, providers frequently attributed imperfect performance to the absence of certain supplies, rather than to gaps in their own skills: “[I]t’s not only about training more people,” argued one newborn care nurse. She continued, “You need more supplies because the students receive good training, but if I don’t have equipment to practice with, it’s like the training isn’t useful.” Further illustrating this point were the explanations that several providers gave for not ranking themselves “very competent”:

I would give myself a ‘4’ because you can resuscitate a baby, but you lack materials. For example, there are often babies that need oxygen, and you don’t have it available. For example, towels for drying the baby… And then it can happen that the baby has already died. It’s because there are things that aren’t there. So you can’t give yourself a ‘5’. Even if sometimes it’s not you the cause. All the materials are set up, the baby needs something that would help the baby to live, and it’s not there. You run to the other side, but it’s not there. –skilled birth attendant

I can’t give myself a ‘5’ because when I need to resuscitate a baby, I may be missing supplies. That can cause a baby who should have cried to not cry. But myself, I know everything I need to do. But if you see me resuscitating a baby, you might not give me ‘5’ out of ‘5’ because I need some item that isn’t there with me. I have the technique to do it well and could give myself a 5, but I must give myself 4.75. –skilled birth attendant

Through these examples, we see how resource shortages constrain providers’ ability to resuscitate newborns, a task that they otherwise feel very prepared to do.

Those who described struggling with some of the technical aspects of resuscitation primarily reported difficulty with bag-mask ventilation. “[The hardest part of resuscitation] is ventilation because there are times when you’re ventilating a child, and for some reason, the air won’t enter,” said one newborn care nurse. Such difficulties with air entry were relatively common and were reported by newborn care nurses and birth attendants alike. A small number of providers complained that some of their colleagues were “too slow” at resuscitating.
Barriers to neonatal resuscitation

Providers described a number of factors that constrain their ability to effectively and consistently resuscitate newborns. The barriers that were most commonly emphasized were systemic in nature, falling into four major categories: personnel shortages, resource shortages, inadequate space, and poorly organized communication systems.

“You only have two hands”: Descriptions of personnel shortages

Inadequate staffing support related to an overall lack of personnel was a major theme in 16 of the 22 interviews. In most cases, participants specifically identified personnel shortages as a problem, and in several cases referred to it as the “hardest” part of their job. In other cases, this was merely the backdrop to anecdotes of the normal, everyday experience of working at HSTH.

Sometimes, the number of personnel is too small. For example, you can have an asthmatic patient that is on oxygen and that needs medication every hour. You have a pre-eclamptic patient outside, or a patient with post-partum hemorrhage. You have a baby who needs resuscitation. Sometimes you have a woman that shows up in the second stage of labor. You’re alone in the delivery room. There’s another birth attendant for the three inpatient rooms. This can be truly difficult. Sometimes you ask the patient’s family members or the cleaning staff to help you. –skilled birth attendant

I’m used to needing help and not being able to find someone, or help doesn’t come. –skilled birth attendant

If we had more staff, it would be good. To give truly high quality care… Imagine, if they put two people on service at night, one outside and one inside, you can’t do everything. You can’t give good quality care. You can’t. They are putting three people on the service in the morning. You can’t do it. All the things you need to do for someone, you can’t do them. When you go to the person who is worst off, you can’t do all the things you need to do for her. So you give a part of the care that will allow a patient to leave the hospital more or less okay, but in everything you do, you lack staff. –skilled birth attendant

The patient load for the birth attendants is considerable, especially at night when staffing ratios are lowest. On nights when a researcher was present, there were as many as twelve vaginal deliveries. Management of these patients was the responsibility of a single birth attendant with
varying support from a second who was also responsible for three other rooms of patients. Words like “ugly” and “misery” were used to describe shifts like these. When multiple patients require urgent attention at the same time, providers are forced to make tough triaging decisions, and delays in care are common. Below are two characteristic anecdotes:

If the baby doesn’t breathe or doesn’t cry, in the time it takes to resuscitate the baby, there can be at least four women ready to deliver. Imagine being the only birth attendant in the delivery room. It’s difficult. Or if there are only two people overnight in the maternity, one outside [on the wards] and one inside [the delivery room]. If there are two babies to resuscitate, what can you do? – skilled birth attendant

For example, if the mother is bleeding, if she has a laceration that is bleeding, or if she is hemorrhaging, and if the baby is born and either it doesn’t cry, doesn’t breathe, or it has another problem, both of them need emergency care. But there aren’t two people. There aren’t two providers. There’s only one for both the mother and the baby. …You have to have help. That’s the problem. It’s only you, and you only have two hands. That’s the problem. – skilled birth attendant

When confronted with such dilemmas, some birth attendants openly acknowledged that they would “leave” or “abandon” the baby in order to “save the mother.” In the words of one birth attendant:

There’s a rule: if the mother is having difficulties, and the child is having difficulties, it’s the mother you save. That’s to say, even if the baby can’t breathe, if the mother is bleeding a lot, I’m obligated to put the baby down, even if it isn’t breathing, and I’m going to save the mother. – skilled birth attendant

In addition to hindering the ability of birth attendants to respond to neonates in need of resuscitation, both newborn care nurses and maternity staff commented that resuscitating a newborn on one’s own, particularly with bag-mask ventilation, was especially “difficult.” “Resuscitation requires two people” and “one person cannot resuscitate by herself” were oft-repeated statements. In some of these cases, providers described struggling with the alternation between using the bag-mask to deliver artificial breaths with performing chest compressions, not to mention stopping periodically to check for changes in the baby’s breathing and heart rate. In
the case described below, the baby’s poor tone and small size – common characteristics of babies in need of resuscitation at HSTH – were what made the resuscitation particularly challenging:

What was difficult was that the baby was really, really floppy, and it was really small. And then the second nurse hadn’t yet arrived. I was obliged to do the resuscitation by myself. It was really difficult for me to keep the head of the baby fixed in place. A resuscitation, it requires two people. When it’s just you, regardless, you will encounter difficulties. –newborn care nurse

To this provider, if she had had a colleague present to help her, maintaining the baby in a position that would allow her to effectively ventilate would have been much easier. Her frustration echoes the lament of her coworker cited above: “You only have two hands.”

The effect of personnel shortages on labor monitoring prior to a baby’s birth also influences newborn outcomes. During labor, overstretched birth attendants are rarely able to monitor fetal well-being and thus cannot promptly intervene in cases of fetal distress. The longer the duration of fetal distress, the greater the risk of ‘birth asphyxia,’ and the more likely it becomes that resuscitation will be needed. This vicious cycle is captured by the one of the nurse-midwives and another birth attendant:

Well, often we end up having to resuscitate a child because there was fetal distress that was not diagnosed in time. If the problem were diagnosed on time, we would have known in advance that it was an operative case, and we would have done the surgery, that’s all. …I will always repeat that it is the lack of personnel that is our problem. You can’t monitor the fetal heart rate because you have all these other things that you have to do.
–nurse-midwife

[S]ometimes in the delivery room, you are alone, and there are several people in labor at the same time. You cannot monitor the fetal heart rate the way you should, and this leads to the deceleration of the newborn’s heart sounds, and you don’t know what the cause is because it hasn’t been monitored. At birth, you see that the baby has breathing problems.
–skilled birth attendant

As a result of the lack of personnel, it is not uncommon for non-clinical staff to be called upon to help with maternal and newborn care. For instance, when a newborn care nurse needed help resuscitating a newborn but had no one around to help her, she asked “the man in charge of
the oxygen” for assistance, even though “he didn’t really know what to do.” In other instances, cleaners or patient family members were asked to help out. An auxiliary nurse employed as a cleaner in the maternity shared that she often steps in when the birth attendants are busy. “It’s like, if they’re lacking people, they have me do it,” she explains. She estimates that she ends up delivering about one baby a week. Although she stated that a birth attendant typically steps in to provide the newborn care, she described providing warmth and stimulation to some newborns. She has not had any formal training in neonatal resuscitation.

According to a nurse-midwife who has worked at HSTH for several years, these personnel shortages have only gotten worse recently, and the quality of care has suffered as a result:

When we had more people, you could say, yes, things were better because there was more staff, and the patients were better taken care of. For example, the hospital admits a huge amount of cases of pre-eclampsia and eclampsia here. We could manage them better because we had more staff. In many cases, those patients were supposed to be cared for, but sometimes, the providers were forced to neglect them because of the lack of personnel. Because most of the cases could have been prevented if there were sufficient personnel. Do you understand what I’m saying? With more staff, we get better results.

–nurse-midwife

Although maternity staffing at HSTH has decreased, the pediatrics staff has expanded since the seven newborn care nurses were hired at the end of 2013 as part of HSTH’s neonatology program. At the deliveries attended by these nurses, they provide the immediate neonatal care and resuscitation. Over half of the skilled birth attendants interviewed spoke positively about the neonatology program, the most salient reason for which was that the newborn care nurses have helped reduce their workload. There were numerous references to how much “help” the nurses provided to the maternity staff. Examples of such statements are below:

I like [the newborn care nurses] because, when the baby’s oxygen saturation is going down, we don’t have time to do everything we need to do. Because for resuscitation, you have to set aside the care of the mother to care for the baby. We can ask another birth
attendant for help, but the fact that [the newborn care nurses] are there, it works well. – skilled birth attendant

[The newborn care program] is very important, especially for babies born via cesarean sections. These deliveries are likely to have complications that don’t go well—for example, fetal distress, or cephalopelvic disproportion. That’s why you always need to have someone who can do something for the baby. The staff we have in maternity is small. To send a midwife to the operating room, it’s not easy. But the newborn care nurses help us…in the delivery room, and in [surgical] cases. Because as soon as you’re done caring for the baby, you have to take care of the mother, too. For example, you can have a baby that needs resuscitating and a mother who is hemorrhaging. You have two problems in one shoe. –skilled birth attendant

With someone else responsible for neonatal resuscitation and immediate newborn care, the maternity staff are able to “focus on the mother.” Additionally, as the second quotation highlights, the maternity staff also appreciate that the newborn care nurses attend cesarean sections. Prior to the establishment of the neonatology program, a birth attendant had to leave the delivery room to receive a baby in the operating room, following which it would carry the newborn back to the delivery room to weigh it, take its vitals, and dress it, while at the same time attending to the patients in the delivery room. In these ways, providing additional personnel dedicated to newborn care has helped reduce the extent to which maternity staff are overstretched and enables more attention to be paid to newborn care. As a result, most of the providers stated that newborn care at HSTH is improving.

**Resource shortages**

As with personnel issues, nearly every individual interviewed (19 of 22) described shortages of resuscitation supplies and equipment. “It’s not our fault,” explained one birth attendant. “Sometimes we search for a bulb suction, and we can’t find one. We look for an Ambu-bag, and we can’t find one.” The supplies that providers most commonly reported missing were bulb suctions, Ambu-bags, face masks, towels, and warming pads.
Several providers described experiences in which they were unable to resuscitate a baby because certain key supplies were missing. In one case, a provider described needing to resuscitate a newborn she had delivered but not having an Ambu-bag. The newborn did not survive, a source of great sorrow and frustration for the provider:

After the experience losing that baby, I felt uneasy. A baby is supposed to live. Because of the lack of materials, everything that I would have liked to do, I couldn’t do all of that… I felt really bad because, when I needed to resuscitate the baby, I didn’t find the materials. It was that that made me feel so bad. –skilled birth attendant

Providers attributed supply shortages to a few different reasons. With respect to the towels needed to dry the baby after birth, providing these was considered the family’s responsibility. However, families were often unaware of what items were needed, or unable to obtain them. Providers simultaneously blamed parents for not bringing towels while also finding fault with the hospital for not having these available either.

[What I would like is] for us to feel confident that parents would give us towels, something to wipe the baby dry. Only I know that I need to have two small towels for each delivery in each room. I need this for each delivery I will do. Because there are times when parents come without even one sheet. Even to cover the little baby, they don’t know what to do. They don’t know that they need to give us a towel to dry the baby, then another after, and then to wrap the baby, you need a sheet. There are parents who don’t know that. At least there needs to be, for every delivery, two towels on the standing tray, without you needing to ask the parents… –skilled birth attendant

When families failed to bring towels with them to the hospital, providers were forced to find alternative ways to dry and warm babies. During daytime hours when the chief of the maternity or volunteers from Midwives For Haiti were present, birth attendants could sometimes access towels from a locked supply closet in the maternity. At night and on weekends, providers often used the mother’s clothing to wipe off the baby and then placed it skin-to-skin with its mother. On rare occasions, providers were observed wrapping babies in cotton batting, chucks, or surgical gowns. Such creativity and resourcefulness sometimes made a difference, but there
was a limit to what providers could achieve in a setting of such scarcity.

In regard to shortages of bulb suctions, Ambu-bags, and masks, the reason most commonly cited by providers was that these items were “dirty.” The quote below is representative of many comments:

For instance, there are materials, materials that are supposed to be available for the number of deliveries you’re going to receive. For instance, in the morning, there’s a woman there who sterilizes the materials. She cleans them. But for the afternoon shift? That person is not there. Everything that was used during the morning shift, they leave it there. Those who come at night, what are they supposed to use? You’ll be missing what you need. … If someone has ten deliveries overnight, and ten children need resuscitation, where are the materials for that? –skilled birth attendant

On slower shifts, providers reported being able to clean and prepare resuscitation equipment. When the delivery room was busy, it was another story, however. “[A] long time ago,” a birth attendant explains, “we had more staff on service. If you came in, you might have time to clean things. But now when they only schedule three of us… If they’re dirty…” The birth attendant trailed off, gesturing with her hands as if to say ‘There’s nothing I can do.’

In addition to not having time to sterilize supplies, providers complained that they were often too busy to set up what was available. One of the newborn care nurses describes this: “[I]f a baby is born and you didn’t have time to prepare the materials, and the baby doesn’t breathe, then you have to look for supplies, and you start the resuscitation too late.” Similarly, a birth attendant comments:

For example, during childbirth, you must prepare all the materials including resuscitation equipment, but sometimes a woman comes for childbirth, and you don’t even have time to evaluate her before the delivery. Once the baby is born, that's when you see that he is struggling to breathe, and you have not prepared the materials for such a situation.

In such cases, providers described having to “run all around looking for supplies,” precious seconds wasted.
Inadequate space and infrastructure

The amount and quality of the space available for neonatal resuscitation was another issue of concern to providers. The area dedicated to newborn care is a tile counter on the back wall of a two-bed cubicle in the delivery room. A window fills the wall space from the counter all the way to the ceiling, with glass panel slats that open and close. A second area in a different cubicle was occasionally used, and the set up was essentially the same. The windows were typically opened for women in labor, and they were supposed to be shut when delivery was imminent. This was not always the case, however, and newborns were frequently exposed to the breeze. “[T]he place where we place the babies for resuscitation is not a good place because everything is too cold,” said one provider as she shivered and emphasized the word *fivet* (cold). In the words of another provider: “Resuscitation would be better if we had a place in the delivery room that was more or less closed off. …That means a place that is warm, that isn’t windy. It would be much better to resuscitate a baby in a place that is warm.”

On a few occasions, providers complained about the amount of space in the delivery room for resuscitation, which felt particularly cramped when more than one person was performing the resuscitation. Notes from the researcher’s observations in the delivery room indicate that there were as many as 33 people in the delivery room at a time, which made transferring the baby from its mother to the counter for resuscitation difficult. The delivery room is only about 18 feet by 12 feet, divided into four cubicles with five beds. The delivery room’s space limitations also mean that there are frequently more women laboring than there are beds. During the delivery room observation period, four deliveries occurred on the floor, one of which took place outside of the delivery room area. At least two women gave birth unattended on the antepartum ward during this period, and two different providers in the interviews brought up
such instances, which are not uncommon. One such instance is described below:

I remember last month, during the night, I was in the pediatric ED when [the birth attendants] sent someone to call me. They called me for a delivery that had taken place in the antepartum room. It was during the night. The woman had given birth on the wards. It was only the woman’s family that was there because, in the delivery room, there were lots of patients in labor, so the birth attendant couldn’t leave the delivery room at all. …Then, the parents came to say the woman had delivered. Time had already passed since the baby was born, and the baby had been born in a state of death. When the parents of the woman saw the baby, they wrapped it in a sheet and threw it away. They said it wasn’t good anymore. It was in this moment that the birth attendant came in and saw the baby. She sent someone to the emergency room to call the newborn care nurse. And then when we came, the baby ended up living. –newborn care nurse

This anecdote highlights some of the problems that arise on days when patient numbers exceed the capacity of the labor ward. Specifically, when there are lots of patients in labor and the delivery room beds are full, as occurred in this case, maternity staff often send women to labor in the antepartum room until they feel “ready to push.” The antepartum room is around a corner about fifty feet away from the delivery room and is overseen by a different provider.

Although the details of what happened between the time this patient was sent away from the delivery room to the time when she gave birth are unknown, it seems evident that the lack of space in the delivery room, combined with the fact that the skilled birth attendants were occupied with other patients, led her to end up delivering on the antepartum ward. Although the newborn care nurses successfully resuscitated this particular newborn, this is not always the case for babies born unattended on the wards.

**Poorly organized communication systems**

Although staff clearly viewed attendance of deliveries by newborn care nurses as a positive development, ensuring that the nurses made it to the delivery room in time for births was a challenge. The nursing schedule was set up so that one or two newborn care nurses were
assigned to attend all deliveries during the day, and one newborn care nurse was responsible for deliveries at night. When not attending deliveries, newborn care nurses worked in the pediatric emergency room, helping out two or three other nurses during the day. Overnight, there was at most one other nurse supervising the pediatric emergency room, and sometimes the newborn care nurse was alone covering this service in addition to being on call for deliveries. During times when the nurses were in the pediatric emergency room, located about 30 meters away from the delivery room, the nurses’ expectation was that someone from the maternity staff would call them when a delivery was anticipated.

Maternity staff repeatedly complained about difficulties getting hold of the newborn care nurses in time for deliveries. The reasons they gave for these difficulties were being too busy to call the nurses, not having minutes on the maternity phone or a personal cell phone, not knowing who to call, and not having anyone available to walk over to pediatrics to get the nurse in person. Some exemplary responses are below:

They [the nurses] always say to call them when there is a problem. But if I don’t have minutes in my phone, how am I going to call them? … We often don’t know [their phone numbers]. Sometimes one of them comes in, she doesn’t even get to know anyone, and then she just says: “If there’s a problem, call me.” It’s not a problem for you to call someone, no? But the time it takes for me to take off my gloves to find the number and call it... A minute has passed in which I could have already saved the baby. But the distance between us and pediatrics is very large. You have to find the number to call someone. I’ve had times when I run out of minutes in the effort to save a baby. –skilled birth attendant

I don’t like when there is a delivery, and they aren’t available, and the baby doesn’t breathe, and we’re obliged to run to pediatrics to call them. They should be available during the day and at night. During the day, there is one there [in the delivery room]. But once the sun goes down, they stay down there in pediatrics. It’s you that has to call them. … And in the time that you’re calling pediatrics, the baby can die. But you have to do it to give the baby life. –skilled birth attendant

The inability to reach a newborn care nurse in time for a delivery was particularly frustrating for the skilled birth attendants at times when maternity coverage was thin, such as at
night, or when they were concerned about fetal distress. At these times, an extra set of hands was strongly desired, but confusing channels of communication and the perceived lack of time for seemingly minor tasks, such as looking up a phone number and calling it, often got in the way.

For their part, the newborn care nurses were similarly frustrated with not being informed of deliveries, particularly of infants requiring resuscitation. “By the time they call us, they have missed ‘The Golden Minute.’ That can cause it to be too late to resuscitate the child.”

**“You do it for love” and other sources of resilience**

Over half of interview participants described experiences in which a neonate they had tried to resuscitate ended up dying. Coping with the emotional weight of these losses emerged as subtle but no less profound challenge facing providers. In the excerpts below, two providers reflect on the losses they have experienced:

I had a beautiful baby! It was such a beautiful baby, and up until now, I am still sad about this baby. The baby spent too much time in the birth canal, and then it also had oligohydramnios. The baby didn’t have enough amniotic fluid in its mother’s belly. When I called the doctor, there wasn’t one available to do a cesarean for her. The doctor took time, and then more time, and then more time. The baby didn’t die in labor, but the heartbeat was extremely weak. Even when the baby was finally born, despite us doing everything for it, it passed away. And what made me feel so bad was that the baby died. Because if there had been a doctor available, even though there wasn’t enough amniotic fluid in the mother’s uterus for the baby, the baby would not have died. …Oh, it really hurt me… But despite the fact that it really hurt me, and even though I couldn’t hear a heart beat, I decided to try [to resuscitate the baby] anyway. –newborn care nurse

“Sadly, the baby didn’t make it; I was devastated… I felt really sad. I would have been happy if the mother was able to keep both babies, even though we hadn’t known there was a second baby. The mother was happy to have both. It would be nice to be able to see the baby again and be able to say: “Here’s the baby who caused us so much trouble!” Unfortunately, it did not survive. –skilled birth attendant

More salient in the interviews than descriptions of resuscitation failures, however, were descriptions of successes. Nearly all providers interviewed recounted an experience in which
they had been able to resuscitate a newborn, and these successes were a source of considerable pride.

When you do something for a child, and then you see that it lives, you are happy. Because you see the work that you have done is not for nothing. If you see a baby that dies, you can think you are not good. You work hard in the program, and when you stop, you wipe off the sweat because you’re exhausted. But when you finish working and you succeed with the baby, you feel good. Because you’re learning to save lives, the mother’s life and the baby’s. –skilled birth attendant

In another instance, a skilled birth attendant described how she came to be the godmother of a baby she resuscitated. The labor had been complicated with worrisome decelerations in the fetal heart rate, and when the baby was born, it was apneic. This led the baby’s grandmother to believe it was a stillbirth, and when the birth attendant started to try to resuscitate it, the grandmother told her not to bother: “Nurse, the baby died. You don’t have to do anything for it.” The birth attendant persisted nonetheless, ultimately saving the baby’s life. Around one year later, the family brought their daughter, now walking and talking, back to the hospital to see the birth attendant. In her interview, the birth attendant reflected on what this experience meant to her:

I feel that it was a good experience because I saved the life of the little baby. Despite the fact that the grandmother said to me, “The baby died. You don’t need to do anything,” I took it into my head… the thought that the baby could live. –skilled birth attendant

Perhaps as a result of such victories, providers were ardent proponents of neonatal resuscitation and saw themselves as essential to the intervention’s success. “You have to fight to try to save the life of the mom and to save the life of the baby,” admonished one. “That’s what is important. The pediatrician isn’t there. You’re the one who is there. You have to do your part…”

Even when they succeeded, providers did not always feel that their efforts were appreciated, however. According to one skilled birth attendant, the perception that the maternity staff “weren’t capable” was the reason the hospital “chose other people” (that is, the newborn
care nurses) to be in charge of neonatal resuscitation. Such sentiments were rarely expressed explicitly in the interviews, more often emerging from informal conversations and observations of life on the wards. For instance, mid-way through the interviews, the skilled birth attendants were called into a meeting by Midwives For Haiti and reportedly chastised for complaints from foreign volunteers about the quality of care being provided by the birth attendants in the delivery room. In the days following this meeting, the mood of the interview participants was noticeably less upbeat. “She’s sad because of the meeting,” my interpreter noted before we turned on the voice recorder for one of these interviews. A month later, when the preliminary data from this investigation was presented to the HSTH staff, the chief of the maternity commented that she was grateful for the praise, noting: “Usually, we only receive criticism.”

Despite the many challenges providers described in the interviews, most of them loved their job. Helping mothers deliver safely, and helping their newborns effectively transition from intra- to extra-uterine life was often described as “the best thing about my job.” The case of an auxiliary nurse who worked at HSTH for four years as a volunteer without pay, is a particularly poignant example:

I continued to come because I love working with newborns and mothers. I love doing deliveries. I liked the maternity a lot. That’s what made me come in. If I didn’t love it, I wouldn’t have come in, no? Even when they didn’t pay me, I didn’t get discouraged. I came in. … I also come in so that I can become a midwife. The first time, I went [to apply for the Midwives For Haiti training program], but they didn’t take me. I became pregnant. After that, I was going to go again. I got pregnant again. Now I can’t go, and I always continue to come in. Every day, I come in. They make a schedule for me the same as for the employees. They put me on for mornings, afternoons, night. And I come in every day. I always come in before the other midwives. … I never get discouraged. Now, they employ me. I’m not appointed by the State, no? But they employ me. Every month, they give me something. Yes, because I like it a lot. I like to work with newborns, mothers. –auxiliary nurse / cleaner

These sentiments were similarly captured, albeit more briefly, by one of the newborn care nurses: “It’s a nice job because you get to save lives,” she stated. “It’s not really for money. You
do it for love. You really feel what you’re doing.”

Discussion

Defining the scope of the problem and the need for neonatal resuscitation at birth

Of the newborns whose births were observed in our study, one third were born with poor or absent respiratory effort requiring intervention, and 10% required ventilation.\textsuperscript{14} These percentages are considerably higher than the estimates reported by the AAP and others frequently cited in the literature (see Figure 8). Differences between the resuscitation rates observed in this study and published estimates may relate to the characteristics of the settings and populations studied. The estimates cited by the AAP are based on a small number of studies of variable quality conducted in middle- and high-income countries. They include a prospective study of 4,751 deliveries at a hospital in China (Zhu et al., 1997), a retrospective analysis of 97,648 births recorded in Sweden’s Maternal Birth Registry (Palme-Kilander, 1992), a pre- and post-intervention study of NRP implementation in teaching hospitals in India (Deorari et al., 2001), and two studies of advanced resuscitation techniques conducted in the United States (Perlman & Risser, 1995; Barber & Wyckoff, 2006).

Higher rates of resuscitation have been reported in two recent studies. In a 2012 study of 5,845 deliveries conducted at a hospital in Tanzania, 16% of newborns required stimulation, suction, and/or bag-mask ventilation (Ersdal et al., 2012). A study of 5,155 births in Canada also reported a basic resuscitation rate of 16% (Singhal et al., 2001). In rural Haiti, where access to timely antenatal and obstetrical care is limited, the risk of intrapartum-related hypoxia is likely elevated. Only roughly one quarter of women in the Central Plateau deliver at a health facility.

\textsuperscript{14} This includes the six newborns who died and the nine newborns who began breathing following bag-mask ventilation, out of the 155 newborns included in the study.
and those who do are probably more likely to have sought care or been referred to HSTH from a primary health center if they had a complication. Our collected qualitative data further reinforces concern regarding pre-delivery obstetrical care. Long delays before cesarean sections and a lack of fetal monitoring during labor were frequently noted by interviewees. It might, therefore, be expected that the proportion of babies born at risk for asphyxia would be higher. Given that the majority of newborns in our study received basic resuscitation within ‘The Golden Minute,’ it is possible that those newborns who required ventilation were already in secondary apnea at the time of birth. If true, then an extended period of intrapartum hypoxia may be the source of neonatal distress.

Figure 8. Global estimates of numbers of babies undergoing neonatal resuscitation, as compared with the findings of this study. Resuscitation rates from this study are provided in the green boxes. Adapted from Wall et al., 2009.

Another possible explanation involves how newborns were classified at birth. In our study, any newborn that failed to cry or breathe well following delivery was considered non-breathing. It is possible that some proportion of these babies would have initiated respirations on
their own within the first minute after birth. However, basic resuscitation was initiated after an average of 16 seconds, making it difficult to distinguish this group from those newborns who truly needed stimulation. Given the paucity of data on this subject, more research is needed, particularly in low-resource settings where the burden of intrapartum-related hypoxia is likely highest.

**Analysis of neonatal mortality in this investigation**

The neonatal mortality rate among the 155 newborns whose deliveries were observed during the study period was 3.9%. Assuming that all the deaths included in this calculation were neonatal deaths rather than fresh stillbirths, this percentage is higher than Haiti’s all-cause neonatal mortality rate (3.1%). This may be explained by the fact that the deliveries occurring at HSTH are higher risk than those occurring at home and primary health facilities, and certainly the burden of complications such as pre-eclampsia and premature rupture of membranes were elevated in the study population as compared to U.S. data.\(^{15}\)

It is also possible that Haiti’s neonatal mortality rates are underestimated by DHS data, which relies on household surveys. For neonatal deaths to be counted in the surveys, they have to be recognized as such by families at the time (in other words, not misidentified as stillbirths), and they must be acknowledged and reported in surveys as many as five years after the fact (the period of time covered by each DHS).\(^{16}\) With two-thirds of births in Haiti occurring at home (and

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\(^{15}\) Studies of women receiving maternity care at Albert Schweitzer Hospital in the Artibonite department reported prevalence rates of pre-eclampsia among pregnant women to be 16-18% (Raghuraman et al., 2014; Small et al., 2005). These rates are similar to those recorded in this study, but well above prevalence rates in the United States.

\(^{16}\) The potential for misclassification of live births as stillbirths by families is illustrated particularly poignantly in the interview data presented on page 45. In this scenario, a family believed a newborn to be dead and therefore encouraged the skilled birth attendant not to resuscitate it. She resuscitated the baby anyway, and it survived.
three quarters of births in the Central Plateau), documentation of neonatal deaths relies heavily on families, and these factors may contribute to unreported deaths.

**Neonatal resuscitation: major challenges**

Our study revealed three aspects of neonatal resuscitation that were particularly problematic in this setting: 1) the speed with which interventions were initiated, 2) bag-mask ventilation technique, and 3) having supplies available and prepared. Interviews contextualized these challenges and also highlighted the systemic barriers that underlie them: personnel shortages, resource shortages, inadequate space, and poorly organized communication systems. These barriers can be succinctly summarized as “staff, stuff, space, and systems,” a phrase physician-anthropologist Paul Farmer has frequently used to describe the essentials of a well-functioning health care system. In Haiti, social forces have conspired for centuries to undermine the development of such a system, however. As a result, public sector hospitals like HSTH face dire shortages of the human and physical resources needed to provide quality health care to patients. These shortages seriously limit the ability of providers to perform effective neonatal resuscitation, as is illustrated in the discussion below.

**Challenge 1: Timing of resuscitation**

Prompt initiation of resuscitation, and bag-mask ventilation when needed, was a challenge underscored by both the quantitative and qualitative data. For cesarean section births in particular, resuscitation was started after a 30-second delay on average. This was primarily due to the fact that, after waiting for the umbilical cord to be cut and the baby to be handed to her in

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17 References to “staff, stuff, space, and systems” can be found in numerous articles and interviews with Paul Farmer, particularly since the start of the Ebola crisis in West Africa in 2014. For a particularly detailed discussion, see Farmer’s article “Who lives and dies?” in the *London Review of Books* (2015).
the operating room, the newborn care nurse would carry the baby to a separate room in the surgical suite where the resuscitation supplies were set up; this distance took 10-15 seconds to traverse. There was no space in the operating rooms where neonatal resuscitation could be performed.

For vaginal births, drying and stimulation were usually initiated quickly, but there were considerable delays (over three minutes, on average) in the initiation of bag-mask ventilation. Based on interviews, these delays seemed to relate mostly to competing demands placed on providers, particularly for birth attendants who described struggling to balance the needs of newborns with those of their mothers and other laboring women. Without colleagues available to help them, birth attendants described a tendency to prioritize the mother in such moments. This is understandable given the birth attendants’ training, which is focused on women’s health and obstetrical care. Many providers may also view newborns as lacking the same degree of ‘personhood’ as the mother (Miljeteig, Sayeed, Jesani, Johansson, & Norheim, 2009). Brand new in the world, a newborn’s needs may not seem to matter as much as the mother’s, and such a mindset may subtly contribute to a birth attendant’s decision to attend to delay newborn care in order to respond to the needs of its mother. Although birth attendants may fully intend to return to the newborn after quickly attending to the mother, even short delays in resuscitation can have a significant impact on whether a neonate lives or dies.

Given the challenges of providing care for mother and baby simultaneously, it is particularly important to have a provider dedicated to newborn care present at all deliveries. Although newborn care nurses are not yet present at all deliveries at HSTH, due in part to a poorly organized system of communication, the impact of their presence at the deliveries they are able to attend speaks volumes about the potential that interventions to fill personnel shortages...
can have. When newborn care nurses were present at deliveries, they provided birth attendants (and newborns) with a second set of hands. By setting up supplies and taking charge of the newborn care and resuscitation once the baby was born, newborn care nurses freed the birth attendants to focus on the mother and may have facilitated quicker interventions for newborns. In these ways, the presence of the newborn care nurses may have facilitated quicker interventions.

*Challenge 2: Resuscitation technique*

According to both the quantitative and qualitative data, bag-mask ventilation was the aspect of neonatal resuscitation with which providers had the most difficulty. In the six newborn deaths observed, the provider was unable to establish good chest rise during ventilation. As previously mentioned, four of these deaths were officially designated as stillbirths by providers. However, even in stillborn babies, positive inflating pressure should lead to manual chest rise. The absence of any observed chest movement with ventilation in these cases makes it more plausible that some if not all of these deaths were actually neonatal and could have been prevented with better ventilation technique.

Even though most providers met the technique criteria as graded by the observers, including making recommended adjustments to head and mask positioning and adjusting the pressure used to squeeze the Ambu-bag, the fact that ventilation did not lead to movement of the thorax suggests that ventilation was ineffective and no air was reaching these newborns’ lungs. Undoubtedly, more practice with bag-mask ventilation is essential for providers to build and maintain effective skills, and most of the providers interviewed made clear a desire for additional training through refresher and/or continuing medical education sessions. The need for further
practice with the bag-mask is especially important given how rarely some providers encounter cases requiring ventilation. In fact, birth attendants at HSTH are likely to be resuscitating fewer babies going forward as newborn care nurses take over responsibility for a greater share of the newborn care.

Aside from bag-mask ventilation, the most important technique indicators on which providers scored poorly in the quantitative analysis were related to wrapping the baby in a dry towel after discarding the initial one used to dry the baby when it was born. Comparison of these data with that on supply availability revealed that there was no second towel available for providers to use in nine of the 23 cases where this was observed. In those cases, the baby was often left wrapped in the initial towel. This information suggests that low scores in these areas were often more about supplies than training.

**Challenge 3: Equipment availability and preparation**

Supplies necessary for neonatal resuscitation and immediate newborn care were frequently lacking at the time of delivery. The absence of warming blankets, heating lamps, baby hats, and towels were identified in the quantitative and qualitative data. For the first several weeks of the delivery room observations, there was no warming equipment present in the delivery room, except for rare occasions on which a newborn care nurse brought over a warming pad from the pediatric emergency room. A lamp was later placed in the delivery room for use as both a warmer and to provide light for pelvic exams; however, it was infrequently used. With respect to towels and baby hats, they were usually donated by Midwives For Haiti and available on the labor ward for families in need. However, due to concerns about theft, these and other donated supplies were kept in a locked closet to which only the chief of the maternity and the
Midwives For Haiti volunteers had keys; these individuals were rarely present overnight or on weekends.

Although the delivery room had two clocks, both were broken for the duration of the study. This seemingly trivial concern is nevertheless important since clocks help providers calculate heart and respiratory rates, as well as remind of the duration of a resuscitation. Providers also need a clock to denote the time of birth. Strikingly, the chief of the maternity reported placing a request for their replacement at some point prior to the start of the study and was still waiting on this at the time of its completion. Amid resource, staff, and systems gaps, replacing even basic supplies can be a considerable challenge.

Even when equipment was available, it was inconsistently prepared in advance of a delivery. In particular, items needed for bag-mask ventilation were only set up about half of the time during the study period. Based on interviews, providers noted that they were often too busy with other patients and tasks to clean and/or set up these materials prior to deliveries. In this way, the delivery room’s resource challenges are fundamentally connected to the hospital’s staffing shortages. It is also possible that some providers might be less attentive to preparing supplies when their concern for fetal distress is low. Lack of robust fetal monitoring prior to delivery may contribute such perceptions.18

Collectively, the barriers to neonatal resuscitation observed in this study serve to underscore how challenging the delivery of quality newborn care is within a system that lacks staff, stuff, space, and systems. The interviews in this investigation, and the observations of actual care being provided to women and newborns in the delivery room, show us what the daily,

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18 It is worth noting that even when birth attendants at HSTH are able to perform fetal monitoring according to hospital protocol, detection of fetal distress is still limited by the lack of technology available in this setting. As Groen and Kushner (2015) point out, use of a fetoscope (as opposed to the electronic fetal heart monitoring available in high-income countries) makes detection of fetal distress difficult.
lived experience of such a system is like, for the providers who “only have two hands,” as well as the for patients who often have nowhere else to go. It is hoped that through bringing these lived experiences to light, this investigation will encourage global health practitioners interested in reducing neonatal morbidity and mortality to invest in the Haitian health care system and the ambitious task of addressing the structural barriers to health.

**Successes and strengths**

While improving outcomes necessitates an understanding of the current gaps in care, it is also important to emphasize a setting’s strengths and successes. Based on our delivery room observations, knowledge of resuscitation steps, the identification of non-breathing newborns, and initiation of the proper resuscitation interventions were areas in which most providers did well. The providers themselves seemed aware of their strengths, and self-reported levels of competence correlated well with observed provider performance.\(^19\) What is particularly evident from the interviews is the resilience and sense of purpose of the providers. Despite daily confrontation with major systemic challenges, most strived to do their best and provide their patients with the care they needed: “we do our best with what we have,” was a common refrain of the chief of the maternity. As a result of their efforts, many newborn deaths and other poor outcomes were averted.

It is likely that the unique support HSTH receives from its NGO and academic partners contributes to the strengths that exist within the system. Prior to the hospital’s collaboration with Ohio State University (OSU), there was no neonatology program and no newborn care nurses at HSTH. At that time, neonatal resuscitation was performed by the skilled birth attendants, or the

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\(^{19}\) This is in contrast to the findings of Ersdal and colleagues (2013). In their study in Tanzania, high self-confidence (also rated on a scale of 1-5) was inversely correlated with observed performance.
baby had to be transferred to the busy pediatric emergency room. With OSU’s support, HSTH was able to hire seven new nurses. The impact of this increase in nursing staff has not only been to improve newborn care at HSTH, but also to reduce the workload of overburdened providers on the labor ward and in the pediatric emergency room. Moreover, the provision of extensive, ongoing clinical mentorship is an integral component of the OSU-led program that has enabled the newborn care nurses to develop strong resuscitation skills.

It is also worth noting that as a result of Midwives For Haiti’s accelerated midwifery course and monthly continuing medical education sessions, HSTH’s skilled birth attendants have received more obstetrical training than even many registered nurses have received in Haiti, and it is certainly far superior to the training obtained in auxiliary school alone. Moreover, both maternity and pediatrics departments benefit from Zanmi Lasante’s broad-based support of HSTH through salaries, training, supplies, and infrastructure. Given that such support is not present at many other public hospitals in Haiti, it is likely that the outcomes observed in this study are actually better than those in many other public hospitals around the country.

**Excluded data**

Twenty-three deliveries were observed as part of this investigation but excluded post-hoc from the data analysis. The reason for this was that, in these cases, an intervention was performed by a clinician who was not a designated participant in the study. Specifically, a foreign volunteer working with Midwives For Haiti intervened in seven cases, and one of the two researchers intervened in 16 cases. Within this subset of deliveries, 35% of newborns were non-breathing at birth, similar to what was observed in the 155 deliveries included in the quantitative analysis.
The outcomes of the excluded data are quite different with respect to rates of bag-mask ventilation, however. Of the 23 newborns in this group, 63% required ventilation, all of whom survived. In contrast, only 18% of newborns included in the quantitative analysis required ventilation, and 12% of these did not survive. The higher proportion of cases requiring ventilation in the excluded group likely reflects the fact that the researchers only intervened clinically when help was requested by a birth attendant (which may have reflected a greater degree of concern for the baby) or when the researcher believed that a newborn would not receive effective and timely resuscitation if she did not intervene herself (in which case, the baby was likely to be doing quite poorly). In both types of scenarios, the need for outside intervention was directly related to the lack of available trained personnel. This is because, in these moments, if the HSTH providers could have obtained the support they needed from colleagues, there would have been no need for a researcher to intervene. The better survival rate of the excluded deliveries may be related to the presence of a second pair of skilled hands (those of the researcher), potentially reinforcing the argument that increasing the availability of trained personnel will lead to reductions in neonatal mortality.

**Study limitations**

There were several limitations of the study. This was a short, observational investigation with the attendant problems of incomplete data collection and possible observer misperception and bias. The study addresses barriers to neonatal resuscitation as perceived by the health care providers responsible for providing the newborn care; there may therefore be other barriers at play that did not emerge from this investigation. Simultaneously a strength and limitation of the study was the student researcher’s own relationship to the participants and the subject matter.
During the two months spent as a participant-observer and the month and a half spent in the delivery room, the student researcher developed relationships with the providers in the study and formed her own impressions about neonatal care at the hospital. While her experience provides context to the research data and allowed her to better understand the issues she was studying, it is important to recognize that these experiences shaped how she saw the data before her, potentially drawing her attention to some issues and blinding her to others.

Further, the presence of the researchers at deliveries may have influenced the behaviors of providers, leading them to perform better than they otherwise would. Such a Hawthorne effect would cause the resuscitation outcomes to appear better than they are in reality. It is possible that any such effect diminished over the course of the study as the researchers’ presence became more normal for participants. Responses to interview questions may likewise have been shaped by the identity of the student researcher asking the questions. In particular, given the researcher’s affiliation with the ZL pediatrics team, it is possible that respondents may not have felt comfortable sharing concerns about the neonatology program or about the importance of neonatal resuscitation. The power dynamic between researcher and study participants may have also shaped responses. Given that participants were hopeful that the research data would lead to more resources and other improvements for the hospital, this could have incentivized them to exaggerate needs.

Data from the hospital birth registry are limited by the accuracy with which they were recorded by the maternity staff. As an example, providers were often observed to struggle with APGAR scoring. Newborn care nurses sometimes had a chart to help them calculate the score, but maternity staff did not. Only a few assigned scores in a systematic fashion; many assigned scores after several minutes, and in some cases, several hours after a birth. The gestational ages
reported in the maternity registry were often general estimates given that many women had not had prenatal care and/or did not know the date of their last menstrual period.

In four of the observed deliveries, providers assigned one- and five-minute APGAR scores of zero, officially categorizing these deaths as stillbirths. However, it is difficult to ascertain whether these deaths were stillbirths, as opposed to early neonatal deaths. There is considerable evidence to support the frequent misclassification of early neonatal deaths as stillbirths (Lawn et al., 2009; Spector & Daga, 2008; Msemo et al., 2013; Waldemar et al., 2010). A weak pulse or faint respirations may be difficult for providers to identify, and none of these babies appeared to receive adequate ventilation as demonstrated by chest rise. It is possible that had resuscitation been performed more effectively, the number of recorded stillbirths would be lower.

Exclusion of certain deliveries from the data analysis is another potential source of bias in the study. Of the 213 women who initially consented to participate in the study, there were 38 who did not have their deliveries observed, either because they were discharged prior to delivery, or because a researcher was not present at the time of delivery. Although researchers missed deliveries for a variety of reasons on all days of the week and times of day, this may have occurred more often overnight when maternity staff were less likely to call a researcher if she was not physically present in the delivery room. Since staffing levels were lower overnight, the missed deliveries may have had worse outcomes on average than those included in the analysis. An additional 23 deliveries were observed but excluded from the data analysis because either one of the researchers or a foreign volunteer participated in the resuscitation. Intervention by either of the researchers occurred in situations in which assistance was requested by an HSTH staff member, or in which needed care was not being provided and the researcher felt that it would
have been unethical not to intervene. These cases may therefore have been more likely to result in a poor outcome had they been included. With respect to cases in which foreign volunteers intervened, the direction of the bias is less clear.

Helping Babies Breathe (HBB): A critique

In the five years since its launch, HBB has been used widely throughout low-income countries and has received considerable praise. “A simple technology is saving newborns from a lack of oxygen,” reads the headline of an article about HBB in Malawi published on USAID’s website (Malumbira, 2015). Similarly, a webpage for an NGO recruiting HBB trainers describes the program as “[s]aving newborns one minute at a time” (Project C.U.R.E. website, 2015).

Some of this praise is certainly deserved. HBB has helped draw community, national, and international attention to the problem of neonatal mortality in resource-poor settings. Thousands of health care workers have been trained in resuscitation. A growing number of newborns are being delivered in settings where there is a health care provider whose job it is to prioritize that newborn’s survival, in a sense offering a sort of accompaniment to babies as they enter the world.

Such uniformly positive rhetoric inevitably elides important flaws, however. First of all, despite the undoubtedly good intentions of those involved in the development of HBB, the program is built on the premise that an inferior level of care is acceptable for newborns and families in resource-poor settings. While NRP training and application is expected of all physicians and nurses responsible for newborn care in the United States, the simplified HBB training is supposed to suffice for many of our counterparts in Haiti and other low-income settings. Although there are subtle differences in the approach to even basic resuscitation
between HBB and NRP, the most significant point of distinction is that NRP provides instruction in advanced resuscitation. The AAP estimates that these interventions are needed in less than one percent of cases, which means that a mortality rate of around 1% is not only expected but accepted. Such an assumption becomes all the more problematic in settings where the need for advanced resuscitation is even higher than 1%. It bears reiterating that, in this investigation, between 4% and 10% of newborns needed such interventions.\(^{20}\)

Second, HBB’s focus on a stand-alone classroom training as a means of creating behavior change is of questionable efficacy in the absence of strong linkages to systems of ongoing support and mentorship. Concerns about this training methodology and its ability to lead to knowledge consolidation and skill retention have been brought up previously (Ersdal et al., 2013; Singhal et al., 2012). In order to facilitate mastery of resuscitation and newborn care skills, the OSU-supported neonatology program at HSTH has prioritized integrating didactic training (in this case, NRP rather than HBB) into a program of ongoing nurse mentorship in the clinical setting. Although an assessment of the impact of this program is beyond the scope of this investigation, our initial observations are at least suggestive that this approach is having a positive effect on clinical practice. More formal evidence of the effectiveness of clinical mentorship programs is also emerging from the Mentorship and Enhanced Supervision at Health Centers (MESH) model, designed by PIH Rwanda in response to observed gaps in nurse support and supervision and in service delivery (Magge et al., 2014; Anatole et al., 2014). Such programs require a greater investment in time and more persistent support than what is required in a stand-

\(^{20}\) Given that it is unknown what proportion of the 15 babies who received bag-mask ventilation also needed chest compressions, a liberal estimate based on the study data reaches as high as 10% of the babies delivered in this study. A conservative estimate would include only the six neonatal deaths recorded in this investigation, amounting to 4% of newborns.
alone training model. Nevertheless, it seems clear that brief didactic trainings are inadequate on their own and, as such, represent a diversion of resources that could be better used elsewhere.

Lastly, the effectiveness of HBB is similarly limited by its failure to substantively address potential shortages of a setting’s health care system and other contextual factors. The exclusion of these issues is a common pitfall of narrow vertical approaches to health care delivery problems. As anthropologists Joao Biehl and Adriana Petryna emphasize, such approaches “perpetuate a limited understanding of narrowly conceptualized problems,” and in this way, they overlook structural forces and local complexities that shape the problems they seek to address (Biehl & Petryna, 2013, p. 8).

Although there is some recognition of the importance of health systems strengthening efforts in the HBB training materials, issues considered relevant are limited to “training and skills retention of birth attendants, supply of resuscitation devices, quality improvement systems, recording of information and reporting systems, supportive supervision, functioning referral system, and monitoring/evaluation” (AAP, 2011, p. 32). Such a list belies a fairly narrow conceptualization of the depth and breadth of the health systems weaknesses in countries, such as Haiti, where HBB is being implemented. Personnel shortages, which were arguably the most critical barrier to performance of neonatal resuscitation that emerged from this investigation, receive no mention here. Similarly, the only supplies of concern are resuscitation devices; items needed for basic resuscitation, not to mention supplies needed for immediate newborn care more broadly, are absent.

The way in which systemic issues are framed as merely barriers to scale or “rollout” is also problematic. It seems to miss the fact that systemic challenges are deeply embedded realities of most resource-poor settings, and as such, they fundamentally constrain the effectiveness of
this intervention even on a small scale. Reiterating the words of a health care provider quoted previously: “[I]t’s not only about training more people…[T]he students receive good training, but if I don’t have equipment to practice with, it’s like the training isn’t useful.” For training to have a lasting impact, it must be integrated into larger efforts to strengthen health systems.

By failing to take the structural barriers to quality health care fully into account, HBB ultimately seems to eschew responsibility for what matters most in the realm of neonatal mortality. Although the task of linking an educational program like HBB to broader systemic interventions is far more complex and ambitious than that of providing training alone, it is absolutely essential to improving newborn outcomes, as this investigation underscores. Moving forward, it will be up to global health policy-makers and implementers to understand and apply HBB as one tool that is only effective when applied within a broader systemic intervention.

**Conclusion**

Through direct observation of neonatal care at birth and through interviews with frontline health care providers, this study sought to identify current neonatal resuscitation practices in the delivery room, to characterize provider experiences with resuscitation, and to identify barriers to the performance of timely and effective resuscitations by providers. Its findings indicate that health care providers are correctly identifying newborns in need of resuscitation and performing the steps in the neonatal resuscitation algorithm appropriately. However, there are delays before key resuscitation steps are performed, bag-mask ventilation is often ineffective, and resuscitation materials are frequently unavailable prior to deliveries. Interviews with frontline providers offered a textured and nuanced understanding of these gaps, painting a picture of deep systemic failures, including critical shortages of personnel and resources, inadequate space, and poorly
organized systems of communication between care providers. These holes in the health care system directly contribute to the gaps in care observed at deliveries and pose a considerable barrier to neonatal resuscitation in this setting.

In order to improve providers’ capacity to provide effective neonatal resuscitation and save newborn lives, investing in the health system is therefore essential. Training, particularly that which is embedded in a system of continuing medical education and mentorship, is also important, but given the extent to which systemic barriers prevent providers from putting into practice the skills they already have, further training alone will be insufficient to overcome the barriers highlighted in this study.

In the current landscape, newborn delivery represents a missed opportunity to impact the burden of global child mortality and will continue to be so until global health policy-makers and implementers recognize that the current narrowly constructed, vertical approaches to this problem are inadequate at best. If we can get them to direct resources towards more comprehensive interventions that target both the proximate and distal causes of neonatal mortality, we can achieve greater success in neonatal resuscitation implementation and outcomes.
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