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Review of Neonatal Resuscitation Service Measurements

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Table of Contents

List of Figures

Summary

Introduction

A global response to avert neonatal death secondary to birth asphyxia has led to the development of the Helping Babies Breathe (HBB) initiative. HBB has been introduced in 60 countries; 18 have a national HBB plan that is coordinated by the national Ministry of Health. Impacts of newborn resuscitation services are measured by the number of newborns who were not breathing at birth that were saved. Hence, World Health Organization (WHO) *Every Newborn: An Action Plan to End Preventable Deaths* (ENAP) global targets were set to increase the "proportion of babies who do not breathe spontaneously at birth, after thorough drying and stimulation, that will be resuscitated with bag and mask ventilation" and also to decrease the global neonatal mortality rate (NMR). Similarly, the American Academy of Pediatrics (AAP) recommends that birth outcome measurements capture "proportion of babies that were resuscitated successfully." To these ends, assessment of newborn resuscitation services requires exhaustive analysis along the continuum of care: quality of a newborn resuscitation service is a function of the service inputs, the conduct of the practical process, and the resulting outcome.

Objective

This review of existing measurement methods for newborn resuscitation services was conducted with the aim of understanding the situation as-is, identifying gaps in delivering high-quality newborn resuscitation services, and supporting measurements that are adaptable in different national contexts.

Methods and Materials

The review included HBB rollout and implementation research in Malawi and Bangladesh as benchmarks for the scale-up of HBB globally because both countries have implemented HBB widely, have high birth rates and numbers of newborn deaths, and are low-resource countries that achieved Millennium Development Goal 4. In addition to Malawi and Bangladesh's experience, the following documents were reviewed:

- ENAP
- AAP *Guide for Implementation of Helping Babies Breathe (HBB)*
- WHO *Guidelines on Basic Newborn Resuscitation*
- Maternal and Child Survival Program's (MCSP's) Quality of Care Survey
- WHO's service availability and readiness assessment (SARA)[1]
- Demographic and Health Surveys (DHS) Program's Service Provision Assessment (SPA)*

Results and Discussion

The majority of the global indicators reviewed that were related to newborn resuscitation, such as **ENAP**, **AAP, and WHO guidelines**, were geared toward measuring coverage of inputs and national-level outcomes. The inputs included trained service providers, complete sets of equipment, and the health information system (HIS), while birth asphyxia outcomes were measured using proxy indicators such as NMR, stillbirth rate (fresh), and asphyxia-related referrals. While inputs are necessary for newborn resuscitation service provision, alone, they cannot ensure appropriate practice and timely service provision. Likewise, crude outcome reports such as NMR and stillbirth rate cannot identify deaths due specifically to birth asphyxia. This has been emphasized in WHO's *Guidelines on Basic Newborn Resuscitation*, which recommends mortality indicators should estimate asphyxia-specific neonatal mortality.

[1] Reviewed for countries that had available reports from the past five years.

WHO's **SARA** as well as DHS's **SPA** have specific checklists for assessing newborn resuscitation practices, in addition to questions about service and equipment availability. However, the document review revealed that observations of providers' newborn resuscitation practices were either not conducted or not reported. Alternatively, country-specific studies used different approaches to assess newborn resuscitation practices of health service providers. MCSP, as part of its Quality of Care Survey, used the list of correct answers given by providers to assess their knowledge about the equipment needed to conduct newborn resuscitation. Direct observation of service providers while they conduct resuscitation on live babies is the most appropriate method of assessment. This has been shown in HBB performance evaluations in Malawi and Bangladesh. Due to feasibility challenges, however, other assessment methods have also been used, such as installing recording cameras in delivery rooms (e.g., in Nepal) and evaluating health care providers' performance on simulators (such as the NeoNatalie newborn simulator in Malawi). The latter presents a feasible alternative for skill assessment particularly in facilities with a low number of deliveries. Service providers' performance is reported in multiple ways: as the length of time needed for newborn resuscitation (Bangladesh HBB evaluation), number of procedures performed (Malawi Queen Elizabeth Central Hospital study), or the steps followed (Malawi HBB evaluation). This discrepancy call for standardization. Moreover, gaps remain in assessing providers' actual practices and enforcing consistent performance.

HBB evaluations in Bangladesh and Malawi revealed the range of factors that need to be assessed to ensure high-quality delivery of newborn resuscitation services. HBB-specific comparisons can be made across space and time. Assessments have been made on coverage (by geographic location/district or between facilities); changes in skill sets (before and after intervention/training and equipment supply); trends in outcome of newborn resuscitation (babies resuscitated and saved) in a given period of time; and differences between community- and facility-based newborn resuscitation.

Assessment of HBB-related indicators in national **HISs** revealed that commonly used national measurements might not clearly provide information on birth asphyxia. Therefore, national-level indicators are needed that specifically measure newborn resuscitation services. Inclusion of HBB in the national HIS, rather than the introduction of a standalone information system for newborn resuscitation services, was possible in Malawi using District Health Information System 2 (DHIS 2). In Bangladesh, where vertical HBB information collection from each facility and community is not possible, the incorporation in the national HIS of indicators of newborn resuscitation services as an integrated part of essential newborn care was more feasible. In addition, surveillance of selected representative samples has been used in Bangladesh in place of detailed newborn resuscitation measurements where resuscitation-specific indicators were not part of the national HIS. This alternative method can be adopted if surveillance sites are prudently selected to reflect nationally representative information.

Conclusion and Recommendations

1. Most global documents with HBB-related measurements focus on coverage, particularly presence of resuscitation equipment such as bag and mask. Emphasis should be given to service providers' performance, which has been captured in ad-hoc studies and specific program evaluations.
2. HBB can be included in the health management information system of some countries; in others, monitoring through selected surveillance sites can be an alternative.
3. A performance evaluation in Malawi used composite indicators for comparison and identified gaps by geographic location. Future studies might benefit further from comparisons by geographic area that take into account differences in catchment population as well as facility coverage and outcome comparisons by the level/type of facility.

4. The importance of using composite measurements to compare overall progress was also shown in the Malawi performance evaluation. Such composite measurements can be made more informative if each indicator is scaled (weighted) for comparison between baseline and follow-ups or between different regions. For instance, presence of a bag and mask or timely supportive supervision might not be as important as the presence of a skilled birth attendant trained on newborn resuscitation to ensuring availability and provision of newborn resuscitation services that can potentially save babies not breathing at birth.
5. Country-specific solutions should be sought for existing measurement challenges, such as integrated supportive supervision that leaves inadequate time for assessing resuscitation skills and data quality, particularly timely reporting and completeness of data. Moreover, possibilities for online, real-time data collection and sharing methods should be explored.

In summary, review of existing newborn resuscitation measurements provided lessons for reproducible methods that can be tailored to the respective country context.

Abbreviations

AAP	American Academy of Pediatrics
CSBA	Community skilled birth attendant
DHS	Demographic and Health Surveys
HBB	Helping Babies Breathe
HIS	Health information system
HMIS	Health management information system
MCHIP	Maternal and Child Health Integrated Program
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MNCH	Maternal, newborn, and child health
MOH	Ministry of Health
MOHFW	Ministry of Health and Family Welfare
NIPORT	National Institute of Population Research and Training
NMR	Neonatal mortality rate
NSO	National Statistical Office
PMNCH	Partnership for Maternal, Newborn and Child Health
SARA	Service availability and readiness assessment
SBA	Skilled birth attendant
SBR	Stillbirth rate
SPA	Service Provision Assessment
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

Background

A systematic analysis of global child mortality from 2000 to 2013 reported 44% of under-five children died in the neonatal period and preterm birth complications and intrapartum-related complications were two of the three leading causes of death. In addition, a rapid decline in mortality was recorded among children one to 59 months while proportion of neonatal mortality in under-five deaths increased from 37.6% to 43.9% in the same 13-year period (Liu et al. 2015), in congruence with Countdown to 2015's 2013 update report, which documented 40% of child deaths as being attributable to newborn deaths (Countdown to 2015 2013). The systematic analysis also projected that global under-five mortality by the year 2030 will be 32.3 per 1,000 live births, with a neonatal mortality rate (NMR) of 15.5 deaths per 1,000 live births, which implies 48% of the under-five mortality will be attributable to neonatal causes (Liu et al. 2015).

Out of the 10 million babies born each year who do not breathe immediately at birth, about 6 million require basic neonatal resuscitation (Wall et al. 2009). Globally, birth asphyxia, which makes up 11% of the cause-specific child mortality rate, is projected to remain at around 10% in 2030, whereas it is projected the proportion will increase from 10% to 12% in sub-Saharan Africa and decrease from 11% to 8% in southern Asia (Liu et al. 2015).

Malawi

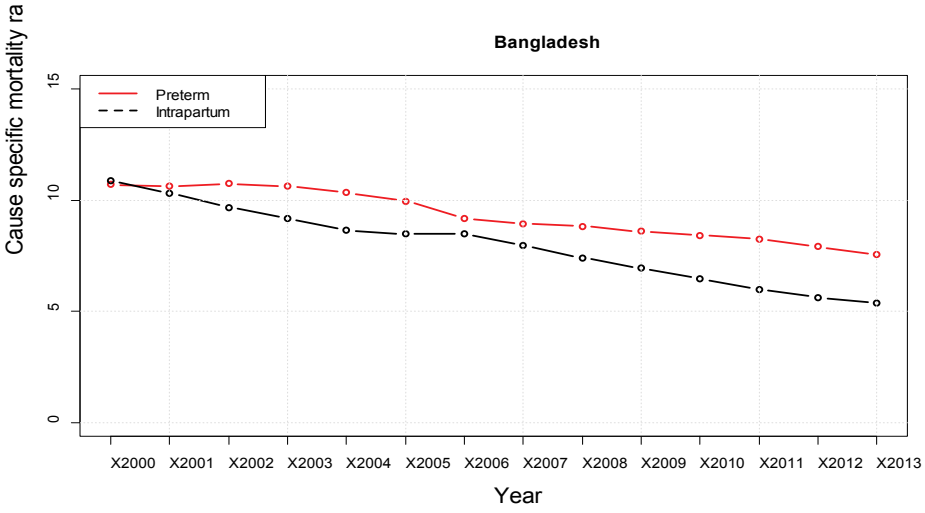
Republic of Malawi, a southeast African nation, is one of the few low-income countries that was able to make a significant reduction in child mortality and consequently achieve Millennium Development Goal (MDG) 4 ahead of time (Healthy Newborn Network 2013). However, though the NMR has dropped by 50% in a little more than 20 years, the reduction has not been as high as that of overall under-five mortality at 70% (United Nations Children's Fund [UNICEF] Eastern and Southern Africa 2014). The NMR at present, which is 23 per 1,000 live births, makes up 34% of under-five deaths in the country (UNICEF 2014). UNICEF's Multiple Indicator Cluster Survey (MICS) for Malawi in 2008 reported NMR had remained high for the 15 years prior to the survey (NSO [National Statistical Office] and UNICEF 2007, 2008). Neonatal asphyxia contributes 22% of the NMR in Malawi (Chikuse et al. 2012). Similarly, verbal autopsy report in Malawi showed stillbirth (mainly, fresh stillbirth) and prenatal birth asphyxia were the leading causes of neonatal death (Vergnano et al. 2011). Helping Babies Breathe (HBB), a global response to avert neonatal death secondary to birth asphyxia, has been rolled out in all 28 districts of Malawi, but at different scales of coverage (McPherson 2014a).

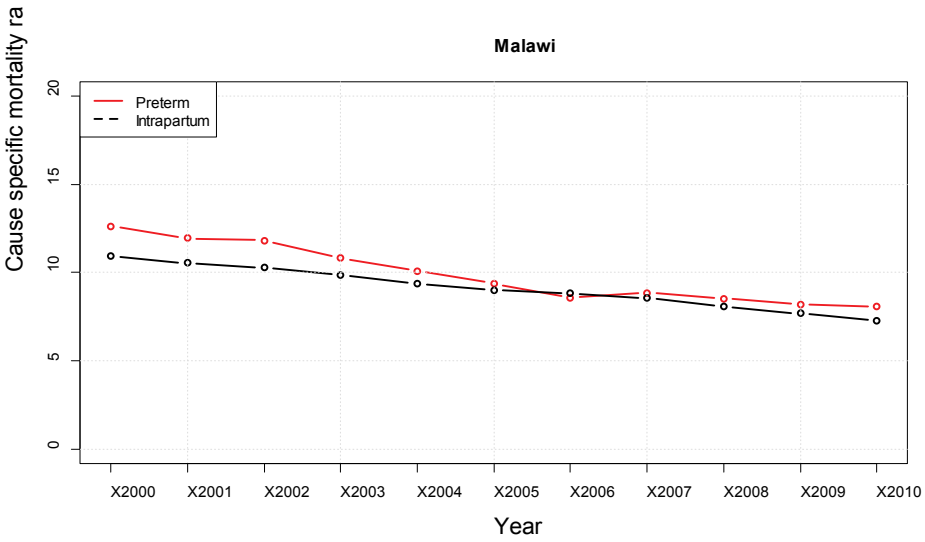
Bangladesh

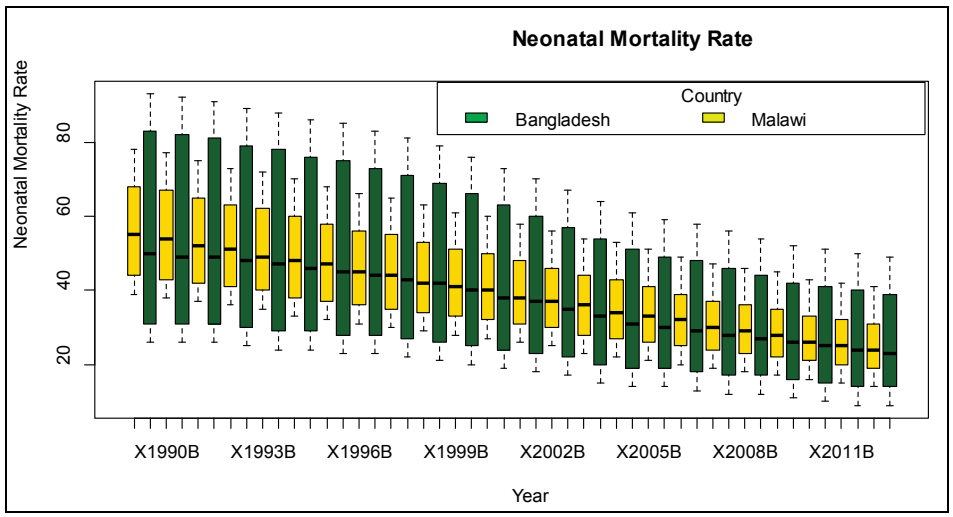
People's Republic of Bangladesh, a south Asian country, is high on the list of countries that have had a significant decline in NMR, from 55 per 1,000 live births in 1990 to 24 in 2013. The NMR contributes 59% of under-five deaths in Bangladesh (UNICEF 2014). According to the Bangladesh Demographic and Health Surveys (DHS) 2011, the country is well positioned to achieve its MDG 4 target of reducing the under-five mortality rate to 48 per 1,000 live births by 2015, while the country's Sample Vital Registration System showed the target had already been achieved in 2011. Both 2011 surveys also corroborated infant mortality rate as being behind the target (United Nations Development Programme 2014). In Bangladesh, both cluster-randomized control trial and verbal autopsy reported birth asphyxia as the leading cause of neonatal death (Darmstadt et al. 2010; National Institute of Population Research and Training [NIPORT], Mitra and Associates, and ICF International 2013). HBB has been rolled out in all districts of Bangladesh.

UNICEF monitoring data for NMR showed an overall decline from 1990 to 2013 in both Bangladesh and Malawi (UNICEF 2015). **Figure 1** presents trends in overall NMR and cause-specific under-five mortality rate secondary to preterm and intrapartum complications in Bangladesh and Malawi.

Figure 1. Preterm, intrapartum, and overall neonatal mortality rate trends in Bangladesh and Malawi, 1990–2013







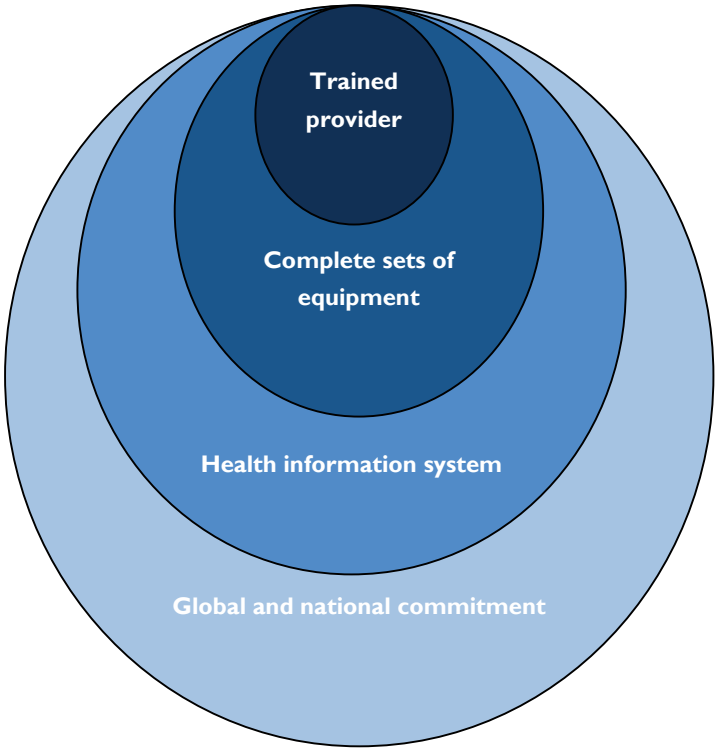
Sources: Liu, L., S. Oza, D. Hogan, et al. 2015. "Global, Regional, and National Causes of Child Mortality in 2000–13, with Projections to Inform Post-2015 Priorities: An Updated Systematic Analysis." *Lancet* 385(9966):430–440. doi:10.1016/S0140-6736(14)61698-6.

United Nations Children's Fund. 2015. "UNICEF Data: Monitoring the Situation of Children and Women." Accessed July 28. http://data.unicef.org/child-mortality/neonatal.

Inputs for Newborn Resuscitation Services

Initiatives to halt newborn death secondary to birth asphyxia entail providing comprehensive and timely newborn resuscitation services—within the "Golden Minute"—that are critical to reducing the adverse outcomes of neonatal asphyxia. Efforts extend along the continuum of care, from having global, national, and sub-national policies; implementation guidelines; and measurement and monitoring and evaluation systems in place to making sure the necessary equipment and trained service providers are available at the level where services are delivered. The readiness of a health facility to provide newborn resuscitation services depends on the inputs it has available. The major inputs for providing newborn resuscitation services include skilled birth attendants (SBAs) that have had newborn resuscitation training, complete sets of functional newborn resuscitation equipment, supportive national policies, and health information systems (HISs) to measure, monitor, and evaluate progress (**Figure 2**).

Figure 2. Inputs for newborn resuscitation service provision



Global and National Initiatives for Newborn Resuscitation

The World Health Organization's (WHO's) *Every Newborn: An Action Plan to End Preventable Deaths* (WHO and UNICEF 2014), newborn resuscitation guideline (WHO 2012), and service availability and readiness assessment survey (WHO 2014), and the DHS Program's standard surveys and Service Provision Assessment (SPA) surveys (DHS Program 2015b), are some of the global resources with relevant information on provision of neonatal resuscitation services and assessment of progress. A document that guides HBB program implementation in low-resource settings has also been developed by the American Academy of Pediatrics (AAP) with significant input from HBB Global Development Alliance partner organizations (AAP 2011). Newborn resuscitation targets, indicators, and measurements taken from these resources and covering global to service delivery levels are summarized in **Annex 1**.

Malawi

At national level, HBB has been endorsed by the Malawian government and initial steps have been taken to include HBB in national policy documents such as "National- and District-Level HIS," "Reproductive Health Strategy (2011 to 2016)," "Reproductive Health Service Delivery Guidelines," "Road Map for Accelerating the Reduction of Maternal and Neonatal Morbidity and Mortality in Malawi," "Integrated Maternal and Newborn Health Training Manual," and the "Obstetric Protocols." Moreover, a national HBB scale-up plan developed in 2011 contained comprehensive information on inputs, funding, and partners with their specific responsibility (McPherson 2014c).

Bangladesh

The Ministry of Health and Family Welfare (MOHFW), with the support of partner organizations including Bangabandhu Sheikh Mujib Medical University, led HBB endeavors in Bangladesh. A national newborn health policy was drafted by the National Core Committee's technical working group, the National Technical Working Committee for Newborn Health. The MOHFW has endorsed the inclusion of HBB in the national policy and in national documents such as "Health Population Nutrition Sector Development Program 2011-2016," "MNCAH [Maternal, Neonatal, Child and Adolescent Health] Operational Plan," and "Newborn Standard Operating Procedures." Moreover, medical schools and nursing colleges have incorporated HBB in their respective curriculums (McPherson 2014b).

Prior to a nationwide scale-up of HBB in Bangladesh that started in 2011, HBB was pilot tested and a dissemination seminar was held in 2010. The national scale-up was standardized, with district-level one-day advocacy and microplanning followed by in-service training of all SBAs and simultaneous distribution of resuscitation equipment.

Health Information Systems

Studies on newborn care practices rarely include comprehensive information on newborn resuscitation practices. Rather, such information is usually documented in standalone evaluation survey reports. The article "Indicators for Global Tracking of Newborn Care" in the Public Library of Science (PLOS) collection ''Measuring Coverage in Maternal, Newborn, and Child Health'' assessed, standardized, and recommended indicators that covered three areas: postnatal care, immediate care behaviors and practices for newborns, and health facility assessments. The recommendation following the assessment suggested immediate inclusion of newborn care practice indicators for thermal care (drying and bathing) and cord care in major reports such as UNICEF-supported MICSs and DHS, while newborn resuscitation, kangaroo mother care, and other indicators were suggested for future inclusion (Moran et al. 2013). Similarly, a qualitative study of delivery and neonatal care among women who delivered in health facilities and at home in Malawi and Bangladesh included information about thermal care, specifically wiping (drying), wrapping, and bathing (Yoder et al. 2010).

Malawi

The Malawi national health management information system (HMIS) collects information on newborn resuscitation from each district through DHIS 2 online system (Health Information Systems Programme, https://www.dhis2.org/).

Supportive supervision on maternal and newborn health in Malawi takes place at national, zonal, and district levels, while HBB-specific supervision is conducted sporadically by partner organizations and the government's reproductive health unit. Supervision of HBB has been integrated into a maternal and newborn health supervision checklist. There is a recent supplementary HBB mentorship or supervision checklist specifically developed for HBB (McPherson 2014c).

Newborn Resuscitation Indicators in Use

Monitoring tools for HBB in Malawi are the maternity register, the HBB register, and the HBB reporting form. The HBB reporting form has facility- and district-level versions. In addition, an indicator for percentage of newborns that experience birth asphyxia has been included in the national HMIS, and the use of HBB monitoring tools has been added into HBB providers' training (McPherson 2014c).

Bangladesh

An "HBB Revisit Program" was designed to provide refresher training and supportive supervision on resuscitation skills, monitor the status of HBB equipment, train untrained providers of delivery services at government facilities and selected untrained providers from private health facilities, and conduct a status review meeting at district level.

Newborn resuscitation measurement indicators have not been integrated into the national HIS in Bangladesh. Therefore, a national newborn care surveillance system that was developed to monitor essential newborn care now incorporates newborn resuscitation information. The surveillance covers 91 sites in eight districts across all facility levels (from medical college hospitals to *upazila* [sub-district] health complexes to sites with community SBAs [CSBAs]).

The data collected are compiled and reported by the facility/hospital surveillance officer weekly or fortnightly, based on the type of facility. The data comprise information on delivery, type of service providers, service providers' training, functional equipment, resuscitation service, and essential newborn care. The report is sent to the district surveillance officer, who in turn sends the report to the documentation officer at Bangabandhu Sheikh Mujib Medical University, HMIS strengthening and surveillance district manager, and focal persons at Directorate General of Health Services and Directorate General of Family Planning.

A Maternal and Child Health Integrated Program (MCHIP) report from 2014 presented information on 17,878 deliveries. Of those, 715 (4%) were community deliveries, 17,315 (97%) were live births, 283 (2%) were fresh stillbirths, and 280 (2%) were macerated stillbirths (percentages are rounded). Of the live births, 25% were low birth weight (≤ 2,500 g in Bangladesh). The report also documented that, out of the 1,060 babies who did not cry at birth, 1,060 were dried, 961 were suctioned, 811 were stimulated, 524 were ventilated with bag and mask, and 331 were referred; 16 babies died secondary to birth asphyxia. The percentage of babies that breathed after resuscitation was 68% and 76% in the facility and community groups, respectively. The percentage of babies who died due to birth asphyxia in the facility group was 2% and in the community group was 1% (MCHIP 2014).

Newborn Resuscitation Indicators in Use

There is neither a vertical HBB information system nor an HBB-related indicator in the national HMIS in Bangladesh. However, there is an initiative to revise the standard maternity register to include newborn asphyxia information, which will result in that information's inclusion in the HIS. The revised register is being pilot-tested in Tangail district. An HBB program performance evaluation and the newborn care surveillance system have been used for monitoring and evaluation of HBB-related activities in Bangladesh (icddr,b 2014; McPherson 2014b).

Complete Sets of Equipment

Sets of equipment for HBB are classified as training or implementation equipment. The training equipment set consists of a NeoNatalie newborn simulator (Laerdal, http://www.laerdalglobalhealth.com/doc/2528/NeoNatalie), Penguin suction device (Laerdal, http://www.laerdal.com/us/doc/2244/Penguin-Suction-Device), Ambu bag, and masks of size 0 and 1 for

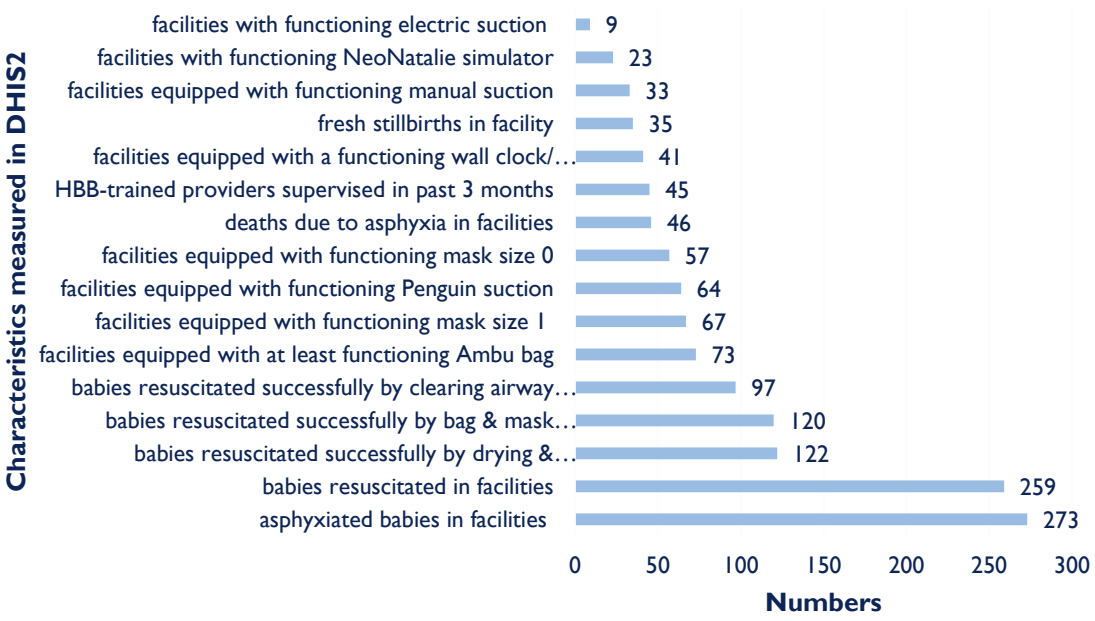
preterm and normal babies, respectively. The implementation equipment set contains everything in the training set except the NeoNatalie simulator.

Malawi

Documentation of the HBB scale-up process indicated that sets of training equipment were initially provided to 20 districts where SBAs were trained on HBB. However, the training equipment was used as implementation equipment due to lack of timely distribution of implementation equipment (McPherson 2014c). A later performance evaluation of HBB in Malawi conducted by MCHIP and the Support for Service Delivery Integration project in collaboration with Malawi's Ministry of Health (MOH) included inventory of HBB and other essential equipment in 81 health facilities from 13 districts and 90 health facilities from 28 districts in two consecutive rounds. This evaluation reported the proportion of health facilities that had bag and mask (infant size) for resuscitation (67.5% in round one versus 83.5% in round two); suction bulb for mucus extraction (61.3% in round one versus 85.9% in round two); resuscitation table for baby (73.8% in round one versus 68.2% in round two); and towel or blanket to wrap baby (23.8% in round one versus 17.6% in round two). In addition, HBB guidelines were found in 31.5% and 59.6% of the health facilities in the first and second rounds, respectively (Gupta et al. 2014).

The 2013–2014 SPA survey for Malawi reported 528 facilities were offering normal delivery services; of those, 89% had a neonatal bag and mask and 63% had suction apparatus (mucus extractor). The SPA survey also reported that most normal deliveries in Malawi take place in health centers (414), followed by hospitals (95) and dispensaries (19). Hospitals (96%) lead the proportion of health facilities with neonatal bag and mask, followed by health centers (89%) and dispensaries (66%) (MOH and ICF International 2014). Malawi's DHIS 2 reports the HBB-related measurements displayed in **Figure 3** for 2014.

Figure 3. Numbers for newborn resuscitation–related characteristics measured in a year among public facilities in DHIS 2 (Health Information Systems Programme, https://www.dhis2.org/), Malawi 2014



Notes: Penguin suction device (Laerdal, http://www.laerdal.com/us/doc/2244/Penguin-Suction-Device); HBB = Helping Babies Breathe.

Bangladesh

HBB equipment has been distributed to all districts in Bangladesh. The United States Agency for International Development (USAID)/MCHIP and UNICEF supplied 40 and 29 districts respectively and the MOHFW paid the value-added and other required taxes. At least one set of equipment was provided, immediately after training, to each facility that had trained providers. Facilities can also submit requests to the Directorate General of Health Services for replacement of broken equipment. In addition to training institutions, district hospitals, medical college hospitals, maternal and child welfare clinics, *upazila* health complexes, family welfare clinics, trained CSBAs, and nongovernmental organizations received HBB equipment sets (McPherson 2014b).

A report on Bangladesh Newborn Care Surveillance reported nearly all surveillance sites assessed (99%) had functional and ready-to-use equipment (MCHIP 2014).

Health Care Provider Capacity

Health service providers' capacity plays a pivotal role in high-quality newborn resuscitation services. HBB training is designed to build SBAs' capacity to provide newborn resuscitation services in a resource-limited setting (HBB 2015). A systematic review matched with expert consensus using the Delphi method estimated skilled care at birth can reduce neonatal death by 25% (Lee et al. 2011). It has also been documented that basic neonatal resuscitation by community health workers and facility-based providers may respectively avert 20% and 30% of intrapartum-related neonatal deaths (Wall et al. 2009).

Malawi

Malawi has a high rate of skilled birth attendance (71%) and health facility delivery (73%); midwives or nurses attend the majority (61%) of deliveries, and most deliveries (57%) take place in public sector facilities (NSO and ICF Macro 2011). In Malawi, the national HBB scale-up plan was initially targeted to train 840 service providers from the 28 districts, with 30 providers per district being trained. For this purpose, seven master HBB trainers were prepared and in turn trained 72 district-level HBB trainers (three per district from 24 of the districts). Financial constraints, however, resulted in only 30% of health care providers per district being trained, with the aim of having at least one trained provider per health facility. The plan to cascade HBB training by having trained providers give the training to their co-workers was not effective, mainly because untrained providers prefer formal HBB training rather than workplace skill transfer. Health care providers trained in HBB equally represented government facilities and providers from Christian Health Association of Malawi (which is also administered by the government), while no provider from private health facilities was trained (McPherson 2014c).

Bangladesh

Most deliveries in Bangladesh take place at home (71%) or in private sector facilities (15%), with a low proportion (32%) of deliveries attended by medically trained providers (NIPORT, Mitra and Associates, and ICF International 2013). Medically trained birth attendants include CSBAs, community-based female health assistants who have taken a supplementary six-month training course in midwifery. The original HBB scale-up plan was designed to train all SBAs from governmental and nongovernmental organizations, but none from private sectors. However, the implementation was later revised to include all providers of delivery services at private health facilities as long as the provider is either a physician with an MBBS (bachelor of medicine, bachelor of surgery) degree or a nurse with a diploma nursing certificate who is registered by the Bangladesh Nursing Council. A team of 14 HBB core trainers (senior influential doctors) and 68 HBB master trainers were trained to cascade the training to their respective districts nationwide (McPherson 2014b).

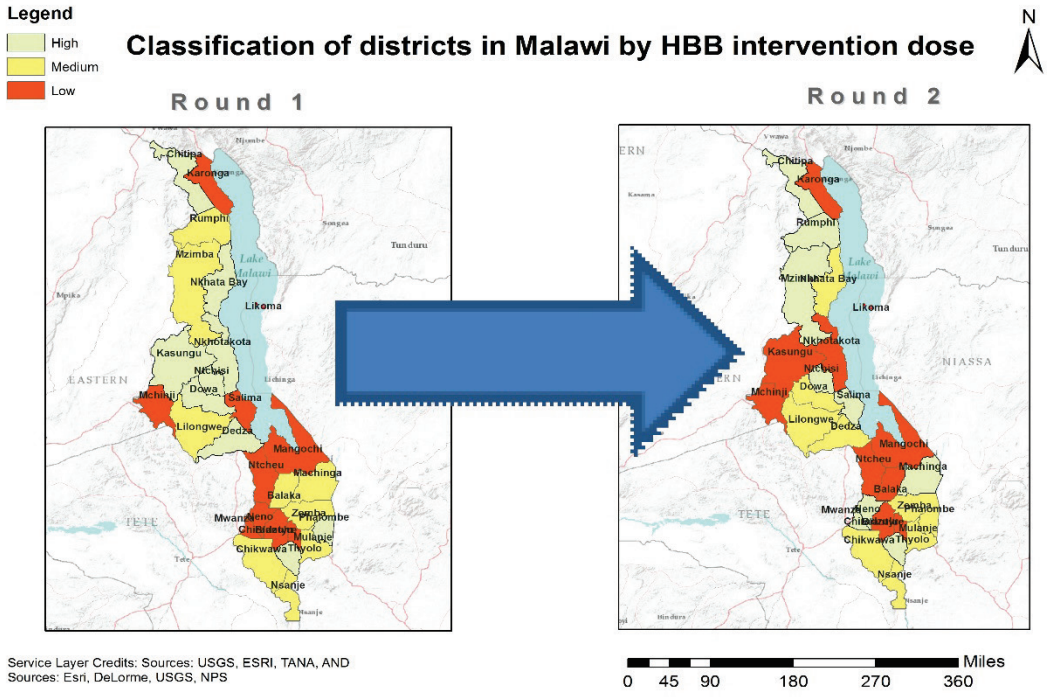
Outputs/Outcomes of Newborn Resuscitation Service Delivery

Malawi

A 2012 study of midwives at Queen Elizabeth Central Hospital in Blantyre district reported that study participants did not adhere to nine out of 21 steps of a resuscitation guideline (Chikuse et al. 2012). A performance evaluation of HBB documented service providers' knowledge and skills and health facilities' supplies and equipment using clinical observation checklists, interviews, and facility inventories. The evaluation was conducted in two rounds in 81 and 90 facilities from 13 and 28 districts of Malawi, respectively, and was carried out with the assistance of USAID's Maternal and Child Survival Program. In the first round, 190 health care providers were interviewed; in the second round, 202 providers were interviewed. The evaluation documented birth asphyxia information for 1,747 babies in round one and for 2,093 babies in round two. Out of the 193 babies that were not breathing at birth in round one, 144 received stimulation, 62 were resuscitated with bag and mask, and 11 died. In the second round of evaluation, out of 280 babies not breathing at birth, 223 received stimulation, 86 were resuscitated with bag and mask, and 14 died (Gupta et al 2014).

The results of the evaluation in the two rounds classified districts as high, medium, and low dose according to the actual strength of the HBB intervention by comprehensively assessing training and capacity building, practice with the NeoNatalie newborn simulator, supervision, and availability of equipment, supplies, and guidelines (Gupta et al. 2014). **Figure 4** shows each district's classification in the first and second rounds of the evaluation based on a composite indicator that generated a relative score to compare districts during first and second rounds of evaluation.

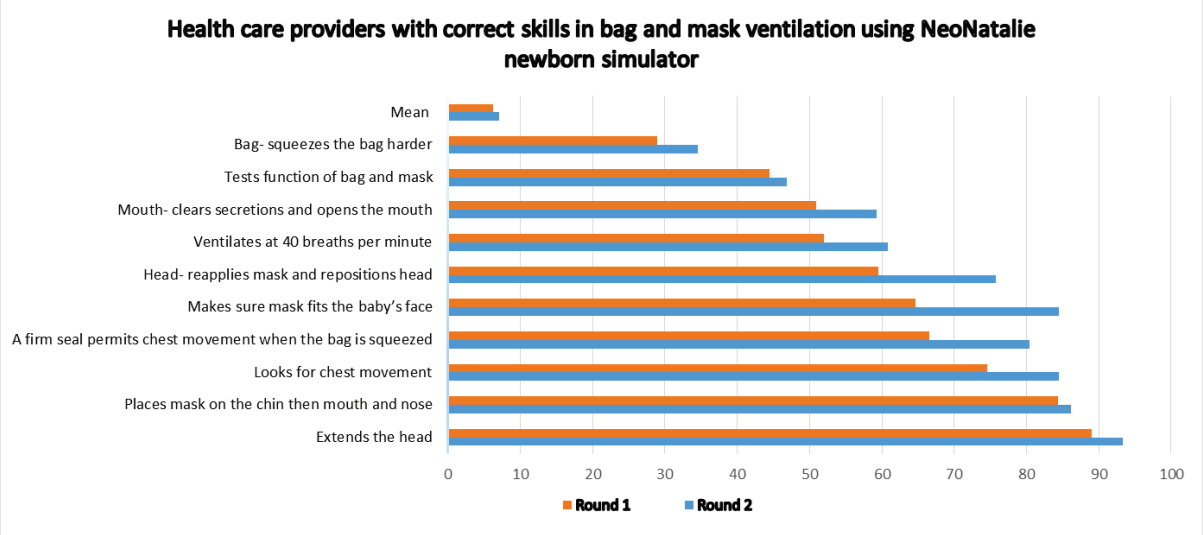
Figure 4. Classification of districts in Malawi by Helping Babies Breathe (HBB) intervention dose in two consecutive rounds



Source: Gupta, S., et al. 2014. Evaluation of the Helping Babies Breathe (HBB) Initiative Scale-Up in Malawi: Results from the Dose Response Analysis, unpublished. Washington, DC: Maternal and Child Health Integrated Program.

The performance evaluation for HBB in Malawi reported that 68.4% of health care providers had trained in subjects related to newborn care in the two years prior to the evaluation. In addition to assessing providers' capacity using a checklist, the evaluation assessed providers' practice on the NeoNatalie newborn simulator as well as on 193 babies (in round one) and 280 babies (in round two) who were not breathing at birth. The assessments on NeoNatalie were done using both term and preterm baby scenarios. Assessment of providers' skills in bag and mask ventilation indicated some skills (such as extending the head) are practiced more than others (such as squeezing the bag harder); no significant difference was observed between first and second round assessments (**Figure 5**) (Gupta et al. 2014).

Figure 5. Percentage of health care providers with correct skills in bag and mask ventilation using NeoNatalie newborn simulator in two rounds

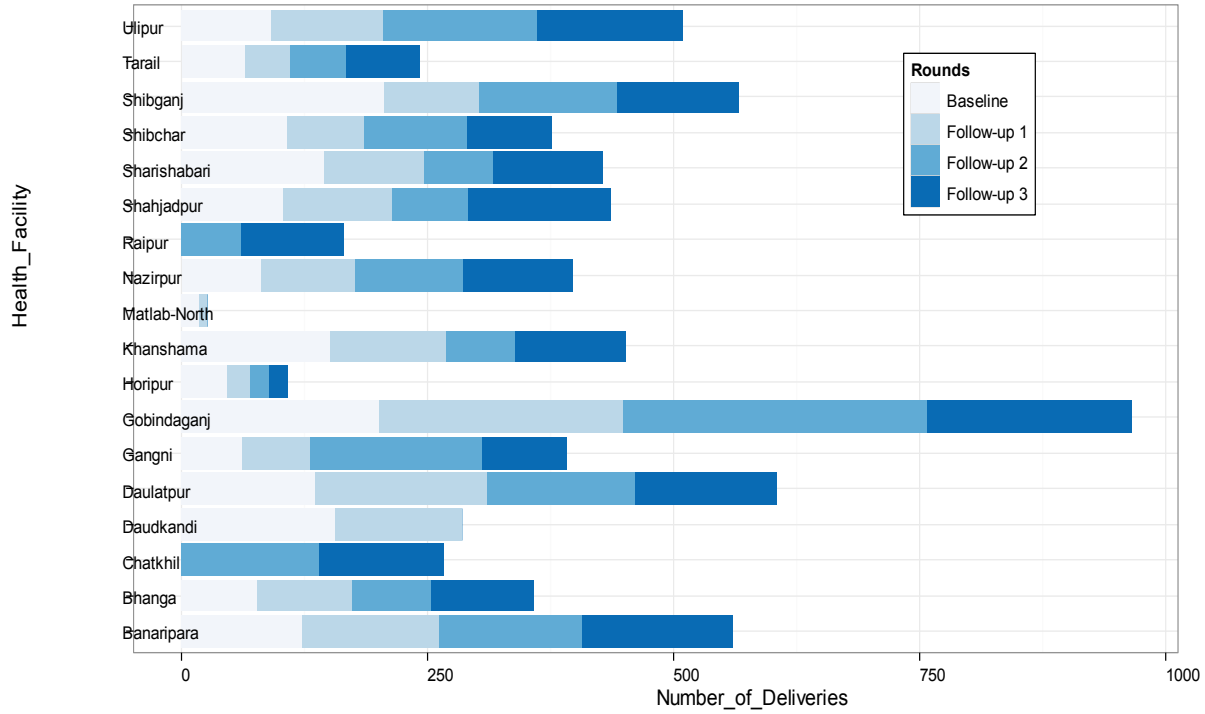


Source: Gupta, S., et al. 2014. Evaluation of the Helping Babies Breathe (HBB) Initiative Scale-Up in Malawi: Results from the Dose Response Analysis, unpublished. Washington, DC: Maternal and Child Health Integrated Program.

Bangladesh

Bangladesh conducted a system evaluation of HBB interventions in facility and community settings. The evaluation followed a cluster randomized control study where both intervention (those who received HBB training) and control groups included SBAs from both health facilities and communities. The community- and facility-based groups who took the training (intervention group) were also compared. For the health facility group, the participating SBAs were taken from 16 *upazila* health complexes distributed in six of the seven major divisions of Bangladesh. And in one rural district (Habiganj), 16 unions with a high number of deliveries and with three or more CSBAs were purposively included in the community group. A baseline assessment was conducted among both intervention and control groups prior to the **introduction of HBB training in the intervention arm.** Then, **three consecutive follow-up assessments** using a checklist were completed, with a three-month gap between each of the three follow-up assessments. There were 7,138 deliveries during the evaluation: 3,731 in the intervention group and 3,407 in the control group (icddr,b 2014). The number of deliveries in each facility is displayed in **Figure 6**.

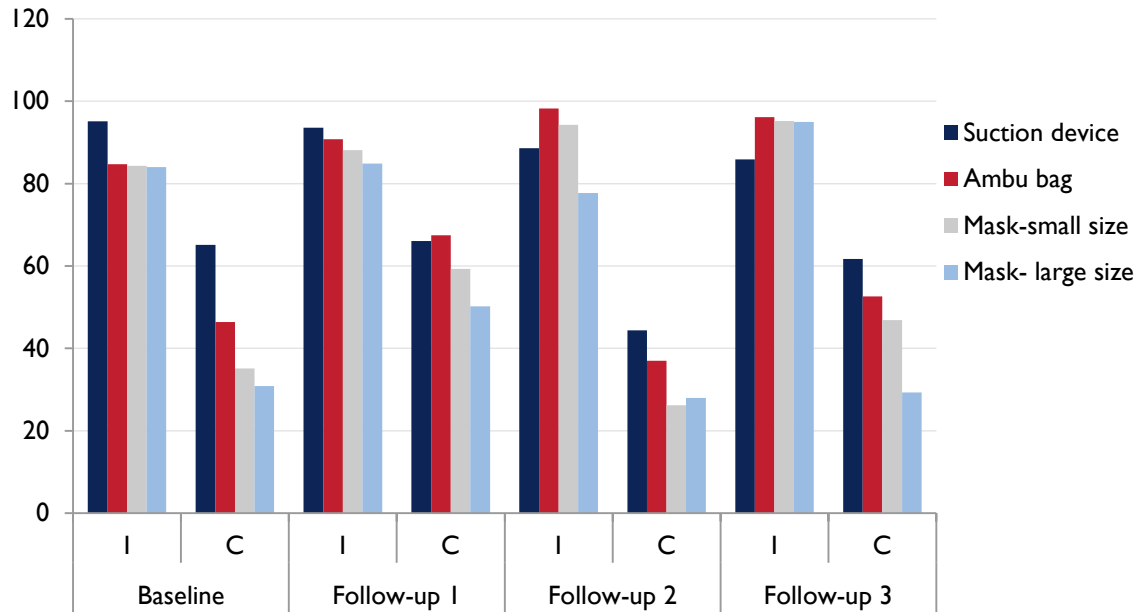
Figure 6. Number of facility deliveries recorded in baseline and three rounds of follow-up assessment in Bangladesh Helping Babies Breathe evaluation



Source: icddr,b. 2014. A Draft Report: System Evaluation of Scaling-Up of Helping Babies Breathe (HBB) Intervention in Facility and Community Settings in Bangladesh, unpublished. Centre for Child and Adolescent Health and icddr,b.

Coverage of newborn resuscitation equipment was assessed at baseline and in the three consecutive follow-ups for both intervention and control groups (**Figure 7**). Overall, the intervention group had higher coverage than the control group throughout the baseline and follow-ups (icddr,b 2014).

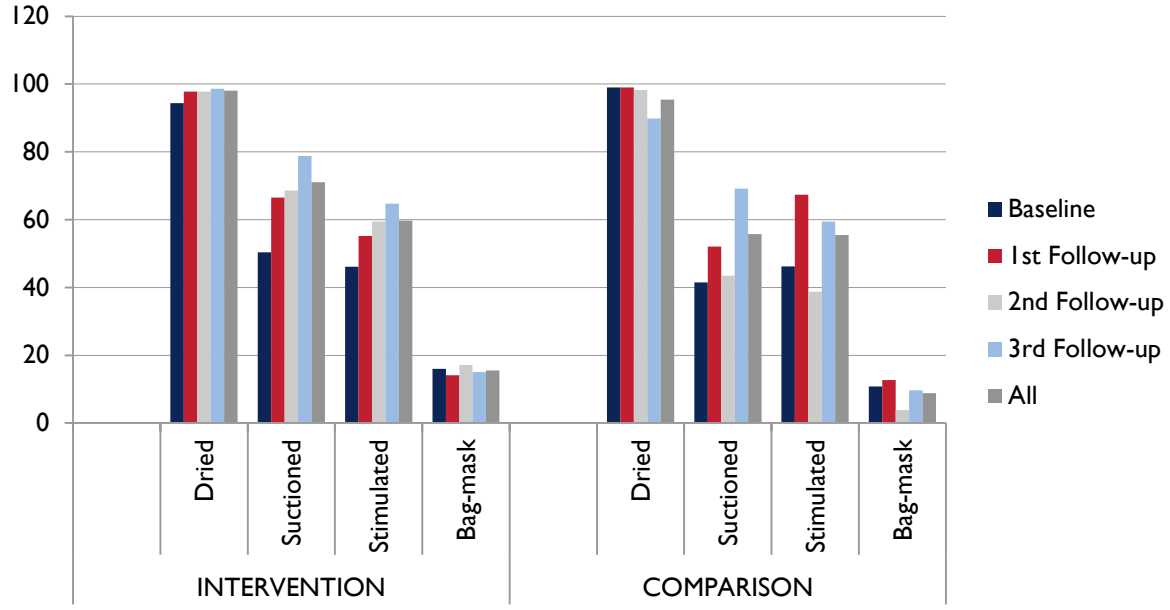
Figure 7. Coverage of resuscitation equipment among intervention (I) and control (C) groups during baseline and follow-ups of Helping Babies Breathe evaluation in Bangladesh



Source: icddr,b. 2014. A Draft Report: System Evaluation of Scaling-Up of Helping Babies Breathe (HBB) Intervention in Facility and Community Settings in Bangladesh, unpublished. Centre for Child and Adolescent Health and icddr,b.

The sequence of procedures and time spent to provide resuscitation services were used to assess the quality of the resuscitation intervention. The recommended sequence was drying followed by suction followed by tactile stimulation followed by ventilation with bag and mask. Procedures were to have been done sequentially and initiated and completed within 60 seconds. The facility-based assessment result for babies who did not cry at birth (excluding cesarean sections) is summarized in **Figure 8**.

Figure 8. Newborn resuscitation practices among facility-based intervention and control groups during baseline and follow-ups of Helping Babies Breathe evaluation in Bangladesh



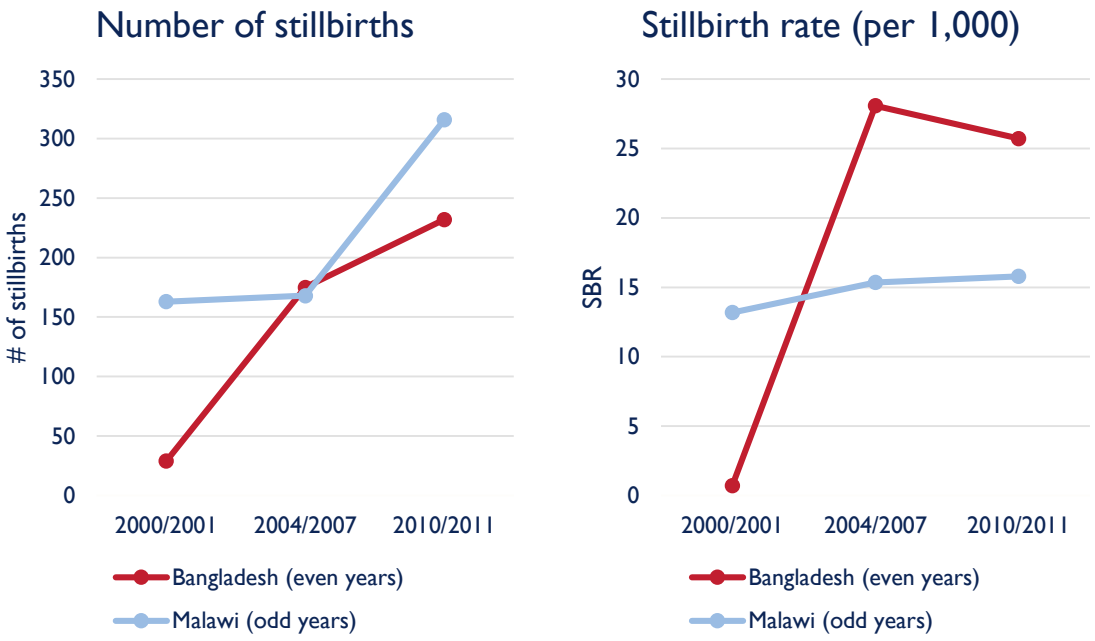
Source: icddr,b. 2014. A Draft Report: System Evaluation of Scaling-Up of Helping Babies Breathe (HBB) Intervention in Facility and Community Settings in Bangladesh. Centre for Child and Adolescent Health and icddr,b.

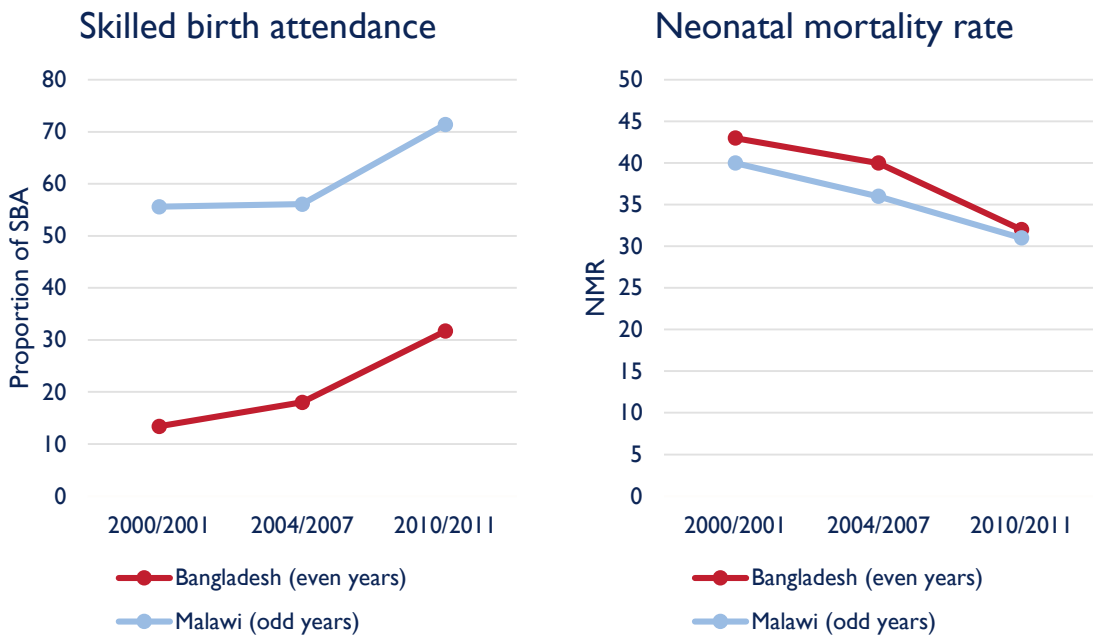
The community-based component assessment among intervention group showed drying, suction, stimulation, and bag-mask ventilation was done for 100%, 44%, 50%, and 25% in the baseline compared to 99%, 56%, 49%, and 23% in the follow-ups. Among the control group, drying, suction, stimulation, and bag-mask ventilation was done for 100%, 0%, 100%, and 0% in the baseline compared to 94%, 61%, 29%, and 0% in the follow-ups (icddr,b 2014).

Challenges of Impact Measurements for Evaluation of Newborn Resuscitation

At national level, the impact of newborn resuscitation is measured by the number of newborns who were not breathing at birth that were saved. The majority of national-level reports of standard birth outcome measurements are captured through retrospective document reviews. Crude reporting of outcomes, such as NMR and stillbirth rate (SBR), make it challenging to identify deaths specifically due to birth asphyxia. For instance, three rounds of standard DHS reports for Malawi and Bangladesh showed increased skilled birth attendance and decrease in NMR, while both absolute number of stillbirths and proportion of stillbirths among women who had completed seven or more months of pregnancy increased (**Figure 9**).

Figure 9. Delivery trends in Malawi and Bangladesh, 2000–2011





Sources: National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. 2013. *Bangladesh Demographic and Health Survey 2011*. Dhaka, Bangladesh: NIPORT, Mitra and Associates, and ICF International. http://dhsprogram.com/pubs/pdf/FR265/FR265.pdf.

National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ORC Macro. 2001. *Bangladesh Demographic and Health Survey 1999-2000*. Dhaka, Bangladesh: NIPORT, Mitra and Associates, and ORC Macro. http://dhsprogram.com/pubs/pdf/FR119/FR119.pdf.

National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ORC Macro. 2005. *Bangladesh Demographic and Health Survey 2004*. Dhaka, Bangladesh: NIPORT, Mitra and Associates, and ORC Macro. http://dhsprogram.com/pubs/pdf/FR165/FR-BD04[FR165].pdf.

National Statistical Office (NSO) and ICF Macro. 2011. *Malawi Demographic and Health Survey 2010*. Zomba, Malawi: NSO and ICF Macro. http://dhsprogram.com/pubs/pdf/FR247/FR247.pdf.

National Statistical Office (NSO) and ORC Macro. 2001. *Malawi Demographic and Health Survey 2000*. Zomba, Malawi: NSO and ORC Macro. http://dhsprogram.com/pubs/pdf/FR123/FR123.pdf.

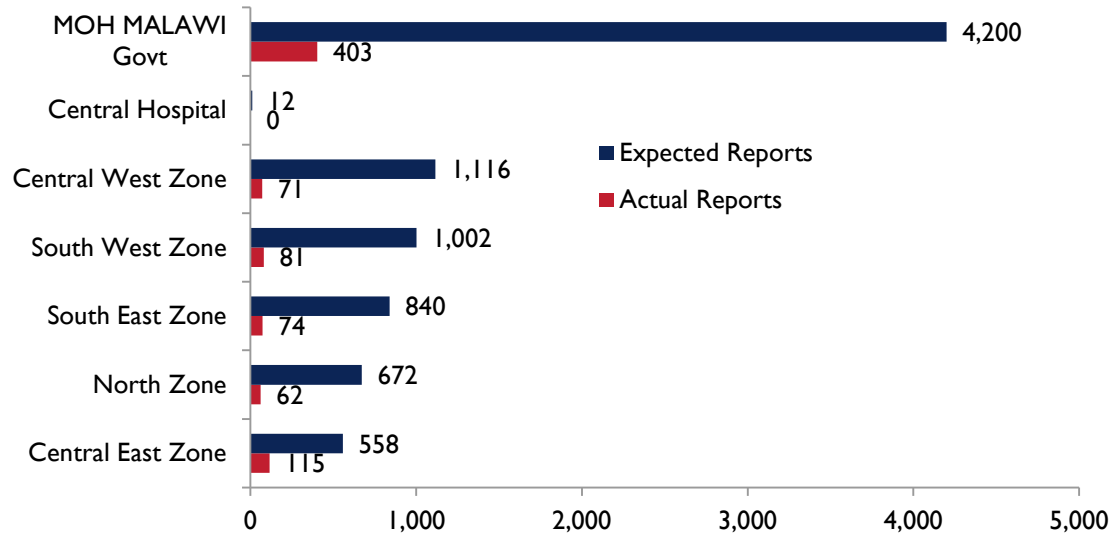
National Statistical Office (NSO) and ORC Macro. 2005. *Malawi Demographic and Health Survey 2004*. Calverton, MD: NSO and ORC Macro. http://dhsprogram.com/pubs/pdf/FR175/FR-175-MW04.pdf.

Abbreviations: DHS, Demographic and Health Surveys; SBA, skilled birth attendant; SBR, stillbirth rate; NMR, neonatal mortality rate.

Because DHS data are collected at the household level, the increase in absolute number of stillbirths might merely be attributable to increased number of pregnancies and improved reporting of stillbirths, rather than an increase in health facility delivery or neonatal death in facilities. Therefore, the use of national crude outcome indicator reports as a proxy for evaluation of birth asphyxia should be viewed cautiously; asphyxia-specific indicators should be standardized, adopted, and prioritized for evaluating newborn resuscitation outcomes.

In addition to crude reports, incomplete and delayed reports affect the information on newborn resuscitation. For instance, the Malawi MOH's HBB report was supposed to compile reports from different zones of the country, covering January to June 2014. **Figure 10** shows the gap between number of expected reports (based on all facilities, including facilities that might not have maternity services) and actual reports received. In addition, only 21 reports were received on time.

Figure 10. Expected versus actual source reports for Malawi Ministry of Health's (MOH's) report on Helping Babies Breathe, January–June 2014

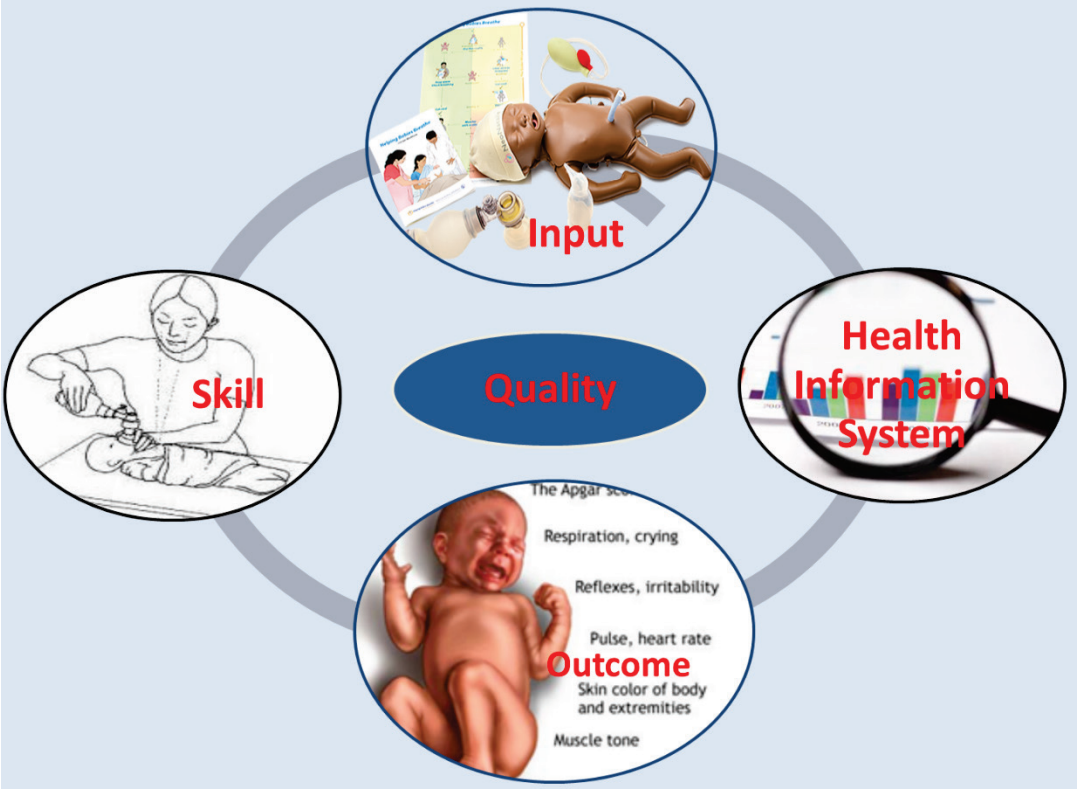


Source: Government of Malawi. 2014. *MOH Annual Summary on HBB*, unpublished.

Quality of Newborn Resuscitation Services

Assessing quality of care specifically for newborn resuscitation requires exhaustive analysis along the continuum of care: quality of newborn resuscitation services is a function of the service inputs, the conduct of the practical process, the resulting outcomes, and the HIS (**Figure 11**). Existing input, process, and output indicators, which are sometimes adopted across multiple reports, have been summarized in **Annex 2**.

Figure 11. Elements of comprehensive quality of care in newborn resuscitation services



The service inputs for newborn resuscitation include trained service providers, complete sets of equipment, and the HIS. Indeed, service inputs are necessary for newborn resuscitation service provision. Outcome indicators such as NMR, SBR (fresh), neonatal "near misses," and asphyxia-related morbidities are also used to assess the quality of newborn resuscitation services (DHS Program 2015b; Padayachee and Ballot 2013). Nevertheless, inputs cannot ensure appropriate practice and timely service provision, much as national-level crude outcome indicators alone cannot describe the quality of newborn resuscitation services.

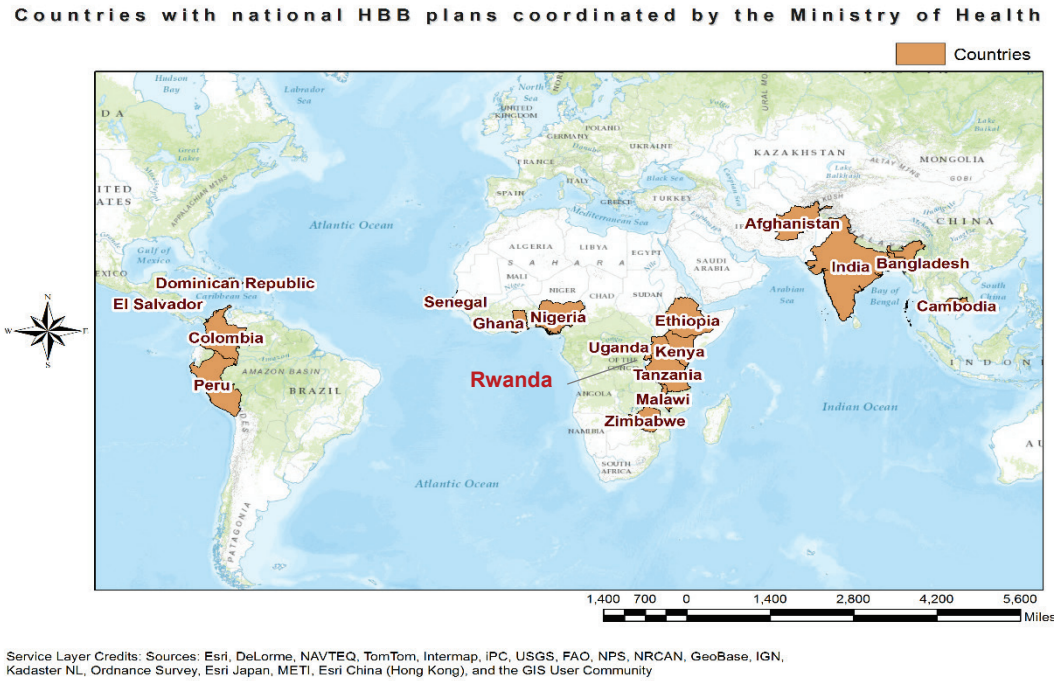
The majority of the indicators currently in use are geared toward capturing information on inputs and outputs of newborn resuscitation as proxy indicators of quality of care. This is mainly because developing standard process indicators that are objectively measurable and adaptable in diverse contexts is challenging.

Multiple approaches have been used to assess newborn resuscitation practices of health service providers. Direct observation of service providers while they conduct resuscitation is the most appropriate method of assessment. This was shown in an HBB performance evaluation in Malawi, in which a data collector used a checklist and spent 10 or more days in a health facility where more than 5 deliveries took place per day (Gupta et al. 2014). Due to feasibility challenges, however, other assessment methods have also been used, such as installing recording cameras in delivery rooms and evaluating health care providers as they follow resuscitation steps on simulators (such as the NeoNatalie newborn simulator) (Carbine et al. 2000; Lindbäck et al. 2014).

Lessons Learned and Recommendations for Reproducible Measurement

HBB has been introduced in 60 countries; 18 have a national HBB plan that is coordinated by the national MOH (**Figure 12**) (Global Development Alliance 2013).

Figure 12. Countries with national Helping Babies Breathe (HBB) plans coordinated by the respective ministry of health



Source: Global Development Alliance. 2013. *Helping Babies Breathe Status Annual Report November 2013*. http://www.laerdalglobalhealth.com/doc/2503/Helping-Babies-Breathe-Global-Development-Alliance.

Malawi and Bangladesh can serve as models for the adoption of HBB globally because each country:

- has a high birth rate and NMR,
- has implemented HBB widely, and
- is a low-resource country that achieved Millennium Development Goal 4.

This rapid desk review summarized the status of HBB and assessed existing measurements. Listed below are the lessons learned in the process:

6. Equipment coverage alone does not guarantee quality service provision and training does not ensure proper practice. Therefore, newborn resuscitation–related quality of care measurements should be included at the national level. In other words, quality should be ensured across the continuum of input, process, output, and HIS.
7. The commonly used national measurements might not clearly provide information on birth asphyxia. Therefore, national-level indicators that specifically measure newborn resuscitation services are needed. In countries where vertical HBB information collection from each facility and community is not possible, the incorporation of indicators of newborn resuscitation services as an integrated part of newborn care measurement was more feasible, such as in the case of Bangladesh. This enabled inclusion of HBB in the national HIS, rather than the introduction of a standalone information system for newborn resuscitation services. Moreover, surveillance of selected representative samples has been used in place of detailed newborn resuscitation measurements where separate resuscitation

indicators were not part of the national HIS. This alternative method can be adopted if surveillance sites are prudently selected to reflect nationally representative information. Whenever the inclusion of newborn-specific indicators in the national HIS is possible, data quality—particularly timely reporting and completeness of data—should be closely monitored. Moreover, possibilities for online, real-time data collection and sharing methods should be explored.

8. Monitoring and evaluation efforts have displayed the range of factors that need to be assessed to ensure quality delivery of newborn resuscitation services. HBB-specific comparisons can be made across space and time. Assessments have been made on coverage (by geographic location/district or between facilities); changes in skill sets (before and after intervention/training and equipment supply); and trends in outcome of newborn resuscitation (babies resuscitated and saved) in a given period of time. Future comparison might benefit further from (a) comparison of coverage by geography that takes into account variation in the underlying population; (b) facility coverage and outcomes comparison by the level/type of facility; or (c) standardized methods for comparing performance (in the past, performance has been measured as the length of time needed for newborn resuscitation, number of procedures performed, or the steps followed).

9. The importance of using composite measurements to compare overall progress has been shown. Such composite measurements can be made more informative if each indicator is scaled (weighted) for comparison between baseline and follow-ups or between different regions. For instance, presence of a bag and mask or timely supportive supervision might not be as important as the presence of an SBA trained on newborn resuscitation to ensuring availability and provision of newborn resuscitation services that can potentially save babies not breathing at birth.

10. Supportive supervision for newborn resuscitation is usually integrated with other supervision activities, leaving inadequate time for assessing resuscitation skills. Newborn resuscitation–specific skills were assessed as part of performance evaluation, either on actual babies that were not breathing at birth or using simulators. The latter presents a feasible alternative for skill assessment, particularly in facilities or communities with a low number of deliveries. Assessing providers' actual practice remains a challenge; enforcing consistent performance will be of paramount importance.

Annex 1: Summary of Existing Targets, Indicators, and Measurements

Level	Measurement
	WHO *Every Newborn: An Action Plan to End Preventable Deaths* (WHO and UNICEF 2014)
Global	**Every newborn coverage and quality of care for small and sick newborns targets:** • **2020:** at least 50% of babies who do not breathe spontaneously at birth after thorough drying and stimulation will be resuscitated with bag and mask ventilation • **2025:** at least 75% of babies who do not breathe spontaneously at birth after thorough drying and stimulation will be resuscitated with bag and mask ventilation **NMR and SBR targets:** • **2020:** Global NMR milestone of 15 per 1,000 live births; SBR 14 per 1,000 total births • **2025:** Global NMR milestone of 12 per 1,000 live births; SBR 11 per 1,000 total births • **2030:** Global NMR milestone of 9 per 1,000 live births; SBR 9 per 1,000 total births • **2035:** Global NMR target of 7 per 1,000 live births; SBR 8 per 1,000 total births
	WHO newborn resuscitation guideline (WHO 2012)
Global	**Recommended implementation, monitoring and evaluation indicators:** • Estimates of asphyxia-specific and early (within first week) NMR
National	**Implementation, monitoring and evaluation framework indicators:** • NMR and early NMR from nationally representative surveys
Service delivery	**Recommended implementation, monitoring and evaluation indicators:** • Proportion of births assisted by a health worker trained in and equipped for newborn resuscitation Proportion of newborn infants with a birth weight ≥ 2,500 g alive on seventh day of life
	Standard DHS (DHS Program: http://www.dhsprogram.com/)
National	**National DHS in selected sample sites every five years:** • Number of skilled birth attendance by type of professional • NMR (number of deaths per 1,000 live births) • Number of stillbirths **Note:** The latest surveys are 2011 for Bangladesh (NIPORT, Mitra and Associates, and ICF International 2013) and 2010 for Malawi (NSO and ICF Macro 2011). Trends for 2000–2011 in Malawi and Bangladesh are presented in **Figure 9**.
	SPA survey (DHS Program 2015a)
National	**Facility readiness indicators:** • Percentage of facilities offering neonatal resuscitation • Percentage of facilities with equipment: suction apparatus (mucus extractor) and neonatal bag and mask **Note:** Both Malawi and Bangladesh have not been in the list of countries that WHO's service availability and readiness assessment (SARA) reports on. SPA contains **all** questions in the WHO SARA tool (DHS Program 2015b).
Service delivery	**SPA Inventory questions:** • Has newborn resuscitation ever been provided in facility? (YES/NO) • Has newborn resuscitation been provided in the past three months? (YES/NO) • Does the facility participate in regular reviews of maternal or newborn deaths or "near-misses"? (YES/NO) • How often are reviews of newborn deaths or "near misses" carried out? (Every ___ week) • Number of newborn bag and mask (size 1 for term babies and size 0 for preterm babies), suction device (suction catheter and electric suction bulb, or mucus aspirator bulb—single use or multiuse sterilizable)

Level	Measurement
	***Guide for Implementation of Helping Babies Breathe (HBB)* (AAP 2011)**

National	**HBB monitoring and evaluation framework indicators**
	Input
	• Financial and human resources:
	  • Funds mobilized for HBB implementation
	Process
	• Integration of HBB in national plan for essential newborn care and emergency/obstetric and newborn:
	  • HBB included in national newborn plan
	Output
	• Improved access, equity, and quality of newborn resuscitation:
	  • Number and percent of trainers trained by type of cadre and district
	  • Number and percent of birth attendants trained by type of cadre and by district
	  • Number and percent of health facilities equipped with resuscitation devices by district
	Outcome
	• Improved health outcomes and behaviors:
	  • Number and percent of babies not breathing at birth who were resuscitated successfully
	  • Number and percent resuscitated successfully by key HBB action step
	  • Crying (stimulation)
	  • Clearing the airway/stimulation
	  • Ventilation with bag and mask
	Impact
	• Improved health status
	  • Early NMR (7 days)
	  • *Optional indicators:*
	  • Early NMR (7 days)
	  • NMR (28 days)
	  • SBR

	HMIS/Malawi DHIS 2

National/ district	**From HBB/maternity registers:**
	• Number of deliveries in health facilities and babies born alive in health facilities
	• Number of asphyxiated babies in health facilities: HBB/maternity
	• Number of babies resuscitated in health facilities: HBB
	• Number of babies with asphyxia resuscitated successfully by drying and wrapping only, by clearing airway and stimulation, and by using bag and mask ventilation: HBB
	• Number of fresh stillbirths and deaths due to asphyxia in health facilities: HBB
	
	From supervision report
	• Equipment data
	  • Number of health facilities with functioning: NeoNatalie simulator, mask size 0, mask size 1, suction device, wall clock/timer and Ambu bag
	• Supervision data
	  • Number of HBB-trained providers who can demonstrate how to use a bag and mask for resuscitation during an HBB supervision visit
	  • Number of HBB-trained providers who received an HBB supervision visit in past 3 months

Level	Measurement
	Newborn care surveillance system, Bangladesh
National/ district	**In 91 representative surveillance sites from eight districts** • Number of deliveries • Number of live births • Number of fresh stillbirths • Number of macerated stillbirths • Number of babies not breathing at birth • Number of equipment (bag and mask) available to use • Number of equipment (bag and mask) ready to use • Number of providers trained on newborn resuscitation on the job • Number of providers "formally" trained on newborn resuscitation • Number of babies that were not crying at birth and were dried • Number of babies that were not crying at birth and were suctioned • Number of babies that were not crying at birth and were stimulated • Number of babies that were not crying at birth and were ventilated using bag and mask • Number of babies that were not crying at birth and were referred

Annex 2: Newborn Resuscitation Input, Process, and Outcome Indicators in Use

Inputs					
Service Availability					
Indicator	**Numerator**	**Denominator**	**Source**	**Method Of Data Collection**	**Country**
Proportion of health facilities with maternity services that have functional bag and masks (two neonatal mask sizes) in the delivery areas	# of health facilities with functional bags and masks (two neonatal mask sizes) in the delivery areas of maternity services	Total # of health facilities with maternity services assessed	WHO global core indicators to measure quality of maternal, newborn, and child health (MNCH) care in health facilities (Mathai 2014; WHO and PMNCH [Partnership for Maternal, Newborn and Child Health] 2014)	Direct observation: facility surveys and self-assessments (e.g., SARA, SPA)	Both Malawi and Bangladesh
Proportion of facilities offering neonatal resuscitation	# of health facilities that offer neonatal resuscitation service	Total # of health facilities	SPA/WHO SARA (DHS Program 2015b; WHO 2014)	National facility survey	No recent report for Bangladesh and Malawi
Proportion of facilities that perform newborn resuscitation in the delivery area	# of facilities that perform newborn resuscitation	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Interview in randomly selected health facilities in all 28 districts	Malawi
Proportion of facilities that performed newborn resuscitation in the last three months with bag and mask	# of facilities that performed newborn resuscitation in the last three months with bag and mask	Total # of sampled facilities that perform newborn resuscitation	HBB performance evaluation (Gupta et al. 2014)	Interview in randomly selected health facilities in all 28 districts	Malawi

Inputs					
Functional equipment and guidelines					
Indicator	**Numerator**	**Denominator**	**Source**	**Method of data collection**	**Country**
Proportion of health care facilities with maternity services that have functional bags and masks for newborns	# of health care facilities with maternity services that have functional bags and masks for newborns	Total # of facilities with maternity services	WHO additional (not core) MNCH indicators (WHO and PMNCH 2014)	Suggested: Supervision checklist and observation	—
Proportion of facilities providing facility-based delivery services with suction apparatus (mucus extractor)	# of facilities providing facility-based delivery services with suction apparatus (mucus extractor)	Total # of facilities providing facility-based delivery services	SPA/WHO SARA (DHS Program 2015b; WHO 2014)	National facility survey—Observed availability, reported functionality, and location in service area or adjacent area	No recent report for Bangladesh and Malawi
Proportion of facilities providing facility-based delivery services with neonatal bag and mask size 1 for term babies (for newborn resuscitation)	# of facilities providing facility-based delivery services with neonatal bag and mask size 1 for term babies (for newborn resuscitation)	Total # of facilities providing facility-based delivery services	SPA/WHO SARA (DHS Program 2015b; WHO 2014)	National facility survey—Observed availability, reported functionality, and location in service area or adjacent area	No recent report for Bangladesh and Malawi
Proportion of facilities providing facility-based delivery services with neonatal bag and mask size 0 for preterm babies (for newborn resuscitation)	# of facilities providing facility-based delivery services with neonatal bag and mask size 0 for preterm babies (for newborn resuscitation)	Total # of facilities providing facility-based delivery services	SPA/WHO SARA (DHS Program 2015b; WHO 2014)	National facility survey—Observed availability, reported functionality, and location in service area or adjacent area	No recent report for Bangladesh and Malawi
Proportion of facilities providing facility-based delivery services with resuscitation table (with heat source) (for newborn resuscitation)	# of facilities providing facility-based delivery services with resuscitation table (with heat source) (for newborn resuscitation)	Total # of facilities providing facility-based delivery services	SPA/WHO SARA (DHS Program 2015b; WHO 2014)	National facility survey—Observed availability, reported functionality, and location in service area or adjacent area	No recent report for Bangladesh and Malawi
Proportion of health facilities with available required resuscitation equipment (bag and mask)	# of health facilities with available required resuscitation equipment (bag and mask)	Total # of health facilities under surveillance	Maternal and Child Health Integrated Program (MCHIP)	Newborn care surveillance system	Bangladesh
Proportion of health facilities with ready-to-use resuscitation equipment (bag and mask)	# of health facilities with ready-to-use resuscitation equipment (bag and mask)	Total # of health facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
# of health facilities with functioning NeoNatalie simulator	# of health facilities with functioning NeoNatalie simulator	Vary	DHIS 2	Supervision report	Malawi
# of health facilities equipped with at least one functioning Ambu bag	# of health facilities equipped with at least functioning Ambu bag	Vary	DHIS 2	Supervision report	Malawi

Inputs					
Functional equipment and guidelines					
# of health facilities equipped with functioning mask size 0	# of health facilities equipped with functioning mask size 0	Vary	DHIS 2	Supervision report	Malawi
# of health facilities equipped with functioning mask size 1	# of health facilities equipped with functioning mask size 1	Vary	DHIS 2	Supervision report	Malawi
# of health facilities equipped with functioning suction device—Electric	# of health facilities equipped with functioning suction device—Electric	Vary	DHIS 2	Supervision report	Malawi
# of health facilities equipped with functioning suction device—Manual	# of health facilities equipped with functioning suction device—Manual	Vary	DHIS 2	Supervision report	Malawi
# of health facilities equipped with functioning suction device—Penguin	# of health facilities equipped with functioning suction device—Penguin	Vary	DHIS 2	Supervision report	Malawi
# of health facilities equipped with a functioning wall clock/timer	# of health facilities equipped with a functioning wall clock/timer	Vary	DHIS 2	Supervision report	Malawi
Proportion of facilities that have bag and mask (infant size) for resuscitation—Size 0	# of facilities that have bag and mask (infant size) for resuscitation—Size 0	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi
Proportion of facilities that have bag and mask (infant size) for resuscitation—Size 1	# of facilities that have bag and mask (infant size) for resuscitation—Size 1	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi
Proportion of facilities that have suction bulb for mucus extraction	# of facilities that have suction bulb for mucus extraction	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi
Proportion of facilities that have towel or blanket to wrap baby	# of facilities that have towel or blanket to wrap baby	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi
Proportion of facilities that have HBB guidelines for newborns not breathing at birth	# of facilities that have HBB guidelines for newborns not breathing at birth	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi
Proportion of facilities that have HBB action plan posted on the wall in the labor and delivery area	# of facilities that have HBB action plan posted on the wall in the labor and delivery area	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi

Inputs					
Provider capacity/training					
Indicator	**Numerator**	**Denominator**	**Source**	**Method of data collection**	**Country**
Availability of health professionals with midwifery skills trained in neonatal resuscitation on duty in the labor and childbirth ward 24 hours a day, 7 days a week	Availability of health professionals with midwifery skills trained in neonatal resuscitation on duty in the labor and childbirth ward 24 hours a day, 7 days a week	Not applicable	WHO additional (not core) MNCH indicators (WHO and PMNCH 2014)	Suggested: Supervision checklist, observation	—
Proportion of facilities providing facility-based delivery services with at least one staff member providing the service who has ever received training in newborn resuscitation	# of facilities providing facility-based delivery services with at least one staff member providing the service who has ever received training in newborn resuscitation	Total # of facilities providing facility-based delivery services	SPA/WHO SARA (DHS Program 2015b; WHO 2014)	National facility survey: Interview response from in-charge of service area day of survey	No recent report for Bangladesh and Malawi
Proportion of maternity service providers that had training on subjects related to newborn care in the two years prior to the 2013 survey	# of maternity service providers that had training on subjects related to newborn care in the two years prior to the 2013 survey	Total # of maternity service providers in sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Interview of randomly selected maternity service providers from sampled facilities	Malawi
Proportion of maternity service providers that had training on resuscitation of newborns not breathing at birth in the two years prior to the 2013 survey	# of maternity service providers that had training on resuscitation of newborns not breathing at birth in the two years prior to the 2013 survey	Total # of maternity service providers in sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Interview of randomly selected maternity service providers from sampled facilities	Malawi
Proportion of maternity service providers that had newborn resuscitation training as part of the HBB initiative in the two years prior to the 2013 survey	# of maternity service providers that had newborn resuscitation training as part of the HBB initiative in the two years prior to the 2013 survey	Total # of maternity service providers in sampled facilities that had newborn resuscitation training in the two years prior to the 2013 survey	HBB performance evaluation (Gupta et al. 2014)	Interview of randomly selected maternity service providers	Malawi
Proportion of birth attendants that had formal training on the HBB curriculum	# of birth attendants that had formal training on the HBB curriculum	Total # of delivery service providers in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
Proportion of birth attendants that had on-the-job training on HBB	# of birth attendants that had on-the-job training on HBB	Total # of delivery service providers in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh

Processes					
Service delivery					
Indicator	**Numerator**	**Denominator**	**Source**	**Method of data collection**	**Country**
Proportion of births assisted by a health worker trained in and equipped for newborn resuscitation	# of births assisted by a health worker trained in and equipped for newborn resuscitation	Total # of women giving birth	WHO additional (not core) MNCH indicators (WHO and PMNCH 2014)	Suggested: Chart review	—
Proportion of babies that did not cry at birth in facilities under surveillance	# of babies that did not cry at birth in facilities under surveillance	Total # of live births in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
Proportion of babies that were suctioned in facilities under surveillance	# of babies that were suctioned in facilities under surveillance	Total # of live births in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
Proportion of babies that were stimulated in facilities under surveillance	# of babies that were stimulated in facilities under surveillance	Total # of live births in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
Proportion of babies that were ventilated with bag and mask in facilities under surveillance	# of babies that were ventilated with bag and mask in facilities under surveillance	Total # of live births in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
Proportion of babies that were referred due to asphyxia-related problem in facilities under surveillance	# of babies that were referred due to asphyxia-related problem in facilities under surveillance	Total # of live births in facilities under surveillance	MCHIP	Newborn care surveillance system	Bangladesh
# of deliveries in health facilities	# of deliveries in health facilities	Vary	DHIS 2	HBB/Maternity Register	Malawi
# of babies born alive in health facilities	# of babies born alive in health facilities	Vary	DHIS 2	HBB/Maternity Register	Malawi
# of asphyxiated babies in health facilities	# of asphyxiated babies in health facilities	Vary	DHIS 2	HBB/Maternity Register	Malawi
# of babies resuscitated in health facilities	# of babies resuscitated in health facilities	Vary	DHIS 2	HBB	Malawi
# of babies with asphyxia resuscitated successfully by drying and wrapping only	# of babies with asphyxia resuscitated successfully by drying and wrapping only	Vary	DHIS 2	HBB	Malawi
# of babies with asphyxia resuscitated successfully by clearing airway and stimulation	# of babies with asphyxia resuscitated successfully by clearing airway and stimulation	Vary	DHIS 2	HBB	Malawi
# of babies with asphyxia resuscitated successfully by bag and mask ventilation	# of babies with asphyxia resuscitated successfully by bag and mask ventilation	Vary	DHIS 2	HBB	Malawi
Percentage of newborns asphyxiated at birth that survive following resuscitation	# of newborns asphyxiated at birth that survive following resuscitation	Vary	HMIS	National HMIS	Malawi

Processes					
Supervision					
Indicator	**Numerator**	**Denominator**	**Source**	**Method of data collection**	**Country**
# of HBB-trained providers who received a supervision visit related to HBB in past three months	# of HBB-trained providers who received a supervision visit related to HBB in past three months	Vary	DHIS 2	Supervision report	Malawi
# of HBB-trained providers who can demonstrate how to use a bag and mask for resuscitation during a supervision visit for HBB	# of HBB-trained providers who can demonstrate how to use a bag and mask for resuscitation during a supervision visit for HBB	Vary	DHIS 2	Supervision report	Malawi
Proportion of health facilities that have an anatomic model (e.g., NeoNatalie) to use to practice resuscitation	# of health facilities that have an anatomic model (e.g., NeoNatalie) to use to practice resuscitation	Total # of sampled facilities	HBB performance evaluation (Gupta et al. 2014)	Inventory checklist in randomly selected health facilities in all 28 districts	Malawi
Proportion of maternity service providers that had the opportunity to practice resuscitating a newborn using a newborn anatomic model/doll	# of maternity service providers that had the opportunity to practice resuscitating a newborn using a newborn anatomic model/doll	Total # of maternity service providers trained on resuscitation of newborns	HBB performance evaluation (Gupta et al. 2014)	Interview of randomly selected maternity service providers from sampled facilities	Malawi
Proportion of maternity service providers that had the opportunity to practice resuscitating a newborn using a newborn anatomic model/doll in the last three months	# of maternity service providers that had the opportunity to practice resuscitating a newborn using a newborn anatomic model/doll in the last three months	Total # of maternity service providers trained on resuscitation of newborns	HBB performance evaluation (Gupta et al. 2014)	Interview of randomly selected maternity service providers from sampled facilities	Malawi
Proportion of maternity service providers that were supervised in in the past three months	# of maternity service providers that were supervised in in the past three months	Total # of maternity service providers trained on resuscitation of newborns	HBB performance evaluation (Gupta et al. 2014)	Interview of randomly selected maternity service providers from sampled facilities	Malawi

Outcomes					
Mortality					
Indicator	**Numerator**	**Denominator**	**Source**	**Method Of Data Collection**	**Country**
Facility NMR disaggregated by birth weight: > 4000 g, 2500–3999 g, 2000–2499 g, 1500–1999 g, < 1500 g	# of neonatal deaths by category of birth weight: > 4000 g, 2500–3999 g, 2000–2499 g, 1500–1999 g, < 1500 g	Total # of live births in the health facility segregated by birth weight	WHO global core indicators to measure quality of MNCH care in health facilities (Mathai 2014)	Suggested: Hospital statistics: Charts, internal monitoring system	—
# of fresh stillbirth rate	# of normally formed stillbirths with no signs of maceration in the preceding three months	Total # of births in the facility in the past three months	WHO additional (not core) MNCH indicators (WHO and PMNCH 2014)	Suggested: Review of registers, monthly summaries	—
Proportion of neonatal deaths audited	# of neonatal deaths audited	Total # of neonatal deaths	WHO additional (not core) MNCH indicators (WHO and PMNCH 2014)	Suggested: Monthly reports of quality improvement team	—
# of fresh stillbirths in health facility	# of fresh stillbirths in health facility	Vary	DHIS 2	HBB	Malawi
# of deaths due to asphyxia in health facilities	# of deaths due to asphyxia in health facilities	Vary	DHIS 2	HBB	Malawi

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