Technical Brief

Advancing routine Health Management Information systems (HMIS) to deliver for Every Newborn (En-Birth study phase 2): Assessing the feasibility of incorporating and exploring data quality and utility for selected maternal and newborn indicators in Kushtia

Key authors Dr. Ahmed Ehsanur Rahman, Ms. Shema Mhajabin, Dr. Shafiqul Ameen, Dr. Shams El Arifeen

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BACKGROUND

Every year an estimated 2.5 million new-borns die in the world we are living, along with another 2.6 million stillbirths and 0.3 million maternal deaths (4,5). Though significant improvements have been made globally in reducing child mortality in the Millennium Development Goals (MDG) era, the rate of reduction of neonatal mortality was much slower than that of child mortality (1). Moving forward from the MDG-era, the Sustainable Development Goals (SDGs) have set targets to reduce the national neonatal mortality rate (NMR) to ≤12 per 1,000 live births, the stillbirth rate to ≤12 per 1,000 total births, and the maternal mortality ratio (MMR) ≤70 per 100,000 live births by 2030 (2,3). Achieving these ambitious 2030-targets will require accelerated rates of progress through the reshaping of existing strategies and consorted efforts by the global communities, development partners, and governments. Therefore, it becomes crucial to track the real-time progress of these national and global efforts toward the reduction of NMR and MMR, improving service coverage, enhancing the quality of services, and achieving equity.

One of the main challenges is the lack of availability of reliable and high-quality data at the community, regional, national, and global levels that can track the progress towards national and international efforts like SDGs, Every Newborn Action Plan (ENAP), and Ending Preventable Maternal Mortality (EPMM) targets. Since data improvement will be fundamental for more rapid progress, ENAP included specific and ambitious milestones to improve data for use by 2030. A five-year, multi-partner ENAP Measurement Improvement Roadmap was developed to integrate the proposed set of core and additional indicators into routine health management information system (HMIS), improve their measurements, and track their progress (1,2).

National HMISs are being strengthened in high-burden countries, and the health care providers (HCPs) in these countries are routinely recording MNH data. However, the primary source of impact and coverage data for women and children remains population-based household surveys in these countries. The most employed household surveys are the United States Agency for International Development (USAID)-supported Demographic and Health Survey (DHS) (10) and the United Nations International Children's Emergency Fund (UNICEF)-supported Multiple Indicator Cluster Survey (MICS). Coverage of many MNH interventions cannot feasibly and/or accurately be collected through household surveys due to data quality which usually depends on the validity of the mother's report, often between two and five years after the birth. There is also evidence that household surveys may not accurately capture clinical

interventions during labor and the immediate postpartum period (3,4). Furthermore, surveys are costly and intermittent, implemented every 3–5 years, limiting their utility.

Therefore, with investment from Children's Investment Fund Foundation (CIFF), the London School of Hygiene and Tropical Medicine (LSHTM) co-ordinated the multi-country *Every Newborn - Birth Indicators Research Tracking in Hospitals (EN-BIRTH) study - phase 1* (2015–19) to test the validity of recording coverage indicators of priority facility-based maternal and newborn interventions for use in routine HMIS by comparing routine registers (as a proxy to HMIS) and exit interviews (as a proxy to household surveys) (5). Coverage indicators included uterotonics to prevent postpartum hemorrhage, early initiation of breastfeeding, newborn bag-mask-ventilation, kangaroo mother care (KMC), and antibiotic treatment for newborn infections. The EN-BIRTH phase-1 study was implemented in five hospitals in Bangladesh, Nepal, and Tanzania between 2017 and 2019. The results of the study show that the documentation practice for the majority of facility-based interventions in the selected high-volume secondary- and tertiary-level hospitals are valid and comparable to or better than maternal exit interviews (proxy to surveys) (6).

Capturing MNH information through routine HMIS is complex and depends greatly on the overall health systems readiness and culture around documentation and data use. The public health systems of Bangladesh are constituted by different types of health facilities where services are rendered through various types of HCPs (7). The reporting structure and mechanisms also differ by various types of health facilities and by different contact points. Therefore, it is important to understand the complex documentation practices, data culture, use, and capacity of HMIS at different facility tiers before integrating the data elements required for capturing EN-BIRTH phase-1 validated indicators in HMIS and before country adaptation and scale-up. Moreover, integrating the data elements in existing registers, reporting forms, and dashboards, the utility felt by health service providers, health managers and policymakers regarding the indicators and early implementation experience need to be explored and documented for potential harmonization of such efforts in similar settings.

Therefore, EN-BIRTH phase 2 has been designed to address the following research objectives in the context of Bangladesh:

OBJECTIVE

GENERAL OBJECTIVE:

To develop and implement a Toolkit for systematically assessing the availability of MNH data elements in the existing HMIS and explore the feasibility of incorporating data elements required for capturing EN-BIRTH phase-1 validated indicators through HMIS.

SPECIFIC OBJECTIVES:

1. To develop a global and a national level protocol for this study
2. To develop and implement an EN-MINI toolkit

SPECIFIC OBJECTIVE ONE: TO DEVELOP A NATIONAL-LEVEL PROTOCOL FOR THIS STUDY

Developing a national-level protocol for this study: The concept note was developed through a couple of online meetings conducted between September-December 2019 with the active participation of icddr,b, London School of Hygiene and Tropical Medicine (LSHTM), Ifakhara Health Institute (IHI), and Data for Impact (D4I) team members. The meetings were conducted to discuss the project activities, budget, and administrative aspects. In December 2019, the first consultative workshop with national-level newborn program managers and deputy program managers were organized in Bangladesh to share the study ideas and methodology and for their feedback. Later, field visits were conducted to understand the documentation process required for expanding the concept note.

In January 2020, icddr,b team members developed and shared the first draft of the protocol with the global team members for their review and feedback. After incorporating feedback and comments, the updated protocol was submitted for IRB approval in February 2020 at icddr,b. In late March 2020, the protocol received Research Review Committee (RRC) approval and the Ethical Review Committee (ERC) approval in early April 2020. The brief national-level protocol is also attached in Annex 1.

Developing a Global level protocol for this study: A total of six implementation workshops were organized online for the global team members to develop a global protocol and to develop a national level protocol for IHI, Tanzania. icddr,b team members presented the IRB-approved full protocol including details on study methodology and implementation plans. All the tools were shared and discussed during the workshops.

The global full protocol received IRB approval from the University of North Carolina in September 2020 and from LSHTM in early June 2021. The national level protocol for IHI, Tanzania was approved in April 2021.

SPECIFIC OBJECTIVE TWO: TO DEVELOP AN EN-MINI TOOLKIT

Map Newborn Data: The EN-MINI Tool 0 is designed to MAP newborn data in the selected context as it moves up the data pyramid from the facility registers and up the data pyramid (Figure 1). EN-MINI Tool 0 is a novel MAPPING tool that generates an automated report showing newborn data elements as they move up the data pyramid.

Use Newborn Data for decisions: Four EN-MINI Tools (Figure 1) address USE Newborn Data for decision-making. The PRISM tools designed by MEASURE Evaluation were adapted to assess the RHIS system. The adaptations were focused on core newborn indicator measurement with ready-to-use digital data collection tools.

Improve Newborn Data quality: The two EN-MINI tools (Figure 1) address IMPROVE Newborn Data Quality, and they were also adapted from PRISM tools with ready-to-use digital data collection. The details of the EN-MINI tool are available at the following link (https://www.data4impactproject.org/resources/en-mini-tools/use-newborn-data-for-decisions/).

METHODS

STUDY SITE

The EN-MINI tools were piloted and tested in the Kushtia District of Bangladesh. The EN-MINI pilot study was done at all levels of health facilities that provide inpatient services for newborns. This was done to learn as much as possible so that the study could be expanded in the future across the country and beyond.

The health care system in Bangladesh can be broken down into six different levels: national, divisional, district, upzilla, and ward. Tertiary level referral hospitals are located in medical college hospitals, which are located at the district level. District hospitals serve as secondary-level referral hospitals. At the sub-district level, the Upazila Health Complexes (UHCs) serve as the primary level of referral hospitals. Union Health and Family Welfare Centers, often

known as community clinics, are the names given to health centers that are located below the sub-district level (CCs). The public health system in Bangladesh includes MCWCs in every district and subdistrict, in addition to all these other types of institutions.

We chose to look at the Khustia district in the Khulna division for this evaluation. Twenty-one health care facilities were chosen from the sample frame listed as all public government health facilities. We chose 1 district hospital (DH), 5 Upazila health complexes (UHC), 1 mother and child welfare center (MCWC), 5 Union sub-centers (USC), 4 union health, and family welfare centers (UH&FWC), and 5 community clinics (CCs). DHs and UHCs were chosen based on the census. In a consultative workshop with stakeholders, the USC, UH&FWC, and CCs, were selected with the help of the deputy director of the district hospital, a civil surgeon, and Upazilla health and family planning officers. USCs were selected as it offers IMCI and newborn sepsis services which are related to the indicators. The UH&FWC and CC were chosen purposively as they offer delivery services. We made it clear that we've decided to count UHC as a district facility, as defined by the PRISM assessment tool. Therefore, the District office (n=6) and lower-level health facilities (n=15) were selected for the PRISM assessment. All the participants who were able to record, report, analyze, and use data were selected.

METHODS USED IN THE STUDY

DESK REVIEW

A comprehensive desk review was conducted to identify the primary indicators related to newborn health. One fifty-five indicators were identified for newborn health. Among them, five indicators were selected as core indicators for the study based on the consultative workshops and meetings with the national and international stakeholders. The indicators were focusing on neonatal mortality, early postnatal care for babies, essential newborn care (tracer, early breastfeeding), neonatal resuscitation, kangaroo mother care, and treatment of serious neonatal infections. The numerator and denominator for each indicator were also identified through the desk review.

HEALTH FACILITY ASSESSMENT

A Health Facility assessment survey was conducted in each health facility to determine the infrastructural (physical, clinical, and organizational aspects) and functional gaps (infrastructure, human resources, basic equipment, medications, and diagnostic capacities) related to maternal and newborn health services and existing documentation practices. A

functional infrastructure, for instance, would have a service contact point (a room or building), a water source, a power source, and an active communication system. The instrument used for the 2017 Bangladesh Health Facility Survey, which has received international validation and is currently being used in more than 30 countries, will be modified for this usage with an emphasis on "readiness for measurement."

DATA EXTRACTION

Data extraction was conducted to measure the data quality in terms of accuracy, completeness, and timeliness for the selected validated indicators. EmONC, KMC, SCANU, and IMCI registers, hard copy reports, and DHIS 2 reports were collected and cross-checked to measure the data quality.

WORKLOAD INDICATOR OF STAFFING NEED (WISN)

This study assessed the current workload and staffing requirements of the study site to deliver the best feasible healthcare services. The main idea was to identify components that can affect the service provider performance such as the standard workload, category allowance factor, individual allowance factor, and the total number of required staff for the selected health facilities. This study employed desk review, qualitative methods such as interviews and observations, and document reviews to gain an idea and understanding of the staffing needs. According to the desk review of previous studies and collected data from forty in-depth interviews workload components and activity, standards were defined. The defined components were cross-checked with the health facility document review. WISN difference and WISN ratio were estimated using WHO Workload Indicator of Staffing Need (WISN) software.

TIME MOTION STUDY

A time-motion study was conducted to observe the healthcare providers' time required for providing healthcare, documenting the process, and preparing the reports. Twenty-seven participants were observed for a whole week and almost 6 hours a day. The participant was observed through a tab-based structured observation checklist and the data was analyzed through STATA 16 software.

KEY INFORMANT INTERVIEW (KII)

Forty-two Key Informant Interview was conducted to understand the experience and perception of healthcare providers in terms of data collection, data compilation, data analysis, data quality, existing monitoring and supervision system, and data use for decision making. The interviews were conducted in Bangla, transcribed verbatim, and translated into English. A priory code was made based on the PRISM framework. During the coding emerging codes are also included. Data was coded in NVIVO 12 pro software and analysed thematically.

EN-MINI PRISM TOOL

RHIS Overview EN-MINI-PRISM Tool 1: This tool examines technical determinants, including the structure and design of existing information systems for newborns, information flows, and interaction of different information systems. It looks at the extent of RHIS fragmentation and redundancy and helps to initiate discussion of data integration and use.

RHIS Performance Diagnostic EN-MINI-PRISM Tool 2: This tool determines the overall level of RHIS performance, the level of data quality, and the use of information. This tool also captures technical and organizational determinants, such as indicator definitions and reporting guidelines, the level of complexity of data collection tools and reporting forms, and the existence of data-quality assurance mechanisms, RHIS data use mechanisms, and supervision and feedback mechanisms.

Electronic RHIS Functionality and Usability Assessment EN-MINI-PRISM Tool 3: This tool examines the functionality and user-friendliness of the technology employed for generating, processing, analysing, and using routine health data.

Management Assessment EN-MINI-PRISM Tool 4:The Management Assessment Tool (MAT) takes rapid stock of RHIS management practices and supports the development of action plans for better management.

Facility/Office Checklist EN-MINI-PRISM Tool 5: This checklist assesses the availability and status of resources needed for RHIS implementation at supervisory levels.

Organizational and Behavioural Assessment Tool EN-MINI-PRISM Tool 6: The Organizational and Behavioural Assessment Tool (OBAT) questionnaire identifies behavioural and organizational determinants, such as motivation, RHIS self-efficacy, task competence, problem-solving skills, and the organizational environment promoting a culture of information.

OUTPUT

OUTPUT ONE: NATIONAL PROTOCOL

Background: Reducing maternal and neonatal mortality and stillbirth remains a slow-going process, with more than five million deaths of women and babies each year. Accurate data is necessary for monitoring progress toward the Sustainable Development Goals (SDGs). Achieving the 2030-SDG targets will require accelerated rates of reduction through consorted efforts. Routine registers' data are often aggregated as source data for the Health Management Information System (HMIS). HMIS is one of the six health system building blocks, yet optimal content or design for data recording and reporting lacks evidence and cohesive global guidance. Therefore, it is necessary to further explore how to improve routine data availability and quality linking to data use and utility whilst not increasing the burden on frontline health workers. Every Newborn Birth Indicators Research Tracking in Hospitals (EN-BIRTH) phase 2, a two-year feasibility and implementation research study in Bangladesh and Tanzania, seeks to assess the content, quality, and flow of routine HMIS data for newborns and women from the health facility level up to the HMIS data pyramid and explore the acceptability, appropriateness, fidelity, feasibility, and costs of the Every Newborn Action Plan (ENAP) indicator integration in the national HMIS. This protocol is specific to the methodology adopted for Bangladesh.

Method: The study will be conducted in selected public health facilities of the Kushtia district in Bangladesh. To understand the current data flow structure and documentation practice in national HMIS, a comprehensive analysis, and facility visits will be conducted. The accuracy, completeness, and timeliness of data will be evaluated by conducting data extraction from the data sources. The resource requirement for data capturing will be conducted at three levels; an environmental scan of health facility readiness will be captured through health facility assessments, the workload of health care professionals for data capturing will be assessed using a time-motion study and workforce indicators of staffing need (WISN) and cost of data

capturing will be identified through document review and interviews. The quantitative analysis will be used to evaluate the data quality and resources available. Through a qualitative approach, the perceived utility of data will be analysed and measured.

The strength of this study:

- This study is the first of its nature to systematically assess the availability of maternal and newborn health (MNH) data elements in existing HMIS and explore the feasibility of incorporating data elements required for capturing selected ENAP indicators through HMIS.

- The strength of this implementation study is that it will use an exploratory research design and will collect data using both quantitative and qualitative approaches to meet the objectives of the study.

- This study will develop and implement a Toolkit, a resource for assessing the routine information systems for low-income countries.

- The burden of MNH documentation on the health workers will be assessed.

- The quality of data captured at different levels of the health facility and factors affecting the data quality will be identified.

- The utility of collected routine data among health professionals and policymakers will be explored.

Limitations of this study: This study will take place in only one of the Bangladeshi districts, which may not present a holistic picture of national HMIS. However, as this study is exploratory and implementation research, representation of facilities or HMIS should not be an issue.

OUTPUT TWO: EN-MINI TOOLKIT

Every Newborn-Measurement Improvement for Newborn & Stillbirth Indicators (EN-MINI) tools were designed and developed to advance newborn data in routine health information systems (RHIS) to support the Every Newborn Action Plan (ENAP) (Figure 1). The tools are free, easy to use, and generate automated reports for sub-national and national use through collaborative implementation research by The London School of Hygiene & Tropical Medicine UK, Ifakara Health Institute Tanzania, icddr,b Bangladesh, USAID, Bangladesh, and D4I. An EN-BIRTH expert advisory group of colleagues from WHO, UNICEF, the national governments of Bangladesh and Tanzania, and additional program newborn and measurement experts and academics provided important guidance from time to time.
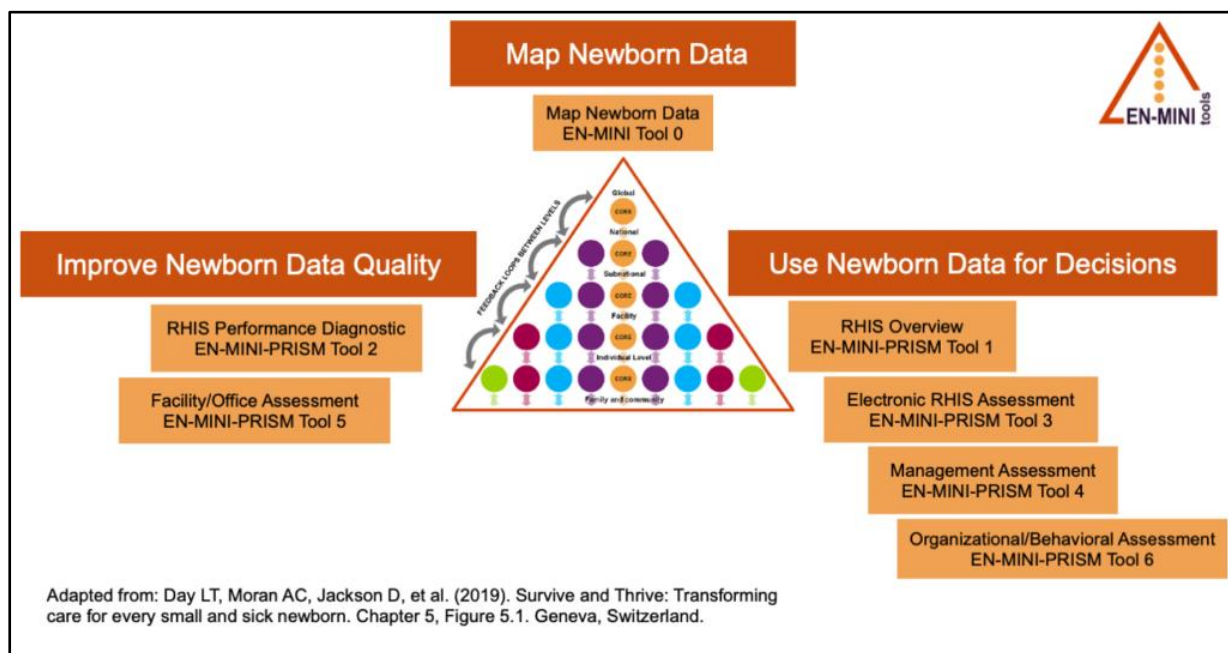
Figure 1: EN-MINI tools in an infographic
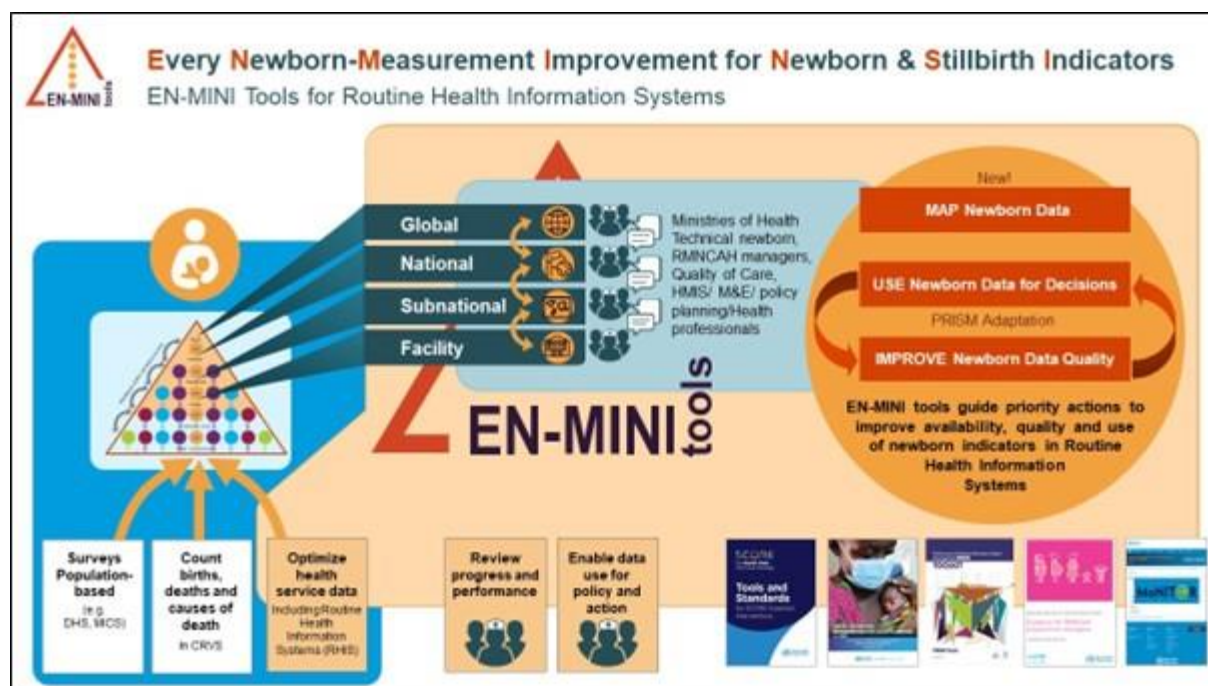
The EN-MINI tools focus on core newborn indicator measurement shown as the yellow data point circles in the center of the data pyramid in Figure 2. EN-MINI tools comprehensively measure RHIS performance for core newborn and stillbirth indicators collected at health facilities. The EN-MINI tools are intended to identify gaps in newborn and stillbirth RHIS data availability, quality, and use.

EN-MINI tools assess RHIS performance for data collected from the health facility up to sub-national and national levels for tracking. EN-MINI currently includes seven tools (Figure 2) ideally implemented as a package but can be used individually for your needs. The tools are organized into three categories: MAP newborn data availability, assess USE of newborn data for decisions and identify how to IMPROVE newborn data quality (Figure 2). The USE and IMPROVE tools are adapted from the Performance of Routine Information System Management (PRISM) series. The details of the EN-MINI tool are available at the following link (https://www.data4impactproject.org/resources/en-mini-tools/map-newborn-data/).

Figure 2: Name of the EN-MINI tools

Adapted from: Day LT, Moran AC, Jackson D, et al. (2019). Survive and Thrive: Transforming care for every small and sick newborn. Chapter 5, Figure 5.1. Geneva, Switzerland.

IMPACT OF EN-MINI TOOL

The EN-MINI toolkit aims to build the technical and organizational capacity of the country to collect, analyze, and apply data to support their sustainable development to gather and use high-quality data to improve country programs, policies, and ultimately health outcomes. The toolkit has a significant impact on Bangladesh and the Global context. For maximum impact, the findings and lessons learned from the country context were disseminated including the national government and international organizations through a webinar. 'Every Newborn-Measurement Improvement for Newborn & Stillbirth Indicators (EN-MINI) Tools for Routine Health Information Systems: Ensuring the right data at the right time and at the right level of the health care system to accelerate progress for newborn health' which had a successful impact across the national and global level participants.

In Bangladesh, we disseminate the tool and findings to the national government. The National Newborn Health Program and Integrated Management of Childhood Illness (NNHP & IMCI) agreed and adopted the tool into their routine information system to get improved and quality data related to newborns. The EN-MINI tool is globally available (in the following link (https://www.data4impactproject.org/resources/en-mini-tools/map-newborn-data/).) The tool and findings were also shared with the World Health Organization, which is interested to

endorse the EN-MINI toolkit as their official toolkit. The discussion is still going on and the team is hopeful that, World Health Organization will endorse the toolkit as the official toolkit.

ANNEX 1: BANGLADESH PROTOCOL

BACKGROUND

We live in a world where an estimated 2.5 million newborns die every year, along with another 2.6 million stillbirths and 0.3 million maternal deaths (4,5). Though significant improvements have been made globally in reducing child mortality in the Millennium Development Goals (MDG) era, the rate of reduction of neonatal mortality was much slower than that of child mortality (1). Moving forward from the MDG-era, the Sustainable Development Goals (SDGs) have set targets to reduce the national neonatal mortality rate (NMR) to ≤12 per 1,000 live births, the stillbirth rate to ≤12 per 1,000 total births, and the maternal mortality ratio (MMR) ≤70 per 100,000 live births by 2030 (2,3). Achieving these ambitious 2030-targets will require accelerated rates of progress through the reshaping of existing strategies and consorted efforts by the global communities, development partners, and governments. Therefore, it becomes crucial to track the real-time progress of these national and global efforts toward the reduction of NMR and MMR, improving service coverage, enhancing the quality of services, and achieving equity.

One of the main challenges is the lack of availability of reliable and high-quality data at the community, regional, national, and global levels that can track the progress towards national and international efforts like SDGs, Every Newborn Action Plan (ENAP), and Ending Preventable Maternal Mortality (EPMM) targets. Since data improvement will be fundamental for more rapid progress, ENAP included specific and ambitious milestones to improve data for use by 2030. A five-year, multi-partner ENAP Measurement Improvement Roadmap was developed to integrate the proposed set of core and additional indicators into routine health management information systems (HMIS), improve their measurements and track their progress (1,2).

National HMIS' are being strengthened in high-burden countries, and the health care providers (HCPs) in these countries are routinely recording MNH data. However, the primary source of impact and coverage data for women and children remains population-based household surveys in these countries. The most employed household surveys are the United States Agency for International Development (USAID)-supported Demographic and Health Survey (DHS) (10) and the United Nations International Children's Emergency Fund (UNICEF)-supported Multiple Indicator Cluster Survey (MICS). Coverage of many MNH interventions cannot feasibly and/or accurately be collected through household surveys due to data quality which usually depends on the validity of the mother's report, often between two and five years after

the birth. There is also evidence that household surveys may not accurately capture clinical interventions during labor and the immediate postpartum period (3,4). Furthermore, surveys are costly and intermittent, implemented every 3–5 years, limiting their utility.

Therefore, with investment from Children's Investment Fund Foundation (CIFF), the London School of Hygiene and Tropical Medicine (LSHTM) co-ordinated the multi-country *Every Newborn - Birth Indicators Research Tracking in Hospitals (EN-BIRTH) study - phase 1* (2015–19) to test the validity of recording coverage indicators of priority facility-based maternal and newborn interventions for use in routine HMIS by comparing routine registers (as a proxy to HMIS) and exit interviews (as a proxy to household surveys) (5). Coverage indicators included uterotonics to prevent postpartum haemorrhage, early initiation of breastfeeding, newborn bag-mask-ventilation, kangaroo mother care (KMC), and antibiotic treatment for newborn infections. The EN-BIRTH phase-1 study was implemented in five hospitals in Bangladesh, Nepal, and Tanzania between 2017 and 2019. The results of the study show that the documentation practice for the majority of facility-based interventions in the selected high-volume secondary- and tertiary-level hospitals are valid and comparable to or better than maternal exit interviews (proxy to surveys) (6).

Capturing MNH information through routine HMIS is complex and depends greatly on the overall health systems readiness and culture around documentation and data use. The public health systems of Bangladesh are constituted by different types of health facilities where services are rendered through various types of HCPs (7). The reporting structure and mechanisms also differ by various types of health facilities and by different contact points. Therefore, it is important to understand the complex documentation practices, data culture, use, and capacity of HMIS at different facility tiers before integrating the data elements required for capturing EN-BIRTH phase-1 validated indicators in HMIS and before country adaptation and scale-up. Moreover, integrating the data elements in existing registers, reporting forms, and dashboards, the utility felt by health service providers, health managers and policymakers regarding the indicators and early implementation experience need to be explored and documented for potential harmonization of such efforts in similar settings.

Therefore, EN-BIRTH phase 2 has been designed to address the following research objectives in the context of Bangladesh:

GENERAL OBJECTIVE:

To develop and implement a Toolkit for systematically assessing the availability of MNH data elements in the existing HMIS and explore the feasibility of incorporating data elements required for capturing EN-BIRTH phase-1 validated indicators through HMIS.

SPECIFIC OBJECTIVES:

1. To explore the availability and gaps in data elements required for capturing all ENAP indicators with a particular focus on EN-BIRTH phase-1 validated indicators through HMIS

2. To assess the quality of recording and reporting data elements required for capturing EN-BIRTH phase-1 validated indicators through HMIS

3. To identify the resource requirements for capturing EN-BIRTH phase-1 validated indicators through HMIS

4. To understand the utility of capturing EN-BIRTH phase-1 validated indicators through HMIS

5. To develop a toolkit

METHODS

STUDY DESIGN

This study proposes to conduct implementation research adopting an exploratory design. This study will employ both quantitative and qualitative methods of data collection to address the research objectives.

FORMATIVE RESEARCH

Formative research will be conducted to gain a better understanding of the context and usual practice of the health workers and the feasibility of conducting this study with the proposed design and method. This will help finalize the data flow gap analysis matrix (heat map structure), the data collection tools, the process and duration of the time-motion study, the process, frequency, and duration of data extraction from hospital records, and the documents required for data extraction. Based on the formative research findings, necessary modifications in the study protocol and data collection tools will be made, if necessary. In case of a major change, necessary approval from the Research Review Committee (RRC) and Ethical Review Committee (ERC) of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) will be sought.

STUDY SETTING

The study will be conducted in selected public health facilities of the Kushtia district in Bangladesh (Table 1). Kushtia is bounded on the north by the Rajshahi district and the east by the Pabna and Rajbari districts. It shares a small international border with India. The population of Kushtia was 19, 86, 344 in 2011 (Table 1). There are five Upazilas in the selected district.

Table 1: A brief description of the proposed districts according to the 2011 Census is presented below:

|	Kushtia District	
Area	1,608.8	sq.km
Population	19,86,344	
Births per year (estimated) **Health Bulletin, 2016**	43,360	

HEALTH FACILITY SELECTION

Public health facilities that provide the selected interventions of interest (uterotonic use immediately after birth, antenatal corticosteroids, neonatal resuscitation, KMC, and treatment of serious newborn infections), are in line with the current World Health Organization (WHO) and National recommendations and are recording the use of these interventions either via standard birth and delivery registers, ward/discharge registers or other hospital-level records, will be selected.

The Ministry of Health and Family Welfare (MoHFW) has two directorates for health service delivery. They are the Directorate General of Health Services (DGHS) and the Directorate General of Family Planning (DGFP). Both DGHS and DGFP focus on providing MNH services, but one of the prime mandates of DGFP is to promote and provide family planning services. Under these two directorates, the public health systems in Bangladesh have three tiers of referral hospitals and two types of health centers. At the district level, there are Medical College Hospitals as tertiary level referral hospitals and District Hospitals (DHs) as secondary level referral hospitals with 250–500 beds. At the sub-district level, there are Upazila Health Complexes (UHCs) as primary level referral hospitals with 50 beds. Below the sub-district level, there are Union Sub-Centres (USC) of DGHS and Union Health and Family Welfare Centres (UH&FWCs) from DGFP. In most USCs, delivery and newborn services are not provided, whereas all UH&FWCs offer these services. At the population level, there are

Community Clinics (CCs) that are used as health centers. In addition, there are Maternal and Child Welfare Centres (MCWCs) of DGFP in all districts and a few sub-districts with 10 beds. Although all these health facilities offer basic maternal and newborn services, the provision of care varies at different types of facilities. Within the referral hospitals, MNH services are provided through different contact points (antenatal care, ANC corner; Integrate management of Childhood Illness, IMCI corner; labor and delivery ward; Kangaroo mother care, KMC corner; pediatric inpatient ward, etc.) by different kinds of service providers, whereas primary health facilities (some USCs and all UH&FWCs) have 1–2 beds to provide care for pregnant women and newborns.

Therefore, from the Kushtia district, one DH, one MCWC, five UHCs, five USCs, five UH&FWCs, and five CCs will be selected. (Figure 1).

Figure 1: Selected health facilities from the Kushtia districts
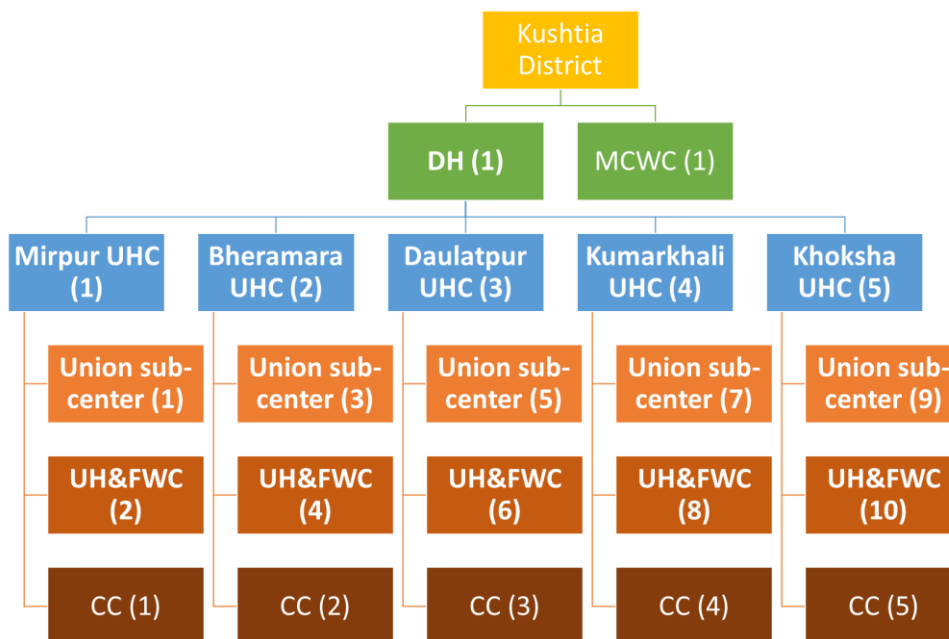
STUDY POPULATION

Our study population will be professionals involved in capturing selected indicator data for use in the national HMIS/DHIS2.

- Data recording: Doctors, nurses/midwives, and paramedics are responsible for documenting the clinical care they have provided related to maternity and newborns in the selected health facilities.

- Data reporting: Nurses/midwives and statistical officers are responsible for reporting data related to maternal and newborn health in the selected health facilities.

- Data analysis: Statisticians and programmers responsible for data analysis at local and national levels.

- Data use at all levels of the health system
  - District and Upazila (sub-district)-level health managers, Ministry of Health (MOH) manager, and policymakers (MNH and HMIS)
  - Development partners supporting MOH in improving MNH (WHO, UNICEF, United Nations Populations Fund (UNFPA), Save the Children, icddr,b, etc.)
  - Health workers at the facility level (HCPs and statisticians)

SAMPLE SIZE

The following equation is used to calculate the sample size:

$$n = Z^2 * P * (1-P)/d^2$$

Here, Z = the critical value of the standard normal distribution of confidence level (1-α), P = proportion of attribute, d = error margin or precision level, and n = required sample size.

Assuming a maximum variance in documentation (P = 50%) and accepting a 5% error margin (d = 5%), the required sample size at 95% confidence interval (Z = 1.96) is 384. The sample size will be **384 records**. It means that we will require 384 records generated altogether from each service register (Emergency Obstetric Newborn Care (EmONC), KMC, IMCI, and CC registers) from the selected facilities.

Table 2: Sample size for records

Type of facility	Reports collected per facility per month	Number of facilities	Reports collected per month	Total records for a year
DH	3 (EmONC, KMC & IMCI)	1	3	36
MCWC	Not applicable			
UHC	3 (EmONC, KMC & IMCI)	5	15	180
USC	1 (IMCI)	5	5	60
UH&FWC	Not applicable			
CC	Form 3 and Form 2	5	10	120
Total reports per month			**23**	**396**

DETAILED METHODS FOR EACH OF THE OBJECTIVES ARE PRESENTED BELOW

Specific objective 1 – gaps in provision: To explore the availability and gaps in data elements required for capturing all ENAP indicators with a particular focus on EN-BIRTH phase-1 validated indicators through HMIS

Availability of data elements in service registers and reporting forms: A document review will focus on identifying the availability of each numerator and denominators for all ENAP indicators with a special focus on selected validated EN-BIRTH phase-1 indicators in MNH service registers and reporting forms. The document review will also explore the availability of ENAP indicators in national documents, such as strategies, guidelines, etc. The information from the document review will be listed and mapped in an Excel file.

Data Flow: A comprehensive desk review, facility visits, and key informant interviews (KII) will be conducted to understand the existing data flow system in the national HMIS/District Health Information System 2 (DHIS2) for selected health facilities. PRISM module 1, routine health information systems (RHIS) overview tool (8), will be used to gather information on the HMIS/DHIS2 of Bangladesh. Data flow diagrams will be generated to understand the processes from recording to use.

Sensitization workshops: Several sensitization workshops will be organized with MOH managers, policymakers (MNH and HMIS), and development partners supporting the MOH in

improving MNH data measurement to present document review findings for further input on the data availability (numerators and denominators) of all ENAP indicators.

National HMIS integration and facility demonstration: A series of consultative workshops will be organized with relevant stakeholders (MOH and development partners) to integrate relevant nominators or denominators for capturing selected indicators before the national scale-up. A country action plan will be developed to modify the data recording and reporting system to address existing data capturing gaps and reduce redundant data elements through these workshops. The role of different stakeholders will be clarified. The modified data capturing system will be implemented in selected facilities as initial demonstration sites for early program learning.

Summary of the selected indicator: A heat map will be developed to summarise the availability of numerators and denominators of the ENAP indicators in the national HMIS/DHIS2. A heat map is a graphical representation of gaps where the individual values/information contained in a matrix are represented with different colors (green, blue, and red). An illustrative example of this heat map is presented below:

Indicator	Union Health Centre	Upazila (sub-district) Hospital	District Hospital	National DHIS2 Database	National DHIS2 Dashboard
Number of women who received uterotonic					
Number of women with uterotonic					
The total number of women delivered					
Indicator-2					
Numerator					
Denominator					

Options:

| Green: Currently available |
| Blue: Partially available (needs modification) |
| Red: Not available |

Existing maternal and newborn health indicators in the national HMIS/DHIS2 will also be heat mapped and their relevance to the Every Newborn Measurement Improvement Road Map. An illustrative example of this heat map is presented below.

MNH variable available in the national HMIS database	ENAP core Impact Indicator	ENAP core Coverage Indicator	ENAP Input Indicator	Indicators mentioned in other global or national documents	Indicators mentioned in other national documents (Sector Programme, Newborn Health Strategy, Child Health Strategy, etc.)
Variable-1					
Variable-2					
Variable-3					
Variable-4					
Variable-5					
Variable-6					

Options:

Green: Directly required to report on the selected indicator

Blue: Partially required to report on the selected indicator

Red: Not required to report on any indicator

Specific objective 2 – data quality: To assess the quality of recording and reporting data elements required for capturing EN-BIRTH phase-1 validated indicators through HMIS.

The quality of data will be primarily assessed through data extraction. PRISM module 2A, RHIS performance diagnostic tool – district level, and 2B, RHIS performance diagnostic tool – health facility level will be adapted as data extraction tools (8). The data collectors will be trained to extract data from the source registers and reports of designated ENAP indicators from the selected health facilities.

KIIs will be conducted with the HCPs, health managers, and statisticians who are involved with the data collection in the service registers, preparing data for monthly reports, reviewing the monthly reporting forms, and uploading those in HMIS/DHIS2 to understand the data flow process, opportunities, gaps and challenges of MNH data collection and reporting.

Specific objective 3 – resource requirement: To identify the resource requirements for capturing EN-BIRTH phase-1 validated indicators through HMIS

Assessment of resources required will be conducted at three levels, such as the logistics required for data capturing through the environmental scan of the health facilities, workload assessment of the HCPs, and cost of data capturing.

Environmental scan of the health facilities: A modified health facility assessment will be conducted in each of the selected health facilities to assess the structural and functional gaps

(infrastructure, human resources, basic equipment, medicines, and diagnostic capacities) related to MNH services and relevant documentation practices. Infrastructure regarding data capturing refers to the physical, clinical, and organizational aspects. For example, a functional infrastructure will be where a service contact point (a room/a building), water source, power supply, and communication system are available. The tool used for the Bangladesh Health Facility Survey 2017 (BHFS 2017; internationally validated and used in more than 30 countries) will be adapted for this purpose and include a specific focus on "readiness for measurement" (13) (Annex-7).

As the BHFS 2017 tool lacks variables to assess the information system of public health facilities, we will develop an information system module. First, a document review of existing health facility assessment tools like Service Availability and Readiness Assessment (SARA), Service Provision Assessment (SPA), NEST-UNICEF 360 (9), and Performance of Routine Indicator System Measurement (PRISM) (8,10,11) will be conducted. Then, the required variables will be identified to assess the information system from the existing tools. After identifying the required variables, meetings and workshops will be organized to finalize the variables and tool structure. The final information system module will be tested in the facilities and then used to collect information from the selected health facilities.

PRISM module 3: Electronic RHIS performance assessment, and PRISM module 5: facility/office checklist, will be used for data collection. PRISM module 3 collects information on the functionality and user-friendliness of the technology employed for generating, processing, analyzing, and using routine health data. PRISM module 5 collects information on the availability and status of resources needed for RHIS implementation at supervisory levels.

Workload assessment: This study will use the WHO's workload indicators of staffing need (WISN) (12) to understand the staffing needs and current workload of existing HCPs to deliver MNH services at the district health system level (from DH to union facilities). The updated WISN manual will be adapted in the context of Bangladesh. The WISN steps have been summarised in figure 2.

Figure 2: Summary of WISN steps for this study
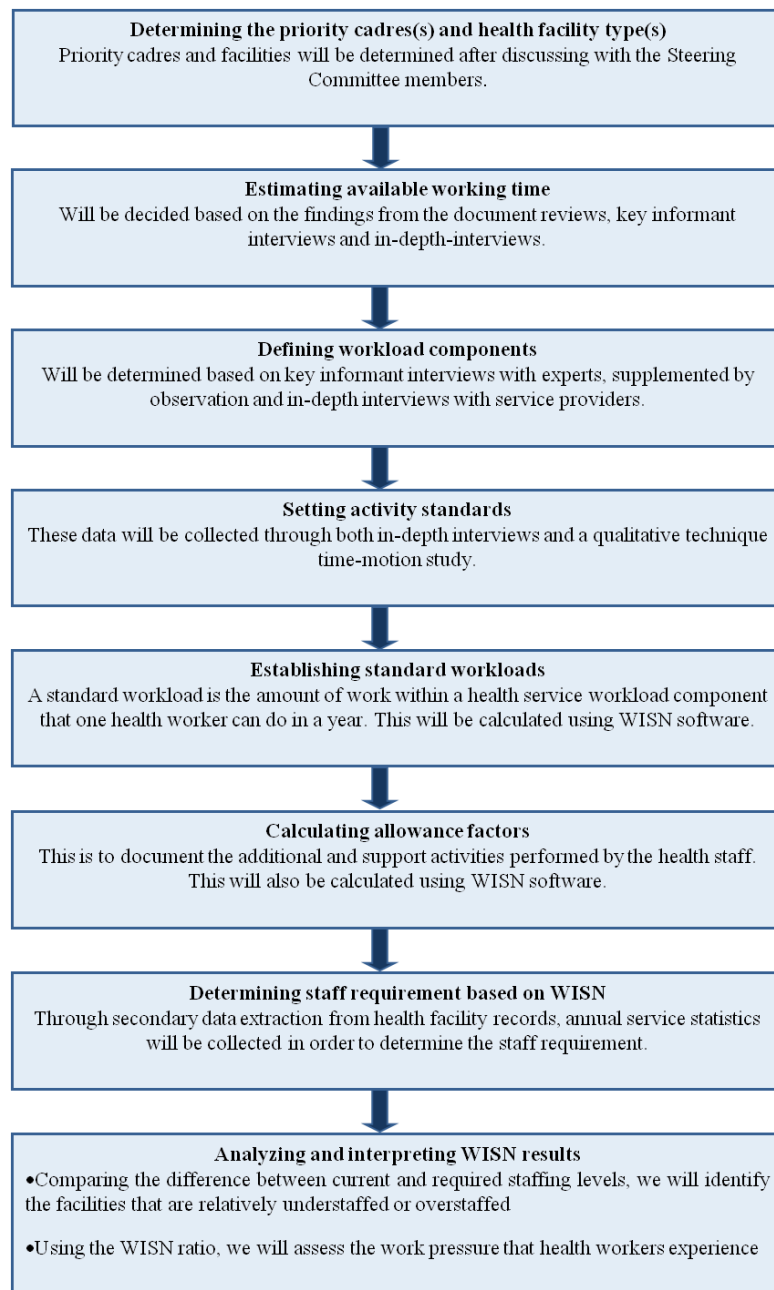
The above-mentioned steps will be conducted using both quantitative and qualitative approaches. In a quantitative method, a time-motion study will be conducted to assess the health professionals' time spent on each activity: health service-related, support activities, and additional activities. In this time-motion study, an external observer employed by the study (trained research assistant) captures detailed data on the duration (i.e., time) and movements/processes (i.e., motion) required to accomplish the specific task/tasks of the

government employed service providers by directly observing and following the subject for an extended period. From WISN step 3, a list of workload components for each service provider will be defined. Computer programmers of icddr,b, in consultation with the study investigators, will develop an app (tab-based) to record the time spent on each workload component. Trained research assistants will shadow the government-employed service providers for 5–7 full days to capture the real-time spent on each of the workload components. The app will minimize observation errors and improve the precision of time and motion captured. We will calculate the proportion of time for health service activity, support activities, and individual measurement activities (direct contact, non-contact productive, inevitable non-productive, avoidable non-productive).

In the qualitative approach, a document review of the service rule, government-approved calendar, attendance sheet/register of the facilities, service registers, HMIS/DHIS2 statistics, KIIs with policymakers related to human resources and health services, in-depth interviews (IDIs) with the service providers (medical officers, nurses, midwives, Sub Assistant Medical Officer (SACMO), Family Welfare Visitors (FWVs)) and observations will be employed.

Activity-based costing (ABC): ABC will be used to determine the cost of data capturing. It is a process of:

- Defining the primary activities of data capturing in which service providers spend their time;
- Tracing the costs of financial and human resources to these primary activities (including staff wages, supplies, equipment, and transportation);
- Tracing secondary activities (such as support and administrative activities) to the primary activities they serve;
- Grouping these primary and secondary activities by service to determine unit costs.

The above-mentioned data will be collected through a time-motion study, interviews with HCPs and health managers, as well as consultation with key informants (MIS-related staff).

Specific objective 4 – perceived utility: To understand the utility of capturing EN-BIRTH phase-1 validated indicators through HMIS.

The perceived utility of data will be explored through the qualitative method of data collection. A series of interviews will be conducted with relevant service providers (doctors, nurses, and

paramedics), health managers (Upazila [sub-district], district, and national), and policymakers (program managers and line directors of maternal, newborn, child, and adolescent health and HMIS). The respondents will be asked about their perception regarding data requirements (specific to selected validated indicators) and experience regarding the use of data in improving the quality of clinical services and tracking the progress of intervention coverage. This qualitative approach will explore potential barriers and enablers associated with data recording, reporting, collating, and analyzing. Also, explore innovative solutions implemented to overcome the challenges to data usage.

Data utility will also be explored with a semi-structured quantitative tool of PRISM module 4, the management assessment tool, and PRISM module 6, the organizational and behavioral assessment tool (13). PRISM module 4 will collect information on RHIS management practices. The PRISM module 6 questionnaire identifies behavioral and organizational determinants, such as motivation, RHIS self-efficacy, task competence, problem-solving skills, and the organizational environment promoting an information culture.

Data quality monitoring

For ensuring data quality, regular monitoring and data checks will be done. The validation of records will be assessed by a subset of records having dual observation. Two percent of all observations should have double observations with feedback. These observations should continuously occur during the process of data collection, with experts visiting various sites.

Data management

All individual identifiers will be removed from the data to be anonymized. The data will be stored on a secure server which is automatically backed up to an off-site location after collection. The data stored on this secure server will be encrypted so only those with the correct encryption key can access it; the encryption key will only be available to members of the immediate research team working on analyzing the data.

ANALYSIS PLAN BY OBJECTIVE

Objective 1: Summary statistics of the total number of service registers and reports by facility type will be prepared. Also, a data structure showing the number of service registers and reports recording information on data elements of all ENAP indicators will be prepared.

Quantitative analysis of objectives 2 and 3: Data quality assessment from objective 2, health facility assessment (HFA) data and time-motion data from objective 3 will be entered and analyzed in Microsoft Excel and/or STATA 13.0. Data generated from WISN steps will be analyzed using WHO's WISN tool.

For objective 2, data quality will be measured in terms of accuracy, completeness, and timeliness for the selected validated indicators adapting the Performance of Routine Information System Management (PRISM) conceptual framework (8), WHO data quality review manual (14), and PRISM tools (8). The steps of data quality review are demonstrated in Figure 2.

Figure 3: Process of data quality review in this study
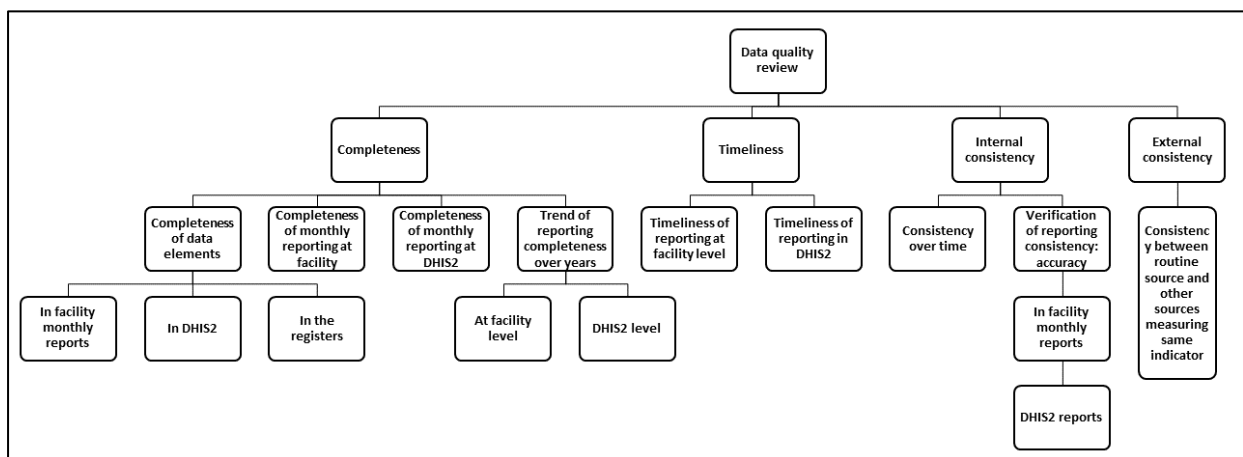
For objective 3, descriptive statistics (proportion) with a 95% confidence interval (CI) will be used to report the level of service availability and readiness of the selected facilities for data availability and the capacity of data capturing. The estimates will be disaggregated by the type of facilities.

For time-motion data, real-time spent on each activity by type of service providers will be presented in percentages. The availability of readiness items required for data capturing will be presented in percentages with a 95% CI by facility type.

WISN data will be analyzed in the WISN tool following the below WISN steps (15) to explore the workload among the health workers.

Qualitative analysis:

All interviews will be audio-recorded with field notes and transcribed verbatim. Transcripts will be randomly checked against the audio recordings to ensure the quality of the transcription.

The qualitative data analysis will be performed through a narrative approach. The process of detailed qualitative analysis is mentioned in Annex 2. Data will be analyzed through Nvivo software. Transcripts will be read and coded by the investigators. We will look for inductive codes to address the study objectives (selective or focused coding method). A codebook will be developed and maintained for all inductive codes. In the beginning, a minimal set of transcripts will be coded by different researchers to check for inter-coder reliability. Upon establishing the inter-coder reliability, a master code list will be generated, based on which the rest of the transcripts will be coded. We will employ the constant comparative analysis method to compare the new data with the earlier data to identify possible similarities and differences.

Patient and public involvement

The experts, policymakers, and health managers will be involved throughout the study, providing their feedback and opinions during in-depth interviews and workshops. Their feedback will be incorporated into finalizing the tools. They will also be invited to participate in dissemination events and develop dissemination materials. This study will assess public health facilities and thus will use only facility data without patient recruitment. We will distribute the results through dissemination workshops, research briefs, posters, report writing, and scientific writing to newborn experts, researchers, public health professionals, policymakers, and others who represent government, non-government (NGO), and development organizations.

DISCUSSION

In most low- and middle-income countries, the use of data to make evidence-based decisions is still limited. Data generated by RHIS are particularly underappreciated. Data from public, private, and community-based health facilities and institutions are included in RHIS. These data gleaned from individual health records, program delivery records, and health resource records provide a granular, site-level image of health status, programs, and resources. The majority of information is collected by healthcare professionals as they go about their work and by managers and regular health facility surveys.

Decision-making in public health is critically dependent on the timely availability of reliable data. Health information systems are responsible for generating, analyzing, and disseminating such data (15). In many low- and middle-income countries (LMICs), national HMISs have been developed to systematically collect and manage facility-based data on health care service delivery (16,17). HMIS generates large amounts of data about health service delivery and

population health and enables decentralized health systems to make data-driven decisions. Nonetheless, the data are underutilized on a local level (18). When the data are of good quality, they can be used – with little-to-no cost – to identify areas that need improvement, evaluate various health interventions, inform evidence-based health policies and design programs and allocate resources at all levels of the health system (19).

HMIS is one of the six health system building blocks, yet the optimal content or design for data recording and reporting tools and systems for newborn and maternal health indicators lack evidence and cohesive global guidance. A survey of 24 LMIC countries in 2017–2018 found MNH data had limited inclusion in HMIS (20,21). The proportion of births that take place in health facilities has increased in the last decade, and now 81% of births worldwide occur in facilities (22). Routine MNH data are routinely obtained by frontline health facility workers (e.g., birth outcomes, service availability, and duration of stay) in labor and childbirth, operating rooms, and other inpatient wards caring for women and newborns. Aggregated routine register data are increasingly used as source MNH data and have become part of the national routine HMIS. Facility data offer an alternative measurement platform to nationally representative population-based surveys (e.g., DHS and MICS) (23,24).

However, concerns about the quality of routine facility data need to be addressed (25,26). Health information systems in developing countries are often criticized for the low quality of data produced and the lack of adequate measures to enhance system efficiency. Moreover, numerous issues with the completeness, timeliness, and accuracy of HMIS data exist (27). Indeed, several studies have evaluated the quality of RHIS in LMIC settings and identified several technical, behavioral, and organizational barriers to their introduction, implementation, and use (28–30). At the technical level, for example, a lack of knowledge, skills, and specialized technical infrastructure can obstruct the collection and use of high-quality data, while low demand for RHIS data, as well as low motivation and competency among health workers, can obstruct its use (13,31). Inadequate governance and management, a lack of training, supervision, and resources, and a failure to promote a data-driven culture have all been identified as organizational issues (13,31). The EN-BIRTH phase-1 found mixed routine register data quality in three high-burden countries. It is, therefore, necessary to further explore how to improve routine MNH data availability and quality linking to data use and utility whilst not increasing the burden on frontline health workers caring for those families (32).

The performance of the health system depends upon the generation and use of high-quality health data and information. Robust RHISs, capable of capturing, storing, managing, and transmitting health information, are required to enhance the quality of healthcare in LMICs and track progress toward achieving targets, such as those outlined in the SDGs (33). Moreover, to improve the performance of the health system, it is critical to have reliable, timely, and transparent data on health services (20). With minimal cost, reliable HMIS data can be used to identify areas for improvement and quantify the impact of healthcare delivery (17). Data along the continuum of care for women and newborns are needed by many actors working at and across different layers of HMIS (32). Routine facility data can provide more frequent information regarding care around the time of birth, including details of clinical interventions that require healthcare training and knowledge to accurately report on MNH indicators (34).

Ethics and consent to participate

Ethical approval to conduct the study is obtained from the Institutional Review Board of icddr,b (PR-20085). Written and informed consent will be obtained from all the participants. Privacy and confidentially of respondents will strictly be maintained. Confidentiality of data will be assured at all steps of data collection, data management, and analysis. All personal identifiers (i.e., names and addresses) will be removed before analysis. In addition, the data (WISN data, time-motion data, KII, and HFA) will be kept under lock and key for protecting privacy.

DISSEMINATION PLAN

The planned completion date of the present study is 31 December 2021. We will publish our findings in a peer-reviewed journal and may also present them at conferences and workshops. We will also develop a detailed report.

ACKNOWLEDGMENTS

DISCLAIMER

Annex 1.1: Research method, data collection tools, respondents, and data collectors

Objective	Questions	Disaggregate	Feasibility Indicators to measure	Methodology
1. Gaps in provision of data capturing	For each specific indicator, what is data flow, degree of complexity, number of steps? What are the opportunities to improve the collection and flow at layers? ^{data} *flow Layers: registers, reporting forms, dashboard,*	Facility type (referral, district, and lower level) Actor (Health service providers, analyst, health manager, policy maker) ^{b}*Provider = nurse, doctors, paramedics*	The proportion of each data element ^{is} available for each data flow layer. The proportion of data elements available that can be reported directly through each system ^{c}*Data elements = specific appropriate variables for numerator & denominator collection/calculation* ^{d}*directly =measure of simplicity*	Desk review Key informant interview Consultative workshop to finalize
2. Resource requirement for data capturing	What are the resource requirements for integration of the new validated indicators in the national HMIS/DHIS2: workforce, time, logistics, etc.? What is the work efficiency (care and documentation) and opportunities to improve?	Facility type Actor	Financial implications identified for indicator measurement The proportion of time for health service activity, support activities & individual measurement activities (Direct contact, non-contact productive, inevitable non-productive, avoidable non-productive)	Health facility assessment Desk review Key informant interview Workforce Indicator for Staffing Need (WISN Tool) Time motion studies
3. Data quality assessment	Accuracy/timeliness/completeness At and between each layer of data flow	Facility type Actor By data flow process (documentation, collation, calculation)	Level of accuracy/timeliness/compl of ENAP indicator elements in registers/reporting forms/dashboard tracking ^{e}*Completeness = operational definition, benchmark*	Data extraction (PRISM tools and WHO data quality review manual adapted) Qualitative Interview
4. Data utility exploration	What DHIS2 outputs do decision-makers need to effectively use ENAP indicators? What are the perceived challenges to the use of data? How is decision-making influenced by ENAP indicator data availability? What innovative solutions were implemented to overcome challenges to the use of data?	Facility type Actor	Perception regarding data requirement Experience regarding data use	Qualitative Interview Consultative workshop

Annex 1.2: Sample size summarise the target population for each research objectives

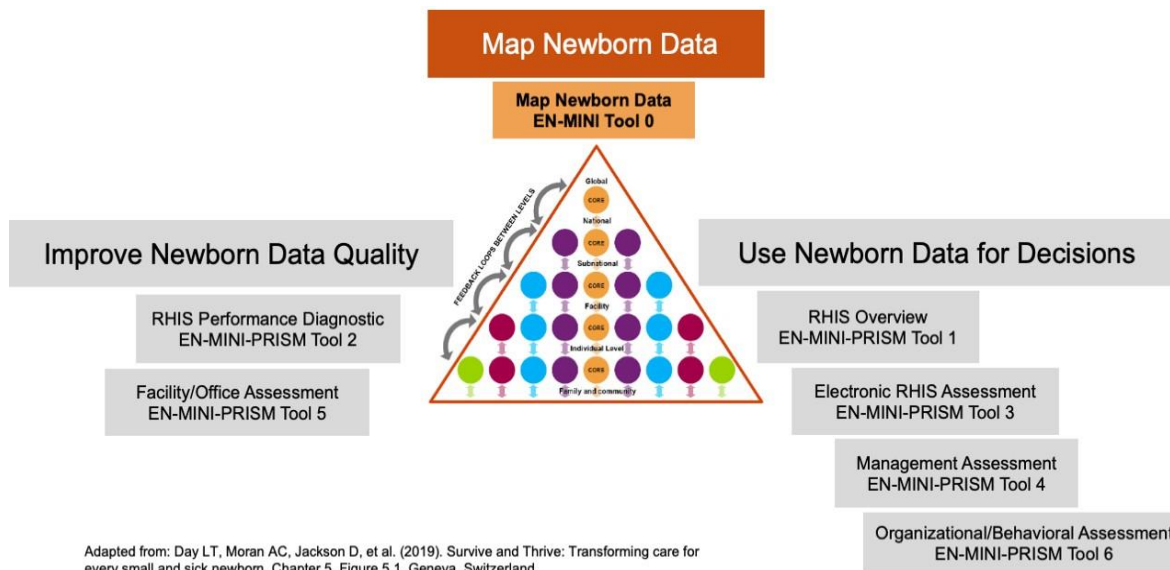| Objectives	Data collection method	Sample size	Justification
Research Objective 2: To assess the **quality of** _data capturing_ of selected validated indicators in national HMIS/DHIS2	PRISM data extraction tools	16 health facilities (1 DH, 5 UHCs, 5 USCs, 5 CCs)	We will conduct data extraction for a year. From each health facility, a total of 396 EmONC, KMC, IMCI, Form 3, and Form 2 records will be extracted.
Research Objective 3: To measure the **resource requirement for** _data capturing_ of selected validated indicators in national HMIS/DHIS2	Health facility assessments survey	22 health facilities (1 DH, 1 MCWC, 5 UHCs, 5 USCs, 5 UH&FWCs, 5 CCs)	Census
	Time motion study	6 health facilities (1 DH, 1 MCWC, 1 UHC, 1 USC, 1 UH&FWC, and 1 CC)	The health facilities DH and MCWC sampling is a census, whereas we will randomly select facilities at UHC, union, and community levels.
	KIIs and IDIs	10–12	We will conduct these interviews to collect information for the WISN steps.
Research Objective 4: To understand the **utility of** _data capturing_ of selected validated indicators in national HMIS/DHIS2 by service providers, managers, and policymakers	KIIs and IDIs	10–12	We will employ an emergent sampling strategy, starting with health providers, managers, policymakers. An emergent sampling strategy will ensure we can respond to the unexpected and provide the flexibility to sample additional participants necessary to fulfill the research objective. We aim to complete approximately 10–12 interviews (lasting max 40 minutes each); until we reach data saturation.
	PRISM modules 4 and 6	10–12	

Annex 1.3: Description of the process of qualitative analysis

Phases of analysis	Description of the process	Result
Data Familiarisation	Data familiarisation will be performed by repeated readings until we get familiar with what the data entails, paying specific attention to patterns that occur and noting down initial ideas/patterns.	Preliminary 'start' codes and detailed notes.
Generation of initial codes	We will generate the initial codes by identifying where and how patterns occur. This will happen through data reduction, where the researcher collapses data into labels to create categories for more efficient analysis. Data compilation will also be completed here. This will involve the researcher making inferences about what the codes mean.	Comprehensive codes of how data answers research question(s).
Searching for themes among codes	Collate codes into themes that accurately depict the data. It is important in developing themes that the researcher describes exactly what the themes mean, what they include, and exclude.	List of candidate themes for further analysis.
Reviewing themes	Check if the themes make sense and account for all the coded extracts and the entire data set. If the analysis seems incomplete, the researcher will need to go back and find what is missing. Generate a thematic "map" of the analysis.	Coherent recognition of how themes are patterned to tell an accurate story about the data.
Defining and naming themes	Generate clear definitions and names for each theme. Describe which aspects of data will be captured in each theme and what is interesting about the themes.	A comprehensive analysis of what the themes contribute to understanding the data.
Producing the final report	Decide which themes will make meaningful contributions to understanding what is going on within the data. Researchers will also conduct verification of the data to check if their description is an accurate representation.	Description of the findings

Map Newborn Data

EN-MINI Tool 0

Purpose

- Find the routine newborn data in your system that can be used now to track progress
- Identify routine data gaps for what you need and want to measure
- Reduce measurement burden, especially for frontline health workers

Adapted from: Day LT, Moran AC, Jackson D, et al. (2019). Survive and Thrive: Transforming care for every small and sick newborn. Chapter 5, Figure 5.1. Geneva, Switzerland.

Instructions

Welcome to the Newborn Indicator Routine Data Mapping Tool!

Step 1. Workbook Set up

1.1) Ensure this workbook is saved as macro-enabled and content has been enabled.

Step 2. Worksheet "Background" - Complete

2.1) Fill in the country or region name and the month and year of data collection.

Step 3. Worksheet Indicator "Definitions" - Review

The newborn indicator definitions listed here are pre-filled based on global recommendations (WHO MoNITOR Online Indicator Toolkit as of 20 December 2021): Indicator name (column D), Indicator definition (column E), Numerator details (columns F and G), Denominator details (columns H and I), and further indicator details (e.g. indicator type, domain, continuum of care)

3.2) Check for any recent updates to global recommendations for indicator definitions (e.g. WHO MoNITOR - https://monitor.srhr.org/) and update the worksheet "3. Definitions" as needed.

3.3) **Adapt indicator definitons:**

If any setting-specific indicator definitions differ from the globally recommended definitions, edit the worksheet "3. Definitions" as needed.

3.4) **Add additional indicators:**

You can add additional indicators for your setting in more rows at the bottom of the table by dragging down from the small handle in the bottom right corner . Do not use any commas in the indicator title, numerator abbreviation, or denominator abbreviation.

3.5) If adding additional indicators, be sure to complete column M "Recommendation for use" with core, optional, etc.

3.6) Ensure the first row remains Indicator name = NA, Numerator = "Not an indicator or data

3.7) After any point that you have entered any data on the worksheet "3. Definitions" you MUST "refresh all" - select the "Data" tab from the Excel ribbon then select "Queries & Connections" subsection and press "Refresh All".

Step 4 - Worksheet "Data collection" - List the data element (columns)

4.1) In the first row of column C, select the HMIS data level of the document you want to map from

the drop-down list e.g register.

4.2) Column D: Type the document name/title in (e.g. labor and delivery register).

4.3) Column E: Type the first data element name.

4.4) Column F: Type any relevant instructions or definitions that accompany the data element or

indicator e.g. for a register "leave blank if not given".

4.5) Repeat the same process for columns D through F (points 2-3 above) for every column/data element in the document you are mapping. Ensure the document name is spelled the same in every

4.6) Expand or shrink the size of the table to match the number of rows needed using the toggle in the bottom right corner of the table. Note: this worksheet can accommodate up to 6,000 rows.

Step 5 - Worksheet "Data collection" - Map data elements (columns) to definit

For every row listed in step 1:

5.1) Column G: select "newborn specific" if the data directly (physically) relates to the newborn (e.g. birthweight, breastfeeding), select "newborn related" if the data connects through the mother/family (e.g. mother's age, parity), select "no" if it is not related to the newborn.

5.2) If you select "no" in column G, fill "NA" for column H through column J.

5.3) If you select newborn "specific" or newborn "related" in column G, use the "Definitions" worksheet to determine which indicator or data element(s) is relevant. Select numerator, denominator, or full indicator in column H. Select "Full indicator" if the numerator and denominator are already combined into a percent or rate (See columns D and E on the

worksheet

"3. Definitions"). Select "NA" if the element or indicator is not one of the core indicators for

5.4) If the element or indicator is not one of the core indicators for tracking listed on the definitions page, select it from the drop-down menu in column I.

5.5) If column I contains a core data element or indicator, decide if the definition meets exactly the WHO-recommended definition. You can check this against the "Definitions" worksheet completed earlier. IF the data element does NOT match exactly but only appoximates the numerator/denominator/indicator, select "Different definition". If the data element or indicator in

column I is not a core indicator ("NA" is selected), you can select "NA" for column J for

5.7) Note, in columns H and I, multiple options can be selected from the dropdown, if applicable

e.g for a register column recording birthweight could be recorded as a numerator for "weighed"

5.8) Note If you make an error in a cell, do not type or edit in the cell manually, but delete the entire contents of the cell and select again.

Step 6. Analysis - Reporting App

6.1) Go to the Reporting App website: https://enmini.shinyapps.io/EN-MINI-mapping-tool/

6.2) On the Reporting App website, Click 'Browse...' on the panel to the left and upload the completed Excel file from your computer.

6.3) Once the App displays 'Upload complete', Click the button: 'Generate report'. After a few seconds or a minute, a window will pop up and you can open or save the report to your computer.

Step 7. Finalise your report

7.1) Edit the word document report to add any additional information relevant to newborn data in your setting.

Background

Country/region:	*[country name]*
Data collection month:	*[month]*
Data collection Year:	*[year]*

Newborn Indicator Definitions

Step 3.1) Pre-filled definitions: The newborn indicator definitions listed here are pre-filled based on global recommendations (WHO MoNITOR Online Indicator Toolkit as of 20 December 2021): Indicator name (column D), Indicator definition (column E), Numerator details (columns F and G), Denominator details (columns H and I), and further indicator details (e.g. indicator type, domain, continuum of care) are found in columns J through M. **Step 3.2)** Check for any recent updates to global recommendations for indicator definitions (e.g. WHO MoNITOR - https://monitor.srhr.org/) and update the worksheet "3. Definitions" as needed	**Step 3.3) Adapt indicator definitions:** If any setting-specific indicator definitions differ from the globally recommended definitions, edit the worksheet "3. Definitions" as needed. **Step 3.4) Add additional indicators:** You can add additional indicators for your setting in more rows at the bottom of the table by dragging down from the small handle in the bottom right corner. Do not use any commas in the indicator title, numerator abbreviation, or denominator abbreviation. **Step 3.5)** If adding additional indicators, be sure to complete column M "Recommendation for use" with core, optional, etc.	**Step 3.6)** Ensure the first row remains Indicator name = NA, Numerator = "Not an indicator or data element", etc. **Step 3.7)** After any point that you have entered any data on the worksheet "3. Definitions" you MUST "refresh all" - select the "Data" tab from the Excel ribbon then select "Queries & Connections" sub-section and press "Refresh All".

Newborn related indicators

Full indicator		Numerator		Denominator		Indicator details (MoNITOR)			
Indicator name	**Indicator definition**	**Numerator**	**Numerator abbreviation**	**Denominator**	**Denominator abbreviation**	**Indicator type**	**Domain**	**Continuum of care**	**Recommendation for use**
NA		Not an indicator or data element	NA	Not an indicator or data element	NA	0	0	0	0
Institutional maternal mortality ratio (per 100 000 deliveries)	Number of maternal deaths in health facilities/institutions per 100,000 deliveries	Number of maternal deaths in health facilities/institutions	maternal deaths	Total number of women who gave birth in a facility	total deliveries (women)	Impact	Mortality	All	Optional
Stillbirth rate in a health facility	Stillbirths [Note: Baby born with no sign of life and weighing at least 1000g or after 28 weeks gestation] This indicator should be routinely disaggregated by fresh and mascerated when possible.	Number of stillbirths	total stillbirths	Number of live births and stillbirths in facility	total births (babies)	Impact	Mortality	Intrapartum	Core

Pre-discharge neonatal mortality rate	Percentage of babies born live in a facility who die prior to discharge	Number of babies born live in a facility who die during the first 28 days of completed days of life and die prior to discharge from the facility, per 1000 live births in a given year or period	newborn deaths predischarge	Number of babies born live in a facility	live births (babies)	Impact	Mortality	Postnatal	Optional
Low birth weight among livebirths (%)	Percentage of live births that weigh less than 2500 grams.	Number of live-born neonates with weight less than 2500 g at birth	live births <2500g	Total number of live births	live births (babies)	Impact	Risk-factors and behaviours	Postnatal	Core
Preterm birth (facility based)	Percentage of births in health facility that are pre-term (less than 37 weeks gestation)	Number of newborns born under 37 weeks gestation	preterm births	Total number of live births in facility	live births (babies)	Impact	Risk-factors and behaviours	Postnatal	Optional
Caesarean section rate	Percentage of deliveries by caesarean section.	Number of caesarean sections.	C-section	Number of total deliveries in facility.	total deliveries (women)	Outcome	Service coverage	Intrapartum	Core
Postnatal care for women (Facility-based)	Percentage of women with postnatal care (PNC) Note: The numerator includes both women who gave birth in the health	Number of women with postnatal care	PNC-woman	Number of deliveries in facility	live deliveries (women)	Outcome	Service coverage	Postnatal	Core

	facility and those who gave birth outside the health facility.								
Posnatal care for newborns (Facility-based)	Percentage of newborns with postnatal care (PNC) *Note: The numerator includes both women who gave birth in the health facility and those who gave birth outside the health facility.*	Number of newborns with postnatal care	PNC-newborn	Number of live births in facility	live births (babies)	Outcome	Service coverage	Postnatal	Core
Newborns breastfed within one hour of birth	Percentage of babies born alive in a facility who are breastfed within one (1) hour of birth.	Number of babies born alive in a facility who are breastfed within one (1) hour of birth	BF1hr	Total number of live births in a facility	live births (babies)	Outcome	Risk-factors and behaviours	Postnatal	Core
Newborn resuscitation with bag and mask	Percentage of newborns not breathing and/or crying spontaneously at birth and, subsequently, required additional	Number of newborns who were not breathing spontaneously or crying at birth and, subsequently, required	BMV	Total number of live births in the facility	total births (babies)	Outcome	Service coverage	Postnatal	Core

	resuscitation actions (stimulation and/or bag and mask) performed.	resuscitation (stimulation and/or bag and mask) to be performed.							
Premature (LBW) babies initiating KMC	Percentage of newborns weighing ≤ 2,000g who are initiated with KMC (or admitted to KMC unit, if separate unit exists).	Number of newborns weighing ≤ 2,000g who are initiated on KMC (or admitted to KMC unit, if separate unit exists)	KMC initiation	Total number of newborns weighed	newborns weighed	Outcome	Service coverage	Postnatal	Core
Newborns treated for neonatal sepsis/infection	Percentage of newborns with suspected severe bacterial infection who receive appropriate antibiotic therapy	The number of newborns who receive treatment (at least one injection of antibiotic) for suspected serious bacterial infection in the facility .	antibiotic injection	Total number of live births in the facility	live births (babies)	Outcome	Service coverage	Postnatal	Core
Chlorhexidine cord cleansing	Percentage of newborns who received at least one (1) dose of chlorhexidine to the cord within 24 hours of birth.	Number of newborns who received at least one dose of chlorhexidine (7.1%) to the cord within 24 hours of birth	chlorhexidine	Total number of live births	live births (babies)	Outcome	Service coverage	Postnatal	Optional

Antenatal corticosteroid use	Percentage of newborns with confirmed ultrasound gestational age of less than 34 weeks whose mothers received antenatal corticosteroids.	All women who gave birth in a facility at <34 completed weeks and received one dose of ACS for risk of preterm birth	ACS	Total number of women with a live birth	live deliveries (women)	Outcome	Service coverage	Antenatal	Optional
Newborns with documented birthweight	Percentage of newborns born in a facility with documented birthweight before discharge.	Number of newborns born in a facility with documented birthweight before discharge	weighed	Total number of live births in a facility	total births (babies)	Outcome	Service coverage	Postnatal	Core
Companion of choice during labor and/or childbirth	Percentage of women who wanted and had a companion of choice supporting them during labor and/or childbirth in the health facility.	Number of women who wanted and had a companion of choice supporting them during labor and/or childbirth in the health facility in a given period	had companion of choice	Total number of women who wanted a companion of choice during labor and/or childbirth	wanted companion of choice	Outcome	Service coverage	Intrapartum	Optional
[Mother & newborn services without separation] UNDEFINED	Not yet defined	Capture any measure related to this concept	no separation	Live births	live deliveries (women)				Desired
[Measure of respectful experience of care]	Not yet defined	Capture any measure related to this concept	respectful care	Total births	total deliveries (women)				Desired

UNDEFINED									
Level 2 inpatient unit for small or sick newborns (ENAP coverage target - Being defined)	Not yet defined	Capture any measure related to this concept	level 2	Total births	total births (babies)				Desired
[Respiratory support for small or sick newborns including continuous positive airway pressure (CPAP)] being defined	Not yet defined	Capture any measure related to this concept	CPAP	Total births	total births (babies)				Desired
Uterotonic for prevention of post-partum haemorrhage	Percentage of women who gave birth in a facility who received a prophylactic uterotonic immediately after birth for prevention of postpartum hemorrhage.

[Note: the standard for operationalizin | Number of women who gave birth in a facility who received a prophylactic uterotonic immediately after birth. | uterotonic | Total number of women who gave birth in a facility. | total deliveries (women) | Outcome | Service coverage | Intrapartum | Core |

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	g *«immediately»* *is within one* *minute]*						

Data Collection: List & map newborn content		
	Note: If you make an error in a cell, do not type or edit in the cell manually, but delete the entire contents of the cell and select again.	EN-MINI tools
List: data availability	**Map: newborn data**	
Step 4. List Complete columns C, D, E, F from the data source (e.g. register, tally sheet, DHIS2) **4.1)** In the first row of column C, select the HMIS data level of the document you want to map from the drop down list e.g register. **4.2)** Column D: Type the document name / title in (e.g. labour and delivery register). **4.3)** Column E: Type the first data element name. **4.4)** Column F: Type any relevant instructions or definitions that accompany the data element or indicator e.g. for a register "leave blank if not given". **4.5)** Repeat same process for columns D through F (points 2-3 above) for every column/data element in the document you are mapping. Ensure the document name is spelled the same in every row. **4.6)** Expand or shrink the size of the table to match the number of rows needed using the toggle in the bottom right corner of the table. Note: this worksheet can accommodate up to 6,000 rows.	**Step 5 Map** **5.1)** Column G: select "newborn specific" if the data directly (physically) relates to the newborn (e.g. birthweight, breastfeeding), select "newborn related" if the data connects through the mother/family (e.g. mother's age, parity), select "no" if it is not related to the newborn. 5.2) If you select "no" in column G, fill "NA" for column H through column J.	5.3) If you select newborn "specific" or newborn "related" in column G, use the "Definitions" worksheet to determine which indicator or data element(s) is relevant. Select numerator, denominator, or full indicator in column H. Select "Full indicator" if the numerator and denominator are already combined into a percent or rate (See columns D and E on the worksheet "3. Definitions"). Select "NA" if the element or indicator is not one of the core indicators for tracking listed on the definitions page.. 5.4) If the element or indicator is not one of the core indicators for tracking listed on the definitions page, select it from the drop-down menu in column I. 5.5) If column I contains a core data element or indicator, decide if the definition meets exactly the WHO-recommended definition. You can check this against the "Definitions" worksheet completed earlier. IF the data element does NOT match exactly but only appoximates the numerator/denominator/indicator, select "Different definition". If the data element or indicator in column I is not a core indicator ("NA" is selected), you can select "NA" for column J for completeness. 5.7) Note, in columns H and I, multiple options can be selected from the dropdown, if applicable e.g for a register column recording birthweight could be recorded as a numerator for "weighed" and "live births <2500g".

Data level Choose from drop down list	Document title Enter	Indicator/Data element (or column) name Enter	Instructions/definition associated with data element/indicator Record any instructions on document	Newborn data (specfic/related) Choose from drop down list	For newborn data: Is the data element or indicator a Numerator, Denominator, or Full indicator? Choose from drop down list, select multiple if applicable	Select the data element or indicator Choose from drop down list, select multiple if applicable	Does the definition meet the exact WHO definition? Choose from drop down list

Troubleshooting

Q. I don't see the indicator I need on the data collection sheet, where is it?

A. First check the definitions sheet; if the indicator isn't in the indicator table, add the indicator and relevant details. When it is complete, in the Excel ribbon at the top of the window, select the "Data" tab and press "Refresh All" from the "Queries & Connections" sub-section. Any time any changes are made on the definitions page, you must "Refresh All". If you already see your indicator in the indicator table, try Refeshing all again.

Q. I tried to change the information in a cell but now the cell shows both responses, what should I do?

A. In some cases, you may need to enter two options, so the data collection sheet allows this to happen. If you want to change the informtaion in a cell, delete the original information first, then enter the new information.

Q. I need to edit something that's password protected, what is the password?

A. The password is "Every Newborn". Please be careful if making any edits. Do not change the names of the tabs or insert any rows above tables as this will affect the automated analysis.

Q. What's the difference between indicator "Exact definition" and "Non-exact definition" for column J in Data Collection?

A. An exact definition would collect data as defined on the "3. Definitions" sheet. A non-exact definition will approximate this measure. For example, if a register or report collects information on preterm birth but uses a 32-week cut-off this could be considered a non-exact definition for the indicator: Percentage of births in health facility that are pre-term (less than 37 weeks gestation). Additionally, composite indicators may be considered non-exact. For example, if a register or report has a data element for "AMTSL done" this might approximate the indicator uterotonics but it is not exact.

Q. A figure or table isn't showing up in my report or my report says "error", what do I do?

A. The first thing to check is if you have any duplicate rows. Click inside the table on the "Data Collection" sheet and then click "Table Design" in the Excel Ribbon. In the tools section, click "Remove Duplicates". You can also look through your table to see if any are flagged by Excel for having an issue. Once you've deleted any duplicate rows and fixed any cell errors, try running your report again.

Q. When I try to select my file to upload to the Reporting App website, a pop-up window says "Not Implemented". What do I do?

A. Check if the file you are trying to upload is currently open on your computer. Try saving, closing the file, and then try uploading it to the app again.

Acknowledgements

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