



# Master of Public Health

## Master de Santé Publique

Focus on Preventable Neonatal Deaths: Analysis of the Burden of Neonatal Infections and Sepsis at a Regional, Country and Facility Level

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## Abstract / Résumé

**Background:** Focus on preventable neonatal deaths, including neonatal infections and sepsis, could result in facilitation of the SDG 3.2 globally and in the LAC region. The neonatal intensive unit at the Queen Elizabeth Hospital in Bridgetown, Barbados, identified the need to expand and improve the quality-of-care of neonates who are at risk of neonatal infections and sepsis.

**Objective:** The first objective was to identify the burden of neonatal infections and sepsis at a regional, country and facility level by focusing on the LAC region, Barbados, and neonatal intensive care unit at the Queen Elizabeth Hospital in Bridgetown, Barbados as case studies. The second objective was to identify the main factors of neonatal infections and sepsis in the neonatal intensive care unit at the Queen Elizabeth Hospital in Bridgetown, Barbados.

**Method:** Data collection and analysis at regional and country level was performed by retrieval and compilation of the neonatal mortality data from WHO GHE 2019, IHME GBD 2019 and PAHO Mortality databases. Data collection and analysis at facility level was performed by adapting a WHO (2016) framework for IPC.

**Results:** Analysis of the data from the three databases allowed to observe consistencies and a positive trend in the burden of neonatal infections and sepsis in the LAC region and Barbados. Analysis of the data at a facility level identified a need to strengthen the surveillance system for quality of neonatal infection and sepsis care.

**Conclusion:** Implementing and improving the standards of quality of neonatal infections and sepsis care in facilities in the LAC region can be one of the many contributions to improve outcomes, save lives and facilitate achievement of the SGD goal 3.2.

**Key words:** neonatal infections, neonatal sepsis, neonatal intensive care unit, surveillance

**Contexte** : la réduction des infections et les septicémies pourraient faciliter les objectifs du SDG 3.2 dans la région des Caraïbes et de l'Amérique Latine, objectifs qui consistent à réduire le taux de mortalité infantile. L'unité de soins intensifs néonatale de l'Hôpital Queen Elizabeth à Bridgetown, Barbade, a identifié le besoin de développer et d'améliorer la qualité des soins apportés aux nouveau-nés risquant de contracter des infections et des septicémies.

**Objectif** : le premier objectif consiste à identifier la gravité de la situation concernant les infections et les septicémies au niveau régional, au niveau du pays et au niveau de l'unité de soins intensifs néonatale en se concentrant sur la région des Caraïbes et de l'Amérique Latine, de la Barbade et de l'unité de l'Hôpital Queen Elizabeth. Le deuxième objectif consiste en l'identification des divers facteurs d'occurrence des infections et des septicémies chez les nouveau-nés au sein de l'unité de soins intensifs néonatale de l'Hôpital Queen Elizabeth de Bridgetown, à la Barbade.

**Méthode** : la collecte des données et leur analyse aux niveaux du pays et du continent s'est faite par la compilation des données sur la mortalité infantile des bases de données de WHO GHE 2019, IHME GBD 2019 et de PAHO. La collecte des données au niveau de l'établissement et leur analyse s'est faite en adaptant le cadre fourni par l'OMS.

**Résultats** : l'analyse des trois bases de données a permis d'observer une corrélation entre elles et de mettre en évidence une tendance à la hausse concernant les infections et les septicémies néonatales dans la région des Caraïbes et de l'Amérique Latine, mais aussi à la Barbade. L'analyse des données issues de l'établissement a permis de mettre en évidence le besoin de mettre en place un système de surveillance afin d'améliorer la qualité du traitement de ces pathologies.

**Conclusion** : l'implémentation et l'amélioration des soins apportés pour traiter les infections et septicémies néonatales dans la région des Caraïbes et de l'Amérique Latine peuvent permettre d'améliorer les résultats, sauver des vies et d'atteindre les objectifs du SDG goal 3.2.

**Mots clés** : infections néonatales, septicémies néonatales, unité de soins intensifs néonatale, système de surveillance.

## List of Acronyms

<b>BFHI</b>	Baby Friendly Hospital Initiative
<b>CDE</b>	Communicable Diseases and Environmental Determinants of Health
<b>CLAP-SMR</b>	Latin American Center of Perinatology, Women and Reproductive Health
<b>CLABSI</b>	Central Line Associated-blood Stream Infection
<b>CVC</b>	Central Venous Catheter
<b>ENAP</b>	Every Newborn Action Plan
<b>FPL</b>	Family, Health Promotion and Life Course
<b>GHE</b>	Global Health Estimates
<b>HAI</b>	Healthcare-associated Infection
<b>ICD-10</b>	International Statistic Classification of Diseases Tenth Version
<b>IHME GHE</b>	Institute for Health Metrics and Evaluation – Global Burden of Disease
<b>IPC</b>	Infection Prevention and Control
<b>KMC</b>	Kangaroo Mother Care
<b>LAC</b>	Latin America and the Caribbean
<b>MDG</b>	Millenium Development Goal
<b>NICU</b>	Neonatal Intensive Care Unit
<b>NMR</b>	Neonatal Mortality Rate
<b>PAHO</b>	Pan American Health Organization
<b>PICC</b>	Peripherally Inserted Central Catheter
<b>QEH</b>	Queen Elizabeth Hospital
<b>SDG</b>	Sustainable Development Goal
<b>WHO</b>	World Health Organization

## 1. Introduction

### 1.1 Neonatal Mortality: Global Agenda

Numerous global efforts have contributed to the reduction of preventable deaths of children under-five. Millennium Development Goal (MDG) target 4.A, aimed at reduction of child mortality by two thirds, was instrumental in reducing mortality of children under-five between 1990 and 2015 (1). During the period, global mortality of children under-five decreased by 53% and neonatal mortality decreased only by 42% (2). Due to the rapidly decreasing mortality of children under-five, mortality of neonates will represent a larger share in mortality of children under-five in the coming years (2). Currently, it amounts to more than 44% of all deaths among children under-five (2).

Neonatal mortality came to prominence and was addressed by the development of the next global agenda – Sustainable Development Goals (SDGs) in 2015 (3). SDG goal 3.2 specifically focuses on reducing neonatal mortality: *“By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births”* (4). In order to achieve this goal, World Health Organization (WHO) initiated the “Every Newborn: a global action plan to end preventable deaths (ENAP)” in 2014 (2). It aims to reduce global neonatal mortality to 9 deaths per 1,000 live births by 2030 and 7 deaths per 1,000 live births by 2035 proposing strategic improvements in newborn and maternal health. Consequently, almost three million neonatal deaths would be prevented by 2030 (2).

### 1.2 Neonatal Mortality: Latin American and Caribbean Agenda

The Latin American and Caribbean (LAC) region has contributed to the global agenda to reduce preventable deaths of children under-five and successfully achieved the MDG target 4.A by reducing mortality of children under-five by 67%, from 53.8 to 17.9 deaths per 1,000 live births between 1990 and 2015 (5). During the same period, neonatal mortality decreased by 57.9%, declining from 22.1 to 9.3 neonatal deaths per 1,000 live births (5). Neonatal deaths represented 52% of the total share of mortality of children under-five in the LAC region in 2015 (5).

Countries in the Pan American Health Organization (PAHO) have adopted the Sustainable Health Agenda for the Americas 2018-2030 in 2017 (5,6). It aims to reduce neonatal mortality to 9 deaths per 1,000 live births in all population groups in region by 2030 improving access



to health services and increasing the universal health coverage (6). The Plan of Action for Women's, Children's and Adolescent's Health 2018-2030 proposes an even more substantial goal: to reduce neonatal mortality in the region to 7.5 neonatal deaths per 1,000 live births in 2026 and to 7 neonatal deaths per 1,000 live births in 2030 (5).

### 1.3 Focus on Preventable Deaths: Neonatal Infections and Sepsis

Globally, neonatal conditions is the fourth leading cause of death and the leading cause of disability-adjusted life years (7,8). The main causes of neonatal mortality are complications of prematurity, intrapartum-related neonatal deaths and neonatal infections (2). These causes are responsible for 35%, 24% and 15% of all deaths among children under-five respectively. The burden is particularly high in low income and lower-middle income (7). In the LAC region, it is particularly prominent in populations of low educational status, among indigenous or Afro-descendent parents and those living in rural areas (5,9). This indicates that neonatal conditions can be prevented and that focusing on interventions that are cost-effective yet have a low coverage, is crucial to equitably achieve neonatal mortality goals by 2030 (2,9).

Interventions to improve survival of neonates who are at risk of complications would have a great impact on the overall neonatal mortality (2). Neonates who are born prematurely or of low birth weight have a weak immune defense system and are at a high risk of infections. Further, they are often admitted to neonatal intensive care units where they undergo therapeutic procedures, have prolonged length of stays, and acquire hospital flora (10). These are factors that make them even more susceptible to hospital-associated infections.

One course of action proposed by ENAP is to expand a package of "care of small and sick newborns" at tertiary level facilities and to focus on prevention and treatment of sepsis (2). This package includes focusing on antibiotic treatment of neonatal infections and extension of supportive care. Supportive care includes safe oxygen therapy, surfactant administration and respiratory support. Feeding support and intravenous fluids are associated with prevention of neonatal infections and significantly better outcomes in small and sick neonates (2). Kangaroo mother care (KMC) is also associated with prevention of reduced mortality due to neonatal sepsis in small and sick neonates (11,12).

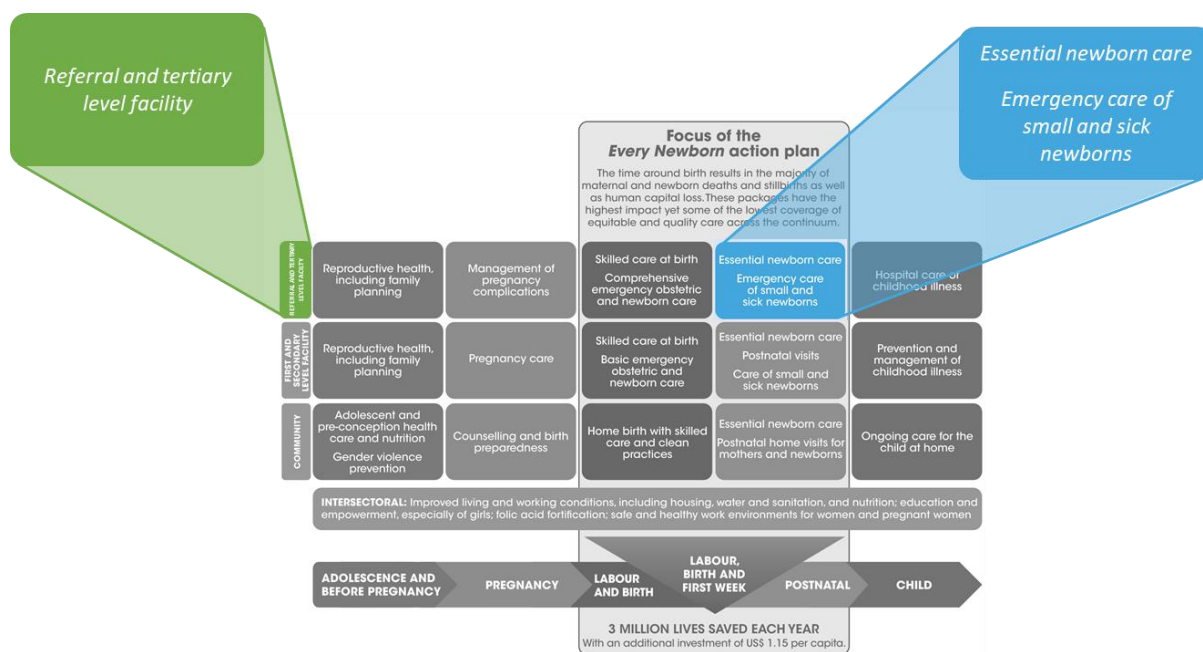


Figure 1. Packages in the Continuum of Care - Focus on Essential Newborn Care at Referral and Tertiary Level Facilities (2).

Focusing on prevention and treatment of sepsis is paramount to reduce all-cause neonatal mortality as it's one of the main causes of deaths and is closely linked to prematurity (2). It's estimated that focusing on small and sick newborns and expanding their care package, would have the second greatest impact on neonatal mortality (2). It would result in almost 600,000 neonatal lives saved by 2025 globally. Furthermore, a study by Arnesen et al. (2016) indicated that implementing an "All-In" intervention package, consisting of oral antibiotics, injectable antibiotics and full supportive care for sepsis/pneumonia, would prevent additional 177,302 neonatal deaths from neonatal infections and sepsis in the LAC region between 2016 and 2035 (13).

A tertiary level facility, the Queen Elizabeth Hospital (QEH), in Bridgetown, Barbados, has identified the need to expand and improve the quality-of-care of neonates who are at risk of neonatal infections and sepsis in their neonatal intensive care unit (NICU). The facility management was particularly concerned about the elevated rates of neonatal infections and mortality due to neonatal infections in the unit as it's the only NICU facility in the country and has a responsibility to provide advanced medical care to sick neonates from other Eastern Caribbean countries (14). As a result, the hospital submitted a request for support to PAHO/WHO at the end of 2020.

## 2. Objectives

(1) To **identify the burden** of neonatal infections and sepsis at a regional, country and facility level by focusing on the LAC region, Barbados, and neonatal intensive care unit at the Queen Elizabeth Hospital in Bridgetown, Barbados as case studies.

(2) To **identify the main factors** of neonatal infections and sepsis in the neonatal intensive care unit at the Queen Elizabeth Hospital in Bridgetown, Barbados.

## 3. Methods

This thesis is based on a project conducted during an internship at the Latin American Center of Perinatology, Women and Reproductive Health (CLAP-SMR) and PAHO/WHO Family, Health Promotion and Life Course Department (FPL) in Montevideo, Uruguay. The project began in February 2021 in collaboration with the experts from the Communicable Diseases and Environmental Determinants of Health department (CDE/PAHO), experts from the FPL department in Barbados and those responsible for the provision of services at the Queen Elizabeth Hospital (QEH) in Bridgetown, Barbados. CLAP-SMR was the lead entity of the project and coordinated all of the activities and documents produced. Experts from CDE/PAHO department were pivotal in providing their verbal and written expertise in the area of infection prevention and control (IPC), while experts from the FPL department in Barbados facilitated communication and coordinated activities between those responsible for the provision of care at the QEH during the baseline assessment stage.

The project follows a standard process of a project and includes four steps 1. Baseline assessment 2. Planning and design 3. Implementation and 4. Evaluation (15,16). Due to the length of this ongoing project, the thesis will only focus on the first diagnostic step: obtaining a baseline assessment.

### 3.1 Baseline Assessment

The main purpose was to collect data to map the situation related to the burden of neonatal infections at the regional, country and facility level, and to identify if an intervention is needed. This was performed using two methodologies described in the following sub-chapters.

#### 3.1.1 Data Collection and Analysis at the Regional and Country Level

Data collection and analysis for the baseline assessment of the burden of neonatal infections and sepsis in the LAC region and Barbados was performed in collaboration with the health

statistics specialist, Dra. Patricia Nilda Soliz Sánchez from PAHO/WHO using Microsoft Microsoft® Excel® 2016 MSO. She facilitated retrieval and compilation of the neonatal mortality data from three databases:

- World Health Organization – Global Health Estimates (WHO GHE) 2019
- Institute for Health Metrics and Evaluation – Global Burden of Disease (IHME GHE) 2019
- Pan American Health Organization (PAHO) Mortality Database.

WHO GHE 2019 and PAHO Mortality Database provide data on neonatal mortality from 2000 to 2019.(17–19). IHME GBD 2019 database provide data from 1990 to 2019 (20). Data from WHO GHE 2019 and IHME GBD 2019 databases are based on estimations (19,20). The PAHO Mortality Database relies on reports from countries in the region that come from their vital registration systems (17). The causes of deaths in all the databases follow the International Statistic Classification of Diseases Tenth Version (ICD-10), but slight variations in code classifications exist between the databases (see Annex 1) (19,20). The countries included in the databases are from the WHO Region of the Americas (see Annex 2) (17,19,20).

	WHO GHE 2019		IGME GBD 2019		PAHO Mortality Database	
Year	2000 – 2019		1990 - 2019		2000 – 2019	
	Country	Region	Country	Region	Country	Region
<b>Total number of neonatal deaths</b>	✓	✓	✓	✓		✓
<b>Neonatal mortality rate</b>			✓	✓*		
<b>Total number of neonatal deaths due to infections and sepsis</b>	✓	✓	✓	✓		
<b>Proportional deaths due to infections and sepsis</b>	✓	✓	✓	✓		
<b>Neonatal mortality rate due to infections and sepsis</b>	✓	✓	✓	✓*		
<b>Total number of neonatal deaths by cause</b>		✓		✓		✓

<b>Proportion of neonatal deaths by cause</b>		✓		✓		✓
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*Table 1. Data collected and analyzed on neonatal mortality from WHO GHE 2019, IHME GBD 2019 and PAHO Mortality Database. \*Data is only available for 2000 – 2019.*

In order to analyze neonatal mortality in the LAC region, trends for the total number of neonatal deaths from the three databases between 1990 and 2019 and neonatal mortality rate (NMR) per 1,000 live births from IHME GBD 2019 database between 2000 and 2019 was interpreted. In order to analyze the main causes of neonatal deaths in the region, proportion of neonatal deaths by cause was interpreted from the three databases for the year 2019. Further, to analyze the burden of neonatal infections and sepsis in the region, proportional deaths from the three databases between 1990 and 2019 were consolidated.

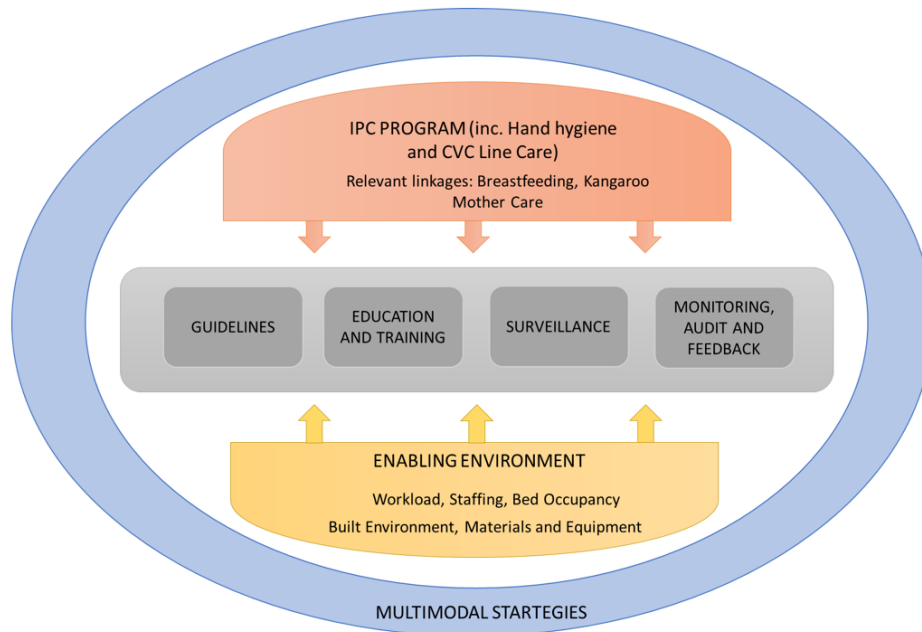
The differences in neonatal mortality and neonatal mortality due to infections and sepsis was performed by interpretation of data from WHO GHE 2019 and IHME GBD 2019 databases. Absolute measure of inequality was calculated by calculating the difference between the country with the highest NMR and the country with the lowest NMR. Relative measure of inequality was calculated by calculating a ratio between the country with the highest NMR and the country with the lowest NMR. All-cause NMR was expressed per 1,000 live births and NMR due to infections and sepsis was expressed per 100,000 live births.

Trends in the total number of neonatal deaths due to all-causes and due to neonatal infections and sepsis were consolidated from WHO GHE 2019 and IHME GBD 2019 databases between 1990 and 2019. All-cause neonatal mortality analysis in Barbados was performed by consolidating the trends in the all-cause NMR from IHME GBD 2019 database between 1990 and 2019. Neonatal mortality due to infections and sepsis analysis in Barbados was performed by consolidating the trends in NMR due to neonatal infections and sepsis from WHO GHE 2019 and IHME GBD 2019 databases between 1990 and 2019. All-cause NMR was expressed per 1,000 live births and NMR due to infections and sepsis was expressed per 100,000 live births. Further, proportional mortality due to neonatal infections and sepsis was also interpreted from WHO GHE 2019 and IHME GBD 2019 databases for the same period.

### 3.1.2 Data Collection and Analysis at the Facility Level

Data collection and analysis to assess the burden and the main factors of neonatal infections and sepsis in the NICU at the QEH in Bridgetown, Barbados was performed by adapting a framework from WHO (2016) for IPC at the facility level (21). The framework includes eight core components: IPC programmes; guidelines; education and training; hospital-associated

infection (HAI) surveillance; multimodal strategies; monitoring/audit of practices and feedback; workload, staffing and bed occupancy; built environment, materials and equipment. The two additional areas of relevance, Breastfeeding and KMC, linked to prevention of neonatal infections and sepsis, were identified by those responsible for the provision of care at the QEH and communicated to the PAHO departments involved in the project during a team meeting in February 2021, and added to the framework.



*Figure 2. Adaptation of the WHO (2016) Framework for Infection Prevention and Control at the Facility Level for the Needs of the Neonatal Intensive Care at the Queen Elizabeth Hospital in Bridgetown, Barbados.*

A data collection tool was generated on Microsoft® Excel® 2016 MSO (see Annex 3). The data collection tool included six modules based on the adaptation of the WHO (2016) Framework for Infection Prevention and Control at the Facility level. Each module included the information requested, the component of the WHO (2016) framework it referred to, the possible verifier for the information requested and a general comment section. Data was requested from the last three years.

**Module 1: General Information.** Workload, staffing and bed occupancy was evaluated by inquiring about the composition of medical and non-medical staff at the unit, number of life births at the QEH and the number of those admitted to the NICU, number of neonates admitted to the NICU yearly, length of stay and bed occupancy. A staffing guideline was requested and the title, year of publication, level, endorsing body, target population, purpose and content were evaluated. Additionally, “General Conditions of Neonates” section, including causes for admission and number of neonates with risk factors, and “Outcomes” section, including

neonatal deaths by cause were added to understand the composition of patients and the severity of the conditions treated in the unit.

**Module 2: IPC Organization.** Data on the surveillance system used and if it's electronic or manual was requested. It also requested data on the IPC structure in the facility and on personnel responsible for IPC activities in the unit. Analysis of infection trends and number of outbreaks was requested. Education and training component was assessed by identifying if an orientation program for new personnel on IPC is present in the unit. It aimed to collect data on the title, content, periodicity of trainings, organizing entity and attendance of the orientation program. Monitoring, audit and feedback component was analyzed by requesting data on annual IPC goals in the unit, data to confirm that decisions are made to achieve these goals and that they are monitored and evaluated. Periodicity of these reports and information dissemination to the staff was also requested.

**Module 3: Hand Hygiene.** Guideline component was evaluated by requesting data on the presence of the hand hygiene guideline and aimed to evaluate the title, year of publication, level, endorsing body, target population, purpose and content of the guideline. Education and training component was evaluated by requesting data on the trainings including hand hygiene and aimed to collect data on the title, content, organizing entity, periodicity and attendance. It also assessed if other initiatives related to education and training and a professional who can serve as a trainer on hand hygiene are present in the unit. Monitoring, audit and feedback component should have been assessed by requesting data on performance of audits to assess the availability of soap, paper towels, other hygiene resources, availability and consumption of hand rub, as well as periodicity of feedback related to these audits given to the healthcare professionals. Data on the built environment, materials and equipment component and monitoring, audit and feedback component were initially included in the data collection tool, but after reconsideration, weren't requested due to time constraints and the inability to perform a physical audit in the unit.

**Module 4: CVC.** Data on the presence of the central venous catheter (CVC) guideline was requested. It aimed to evaluate the title, year of publication, level, endorsing body, target population, purpose and content. Education and training component was analyzed by requesting data on the group of caregivers who are responsible for CVC insertion, training on CVC maintenance, management and monitoring of adverse events. It aimed to collect data on title, content, organizing entity, periodicity and attendance of these trainings.

**Module 5: Breastfeeding.** information was provided during a team meeting in February that the QEH is a part of the Baby-friendly Hospital Initiative led by UNICEF and WHO. Thus, this component was built based on it. Data on breastfeeding/infant feeding policy covering all Ten Steps to successful breastfeeding and compliance to the Code, HIV infant feeding and mother friendly care were requested. It aimed to evaluate the title, year of publication, level, endorsing body, target population, purpose and content of the guidelines. The education and training component aimed to evaluate the trainings available in the facility on breastfeeding and aimed to evaluate the title, content, organizing entity, periodicity and attendance of the training. The monitoring, audit and feedback component assessed if there is a breastfeeding committee and coordinator in the hospital, if procedures to monitor that the hospital maintains BFHI status have been implemented, and if a re-assessment of the status was performed in 2017. The built environment, materials and equipment component was assessed by enquiring about visitation hours. Other data on the built environment, materials and equipment component was also initially included in the data collection tool, but after reconsideration, wasn't requested due to time constraints and the inability to perform a physical audit in the unit.

**Module 6: KMC.** Data on the presence of the KMC guideline was requested. It aimed to evaluate the title, year of publication, level, endorsing body, target population, purpose and content. Education and training component was assessed by inquiring about the title, content, organizing entity, periodicity and attendance of trainings including KMC. The monitoring, audit and feedback component was assessed by inquiring if a KMC coordinator is present in the facility and if indicators to monitor KMC are developed, monitored and evaluated.

Access to the data was facilitated by the Head of the NICU, Dr. Gillian Birchwood, who identified two clinical experts, a Registered Nurse Jesezar Gibson and Dr. Kerriann Pereira employed in the NICU at the QEH hospital. The experts collected the data requested from the last three years and were continuously consulted during the data analysis stage. Data on the built environment, materials and equipment component was initially included in the data collection tool, but after reconsideration, wasn't requested due to time constraints and the inability to perform a physical audit in the unit.

## 4. Results

### 4.1 Case Study: The Americas Region

#### 4.1.1 Neonatal Mortality in the Region

A comparison of mortality rates in the three databases: WHO GHE 2019, IHME GBD 2019 and PAHO show a pattern of reduction in the total number of neonatal deaths in the Americas



region between 1990 and 2019. According to the WHO GHE 2019 database, the total number of neonatal deaths decreased from 202,691 in 2000 to 110,159 in 2019 (45.7% reduction). According to the IHME GBD 2019 database, the total number of neonatal deaths decreased from 279,772 in 1990 to 113,740 in 2019 (59.3% reduction). The figures presented in the PAHO Mortality Database for the total number of neonatal deaths are lower than for WHO GHE 2019 and IHME GBD 2019 databases. According to PAHO Mortality Database, the total number of neonatal deaths decreased from 125,149 in 2000 to 79,546 in 2019 (36.4%).

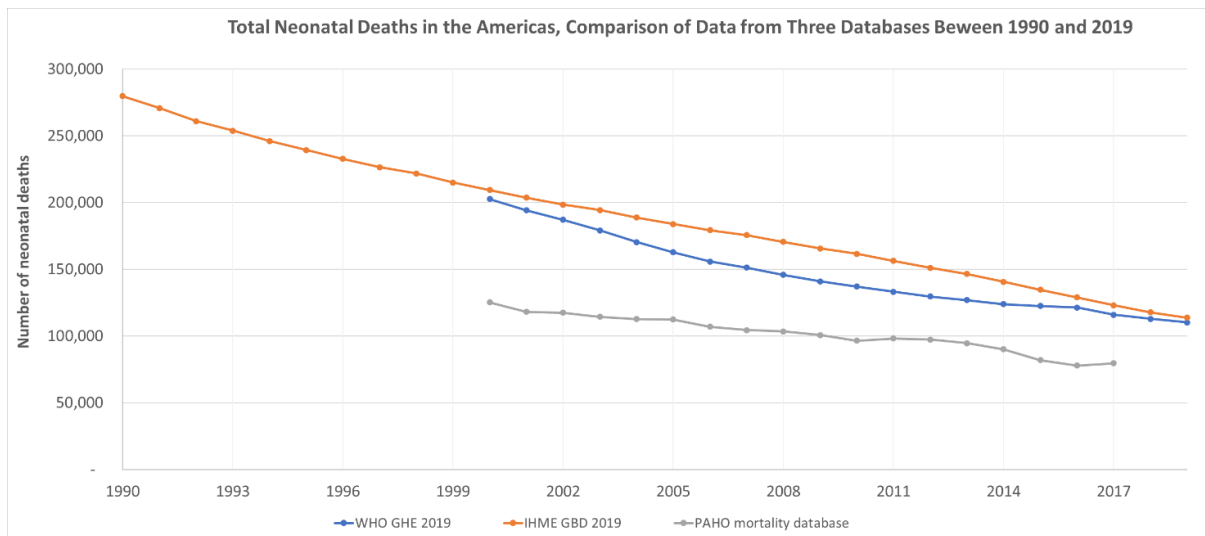


Figure 3. Comparison of Total Neonatal Deaths Between 1990 and 2019 from WHO GHE 2019, IHME HBD 2-19 and PAHO Mortality Databases.

NMR for the Americas region between 2000 and 2019 was obtained from IHME GBD 2019 database. The pattern of reduced neonatal mortality can be seen in Figure 5. below. The NMR decreased from 12.86 per 1,000 live births in 2000 to 7.48 per 1,000 live births in 2019.

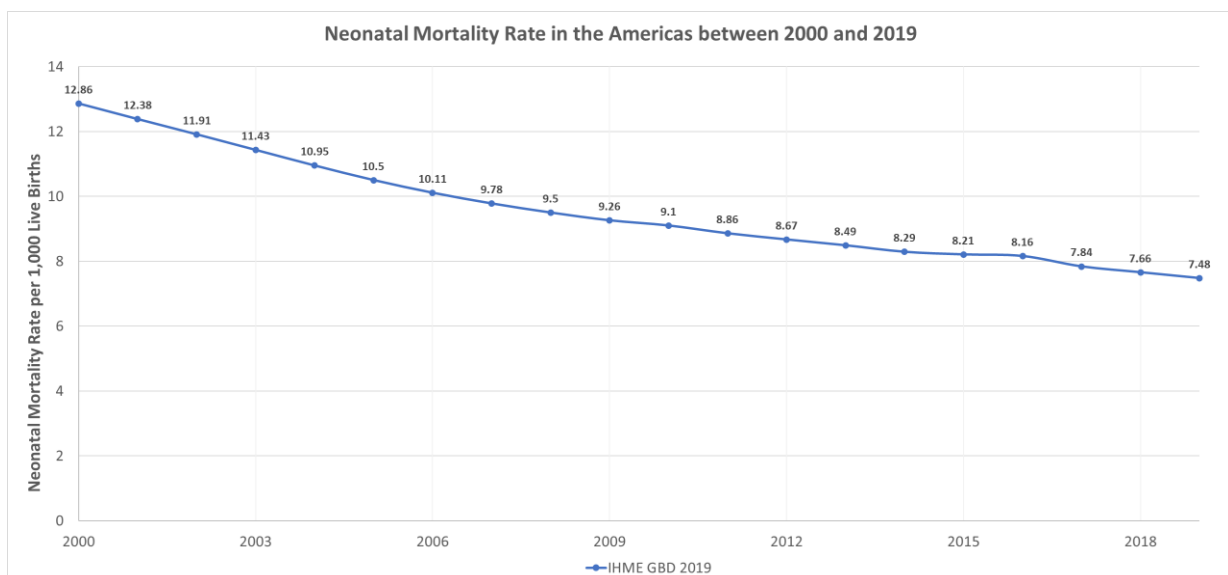


Figure 4. Neonatal Mortality Rate per 1,000 Live Births in the Americas Between 2000 and 2019 from IHME GBD 2019 Database.

#### 4.1.2 Main Causes of Neonatal Deaths in the Region

The proportional distribution of deaths by cause was obtained from all three databases: WHO GHE 2019, IHME GBD 2019 and PAHO Mortality Database (see Annex 4). According to the WHO GHE 2019 database, the four main causes of neonatal deaths in the Americas region in 2019 were preterm birth complications (35.0%), congenital anomalies (22.0%), birth asphyxia and birth trauma (14.3%), and neonatal infections and sepsis (12.5%). According to the IHME GBD Database, the four main causes of neonatal deaths in the Americas region in 2019 were neonatal preterm birth (31.3%), congenital birth defects (20.5%), encephalopathy due to birth asphyxia and trauma (15.0%) and neonatal infections and sepsis (12.5%). According to the PAHO Mortality Database, the four main causes of neonatal deaths in the Americas region in 2017 were preterm birth complications (24.5%), other neonatal conditions (22.9%), congenital anomalies (22.6%) and birth asphyxia and birth trauma (14.2%). Neonatal sepsis was the fifth most common cause of death (11.7%).

#### 4.1.3 Burden of Neonatal Infections and Sepsis in the Region

It can be observed that neonatal mortality due to neonatal infections and sepsis has not decreased at the same pace as the overall neonatal mortality and there is evidence that in fact, it has been increasing. Analysis from the three databases: WHO GHE 2019, IHME GBD 2019 and PAHO Mortality Database, show a similar neonatal mortality pattern due to infections and sepsis in the region.

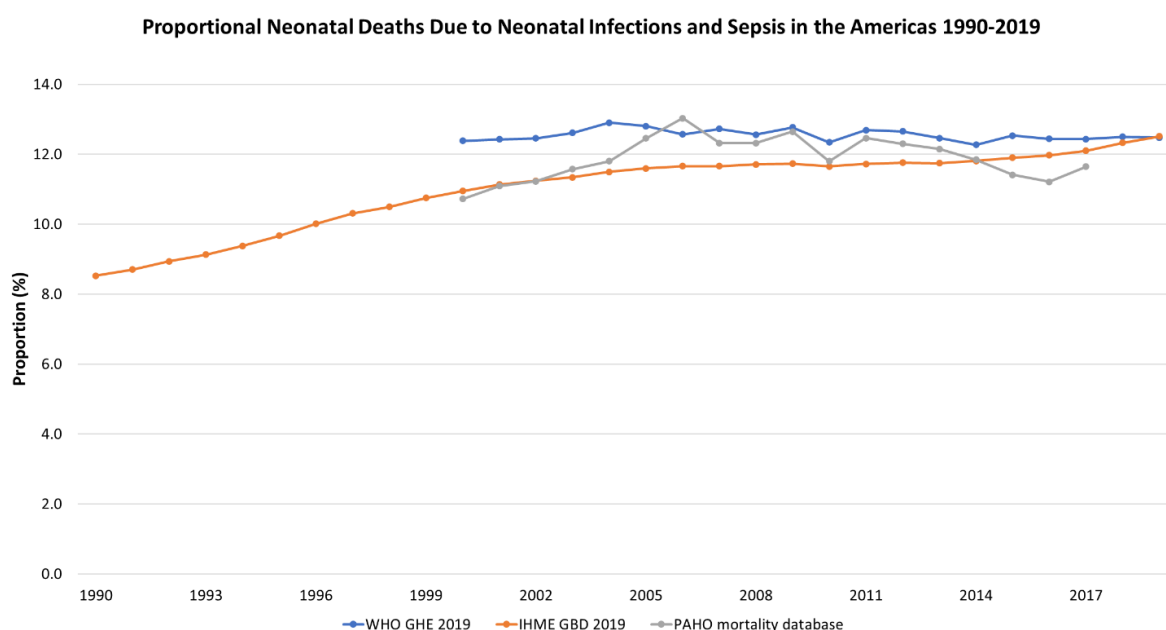


Fig 5. Proportion of Neonatal deaths due to Neonatal Infections and Sepsis in the Americas from 1990 to 2019. Comparison of data from WHO GHE 2019, IHME GBD 2019 and PAHO Mortality Databases.

According to the WHO GHE 2019 database, the burden of neonatal mortality due to infections and sepsis in the region has remained around 12.4% between 2000 and 2019. The estimates from the PAHO Mortality Database indicate an increase in neonatal mortality due to infections and sepsis from 10.7% to 11.6% in the region between 2000 and 2017. The estimates from the IHME GBD 2019 database indicate an increase in neonatal mortality due to infections and sepsis from 8.5% to 12.5% in the region between 1990 and 2019.

#### 4.1.4 Inequalities in Neonatal Mortality in the Region

The inequalities in neonatal mortality between countries described in the introductory chapter can also be observed in the analysis of all-cause neonatal mortality and neonatal mortality due to infections and sepsis from the IHME GBD 2019 database.

NMR per 1,000 live births varies greatly between countries in the region. The estimated highest neonatal mortality in the region was in Dominica (28.1), Haiti (25.3) and Dominican Republic (19.4) in 2019. The estimated NMR per 1,000 live births in the region was the lowest in Cuba (2.2), Canada (3.3) and Antigua and Barbuda (3.7) in the same year. The absolute measure of inequality remained the same between 2000 and 2019. Country with the highest neonatal mortality had 26 more deaths than the country with the lowest neonatal mortality per 1,000 live births in 2000 and in 2019. The relative measure of inequality has decreased from 2000 to 2019. Neonatal mortality was 12.9 times higher in 2000 and 8.0 times higher in 2019 in the country with the highest neonatal mortality compared to the country with the lowest neonatal mortality respectively.

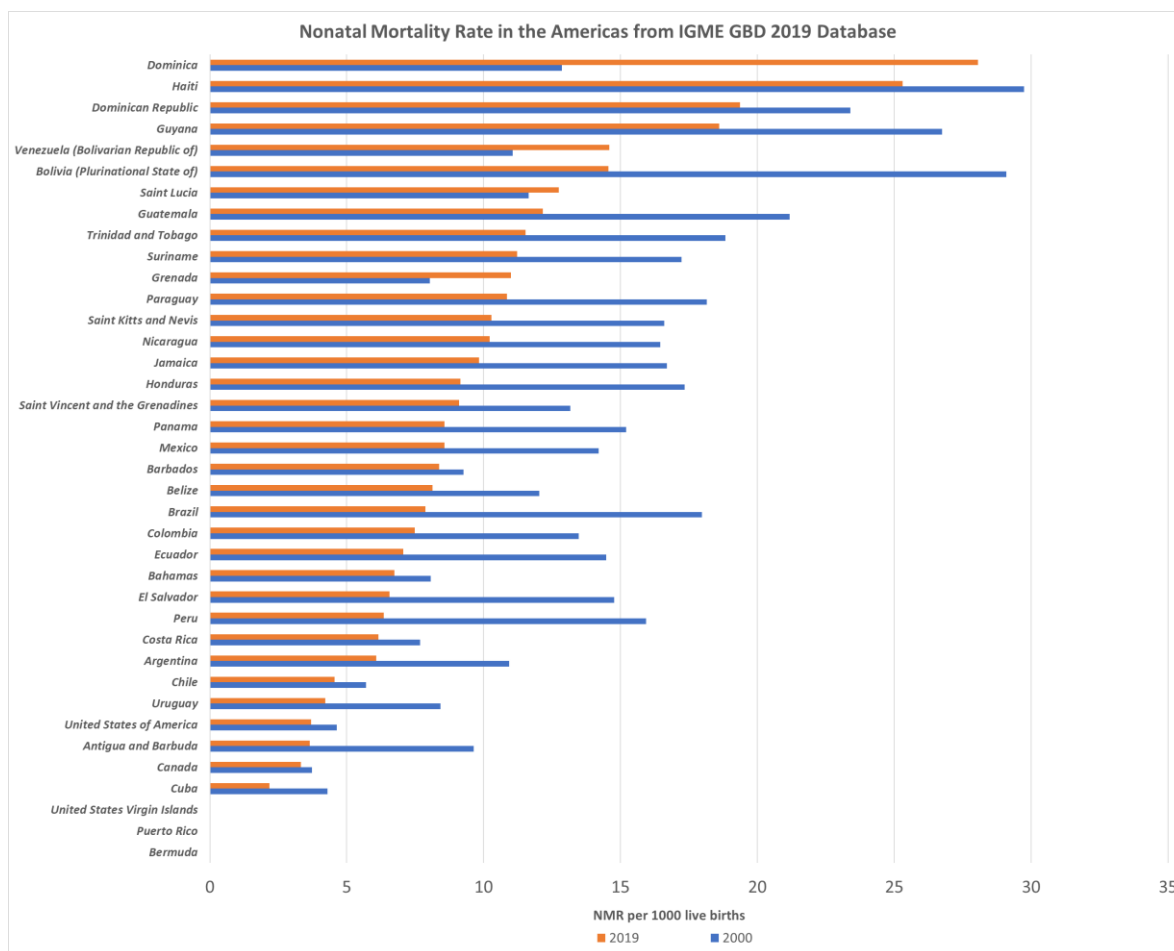


Figure 6. All-cause Neonatal Mortality Rate in the Americas, Comparison of 2000 and 2019 from IGME GBD 2019 Database.

Numerous countries have made significant progress in reducing neonatal mortality from 2000 to 2019. The estimates indicate that the three countries that managed to make the greatest progress in reducing neonatal mortality between 2000 and 2019 were Peru (from 15.9 to 6.4), Brazil (from 18.0 to 7.9) and El Salvador (from 14.8 to 6.6). In contrary, neonatal mortality has increased in four countries in the region between 2000 and 2019. These countries were Dominica (from 12.9 to 28.1), Grenada (8.0 to 11.0), Venezuela (Bolivarian Republic of) (from 11.1 to 14.6) and Saint Lucia (from 11.6 to 12.7).

#### 4.1.5 Inequalities in Neonatal Mortality Due to Neonatal Infections and Sepsis in the Region

NMR due to infections and sepsis also varies greatly between countries in the region. Countries that have high all-cause mortality rates also have high NMR due to infections and sepsis. Likewise, countries that have low all-cause mortality rates also have low NMR due to infections and sepsis. The estimated NMR due to infections and sepsis varies slightly between the WHO GHE 2019 and IHME GBD 2019 databases (see Annex 5). However, similar patterns

can be observed. According to the WHO GBD 2019 database, the highest NMR per 100,000 live births due to infections and sepsis was in Haiti (392), in Guyana (299) and in Grenada (275) in 2019. The estimated NMR per 100,000 live births was the lowest in Antigua and Barbuda (0), Costa Rica (13) and Canada (14). According to the IHME GBD 2019 database, the estimated highest NMR per 100,000 live births due to infections and sepsis was in Dominican Republic (453), in Dominica (432) and Bolivia (266) in 2019. The estimated NMR per 100,000 live births due to neonatal infections and sepsis was the lowest in Antigua and Barbuda (0), Saint Kitts and Nevis (0.0) and Canada (10) in 2019. The absolute measure of inequality has decreased according to the WHO GBD 2019 database. Country with the highest neonatal mortality due to infections and sepsis had 473 more deaths per 100,000 live births than the country with the lowest neonatal mortality due to infections and sepsis in 2000. Country with the highest neonatal mortality due to infections and sepsis had 392 more deaths per 100,000 live births than the country with the lowest neonatal mortality due to infections and sepsis in 2019. The absolute measure of inequality has increased according to the IHME GBD 2019 database. Country with the highest neonatal mortality due to infections and sepsis had 397 more deaths per 100,000 live births than the country with the lowest neonatal mortality due to infections and sepsis in 2000. Country with the highest neonatal mortality due to infections and sepsis had 453 more deaths per 100,000 live births than the country with the lowest neonatal mortality due to infections and sepsis in 2019.

Some countries in the region have made significant progress in reducing NMR per 100,000 live births due to infections and sepsis between 2000 and 2019. The estimates from the WHO GBD 2019 indicate that the three countries that managed to make the greatest progress in reducing neonatal mortality due to infections and sepsis for the reference period were Saint Lucia (from 205 to 47), Costa Rica (from 52 to 13) and Peru (from 190 to 48). Neonatal mortality due to infections and sepsis has also increased in Grenada (from 161 to 275), in Saint Vincent and the Grenadines (from 94 to 13), in Venezuela (Bolivian Republic of) (from 194 to 238), in Trinidad and Tobago (from 80 to 99), Belize (from 110 to 125), Haiti (from 351 to 392), Dominican Republic (from 239 to 255) and in Colombia (from 134 to 136). The estimates from the IHME GBD 2019 indicate that the three countries that managed to make the greatest progress in reducing neonatal mortality due to infections and sepsis between 2000 and 2019 were Paraguay (from 317 to 95), Costa Rica (from 51 to 20) and Ecuador (from 183 to 72). As all-cause neonatal mortality increased in the four countries mentioned in the previous paragraph, mortality due to infections and sepsis has also increased between 2000 and 2019 in these countries. It has increased from 161 to 432 in Dominica, from 80 to 183 in Grenada, from 167 to 247 in Venezuela (Bolivian Republic of), and from 92 to 134 in Saint Lucia. Additionally, even though all-cause neonatal mortality decreased in Belize, Barbados and

Dominican Republic, neonatal mortality due to infections and sepsis has increased between 2000 and 2019 in these countries. The increase was from 96 to 106, from 90 to 134, and from 397 to 453 respectively.

## 4.2 Case Study: Barbados

### 4.2.1 Neonatal Mortality and Burden of Neonatal Infections and Sepsis at the Country Level

According to the analysis from the WHO GHE 2019 database, the total number of neonatal deaths has decreased from 35 to 25 between 2000 and 2019 in Barbados. According to the analysis from the IHME GBD 2019 database, the total number of deaths has decreased from 53 to 25 and NMR per 1,000 live births decreased from 11.76 to 8.37 between 1990 and 2019 (see Annex 6).

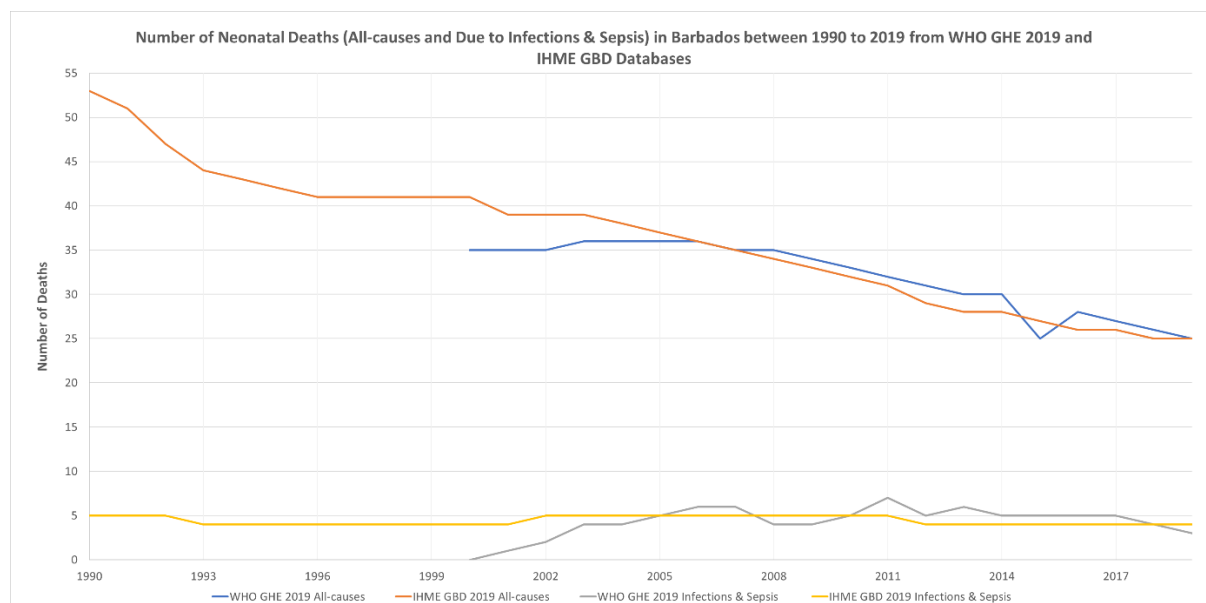


Figure 7. Total Number of Neonatal Deaths Due to All-causes and Due to Neonatal Infections and Sepsis between 1990 and 2019 from WHO GHE 2019 and IHME GBD 2019 Databases.

However, estimates from the WHO GHE 2019 database indicate that number of neonatal deaths due to infections and sepsis has increased from 0 to 3 and NMR per 100,000 live births increased from 0 to 100 between 2000 and 2019. Estimates from the IHME GBD 2019 database indicate that neonatal deaths due to infections has only decreased from 5 to 4 and the NMR per 100,000 live births increased from 111 to 134 between 1990 and 2019. Due to the decreasing all-cause NMR and the increase in the NMR due to neonatal infections in the country, the burden of mortality due to infections and sepsis has a positive trend. According to the analysis of the WHO GHE 2019 database, the proportional mortality due to this cause

has increased from 0% to 12% between 2000 and 2019, and according to the analysis of the IHME GBD 2019 database, it has increased from 9.4% to 16.0% between 1990 and 2019 (see Annex 6).

### 4.3 Case Study: Neonatal Intensive Care Unit at the Queen Elizabeth Hospital

Data analysis at the facility level is presented in this chapter. The tables in each sub-section below present the data that was requested according to the WHO (2016) framework for IPC at the facility level and includes information if the data was received or unobtained. The data that was received was analyzed. The data that was not obtained was either unavailable or wasn't communicated.

#### 4.3.1 General Conditions and Outcomes of Neonates

<b>General Conditions of Neonates</b>		
	Admission of neonates by cause	Risk factors of admitted neonates
<b>Received</b>		✓
<b>Unobtained</b>	X	
<b>Outcomes of Neonates</b>		
	Neonatal deaths by cause	
<b>Received</b>		
<b>Unobtained</b>	X	

*Table 2. Visual Representation of the Data that was Received or Unobtained for the General Conditions and Outcomes of Neonates Module for the Baseline Assessment of the NICU at the QEH.*

Patient days according to weight and other risk factors (CVC line, ventilation, urinary catheter) have been obtained. There was a total of 4263 patient days in the NICU between June 2019 and June 2020. Neonates who weighed less than 750 grams accounted to 349 patient days. Neonates who weighed between 751 to 1000 grams accounted to 697 patient days. Neonates who weighed between 1001 to 1500 grams accounted to 914 patient days and neonates who weighed between 1501 and 2500 grams accounted to 944 patient days. Neonates who weighed over 2500 grams accounted to 1415 patient days.

The rate for CVC line utilization was 0.12 per total patient days (total of 493 CVC utilization days) in the unit between June 2019 and June 2020. The CVC line utilization rate of 0.15 per total patient days was the highest for neonates who weighed over 2500 grams, followed by the rate of 0.12 for neonates who weighed between 1001 and 1500 grams. The rate for

ventilation utilization was 0.16 per total patient days (total of 696 ventilator utilization days) in the unit between June 2019 and June 2020. The ventilation utilization rate of 0.39 per total patient days was the highest for neonates who weighed between 751 to 1000 grams, followed by the rate of 0.28 per total patient days for neonates who weighed less than 750 grams. The rate for urinary catheter utilization was 0.01 per total patient days (total of 36 urinary catheter utilization days) in the unit between June 2019 and June 2020. The urinary catheter utilization rate of 0.02 per total patient days was the highest for neonates who weighed over 2500 grams, followed by the rate of 0.01 per total patient days for neonates who weighed between 1501 to 2500 grams. Neonates who weighed less than 750 grams to 1500 grams had the rate of 0.00 per total patient days for urinary catheter utilization.

Neonatal deaths by cause were not obtained, but instead, NMR from 2017 to 2020 was received. NRM in the unit has been steadily decreasing since 2017. It was 9.7 (23 deaths) in 2017, 8.6 (20 deaths) in 2018, 5.6 (14 deaths) in 2019 and 5.0 (14 deaths) in 2020.

#### 4.3.2 Workload, Staffing and Bed Occupancy

<b>Workload, Staffing and Bed Occupancy</b>					
	Composition of staff	Number of life birth at QEH and number of those admitted to NICU	Number of neonates admitted to the NICU yearly	Length of stay	Bed occupancy
<b>Received</b>	✓	✓ (partially)	✓		
<b>Unobtained</b>				X	X

*Table 3. Visual Representation of the Data that was Received or Unobtained for the Workload, Staffing and Bed Occupancy Component for the Baseline Assessment of the NICU at the QEH.*

The NICU has a number of medical and non-medical staff who support functioning of the unit. From the medical staff, it has one neonatologist, eight senior doctors who rotate between NICU/Pediatrics and Labor Wards at the hospital, an unknown number of medical interns who rotate throughout the directorate on a three-month basis, two nursing officers, 17 registered nurses and midwives, as well as an unknown number of fourth- fifth year medical students and nursing/midwifery students occasionally rotate throughout the units. It has one clerk, three department aids and three housekeepers as support staff.



Additionally, number of patients and number of nurses working for each shift were submitted for review for March 2021. On four-morning shifts, 11-evening shifts and nine-night shifts out of the 31 days, there was a need for a nurse(s) to either do overtime to assist in provision of care, or help was received from another department. On six days out of 31 days, there was one patient requiring 1:1 care and on 17 days out of 31 days, there were two patients requiring 1:1 care due to infection control precautions.

In total there were 2326, 2301, 2413 and 2211 live births for 2017, 2018, 2019 and 2020 respectively at the QEH. The number of neonates admitted to the NICU was stable through the last four years: 462, 283, 447 and 400 for 2017, 2018, 2019 and 2020 respectively.

### 4.3.3 Guidelines

The title, year of publication, level, endorsing body, target population, purpose and content was evaluated of each guideline that was obtained (see Annex 7).

<b>Guidelines</b>					
	Staffing	Hand hygiene	CVC	Breastfeeding	KMC
<b>Received</b>	✓		✓	✓	
<b>Unobtained</b>		X			X

*Table 4. Visual Representation of the Data that was Received or Unobtained for the Guidelines Component for the Baseline Assessment of the NICU at the QEH.*

Booklet for Nursing Staff NICU exists in the NICU. The purpose of the booklet is to compile objectives and guidelines for new nurses and midwives at the unit and it includes a chapter on staffing recommendations for morning, evening and night shifts. It was last updated in 2001.

Insertion of CVCs and peripherally inserted central catheters (PICCs) guideline exist in the unit and is effective since June 2015. Two checklists are also applied in the unit: the CVC Insertion Checklist and CVC Maintenance Checklist. They were last published/updated in March 2018 and March 2017 respectively.

The QEH hospital has developed its facility wide breastfeeding policy in 2017. The facility wide breastfeeding policy covers all Ten Steps to successful breastfeeding and states compliance to the International Code of Marketing of Breast-milk Substitutes (22). The Mother-friendly care is not addressed in the guideline and the QEH has not signed the agreement of UNICEF/WHO Infant Feeding Recommendations for HIV Positive Women (23). However, staff at the QEH are obliged to provide each woman who is HIV-positive one-to-one discussion to help her decide the best way to feed her infant in her individual situation. Creation of the facility breastfeeding policy in 2017 has also initiated the creation of the visitation policy at the QEH, which should emphasize mother and infant bonding and decrease interactions to infant feeding and sleeping patterns, but do not unreasonably restrict visitations. This policy was not accessed during the review. The QEH has also developed a guideline on safe management of expressed milk in March 2020, with the goal to establish an environment where practices are consistent and to permit for the safe and quality management and use of expressed breast milk.

A guideline on kangaroo mother care has not been developed.

#### 4.3.4 Education and training

Education and Training					
	IPC	Hand hygiene	CVC	Breastfeeding	KMC
<b>Received</b>	✓ (partially)			✓ (partially)	✓ (partially)
<b>Unobtained</b>		X	X		

Table 5. Visual Representation of the Data that was Received or Unobtained for the Education and Training Component for the Baseline Assessment of the NICU at the QEH.

According to the information obtained from the clinical experts during the data collection stage, The Training Team in the Human Resource department is responsible for providing trainings and upkeeping registries of staff who have participated in trainings in the facility. However, records of available trainings, content, organizing entity periodicity and attendance hasn't been obtained. The information on education and trainings presented in this section is obtained either from personal communication with the clinical experts or from the guidelines that have been accessed.

Participation in infection control and A.I.D.S workshops and seminars are compulsory for the medical staff at the facility. Previously, according to communication with the clinical experts, link nurses were also allocated in the unit for infection prevention and control activities, but this position is currently inactive.

According to the Insertion of CVC Lines and PICC Lines Bundle guideline (2015), medical staff can only insert and maintain peripheral line and central vascular catheters if they have been trained and are aware of appropriate infection prevention and control measures to prevent blood stream associated infections. These trainings should be provided at the time of hire and annually thereafter.

All staff in the NICU need to be trained on skills necessary to implement the breastfeeding policy upon hire and annually thereafter (Breastfeeding Policy, 2017). The following must be insured: policy orientation within 4 weeks of hire (recorded in the orientation checklist), training to implement the policy within 6 months of hire, all staff should participate in the Baby Friendly Hospital Initiative (BFHI) 20 Hour Course developed by WHO and UNICEF, and receive certificates. According to communication with the clinical experts, the orientation checklist for new hires is not currently used in the NICU. The last BFHI 20 Hour Course was conducted in 2018 and other hospital level courses covering breastfeeding were conducted in 2019. Lactation nurse position was also created in 2017. The role of the lactation nurse was to guide breastfeeding mothers and the staff. This position is no longer active in the hospital.

An “Essential Care for Small Babies” in the context of Zika was conducted in November 2018 and included a section on Thermal Care (temperature maintenance, continuous and prolonged skin to skin care, other warming methods: incubators, radiant warmers).

#### 4.3.5 Surveillance

Surveillance					
	Surveillance system			Support (paper, electronic)	
<b>Received</b>					
<b>Unobtained</b>	<b>X</b>			<b>X</b>	
Indicators					
	IPC	Hand hygiene	CVC	Breastfeeding	KMC

<b>Received</b>	✓ (partially)				
<b>Unobtained</b>		X	X	X	X

Table 6. Visual Representation of the Data that was Received or Unobtained for the Surveillance Component for the Baseline Assessment of the NICU at the QEH.

For surveillance, partial data on infections for the unit was obtained. Data from December 1<sup>st</sup> 2017 to June 2<sup>9th</sup> 2020 was analyzed. The most frequently reported organisms responsible for 55 cases (55%), at the unit were gram negative organisms, followed by gram positive organisms responsible for 39 cases (39%) and yeast responsible for 6 cases (6%) between 2017 and 2019. 68 cases (68%) were identified from blood cultures, 14 cases (14%) were identified from urine cultures and 9 cases (9%) were identified from wound swabs. The most frequently reported organisms were *Klebsiella pneumoniae* (19), *Staphylococcus aureus* (14), *Staphylococcus haemolyticus* (13), *Escherichia coli* (10), *Serratia marcescens* (10), *Staphylococcus epidermidis* (8), *Proteus mirabilis* (6) and *Enterococcus faecalis* (5). These organisms were responsible for 61.5% of the total infections. The most common organism reported from blood cultures was *Staphylococcus haemolyticus* (16.9%), followed by *Staphylococcus aureus* (15.6%) and *Staphylococcus epidermitis* (10.4%). The most common organism reported from urine cultures was *Klebsiella pneumoniae* (45.5%), followed by *Escherichia coli* (22.7%) and *Enterobacter cloacae* (0.1%). The most common organisms reported from wound swabs were *Enterococcus faecalis* (25.0%) and *Proteus mirabilis* (25.0%).

According to the Insertion of Central Venous Lines and PICC Lines Bundle guideline (2015), central line associated-blood stream infection (CLABSI) rate is the most important indicator to be collected by the Infection Control Team to monitor infections associated to CVCs and peripheral lines. However, CLABSI rates have not been obtained during the baseline assessment stage.

According to the two consultants, indicators for breastfeeding and KMC have not been implemented the unit.

#### 4.3.6 Monitoring, Audit and Feedback

<b>Monitoring, Audit and Feedback</b>
---------------------------------------

	IPC	Hand hygiene	CVC	Breastfeeding	KMC
<b>Received</b>				<b>X</b>	
<b>Unobtained</b>	<b>X</b>	<b>X</b>	<b>X</b>		<b>X</b>

*Table 7. Visual Representation of the Data that was Received or Unobtained for the Monitoring, Audit and Feedback Component for the Baseline Assessment of the NICU at the QEH.*

According to the Insertion of Central Venous Lines and PICC Lines Bundle guideline (2015), the Infection Control Team is responsible for measuring the team compliance with the central line bundle, best practices and evidence-based guidelines, as well as measuring the effectiveness of prevention strategies and communicating this information to the Hospital Infection Control Committee, Executive Directors, Medical and Nursing Staff, and other clinicians. However, this information for IPC, hand hygiene and CVC line care has not been obtained.

QEH was designated as “Baby-friendly” hospital in November 2017, which is an initiative created by UNICEF and WHO to ensure that all maternities become centers of breastfeeding support. The hospital implemented all Ten Steps required by the initiative and an optional component of mother-friendly care. The HIV and Infant feeding optional component weren’t included. The report of the November 2017 assessment has provided with specific recommendations on how to improve and maintain status of Baby-Friendly Hospital Initiative (BFHI) for each step as well as provided with general recommendations. The report stressed the importance for the hospital to develop and implement procedures for monitoring the implementation of BFHI to ensure that the recommended standards are maintained and suggested a re-assessment in two years’ time. To current knowledge, the re-assessment of the BFHI for the hospital has not been performed at the end of 2019.

According to the two consultants, KMC practices are not monitored or evaluated in the unit.

#### 4.2.7 Built Environment

<b>Built Environment</b>			
	Number of beds	Distance between beds	Number of isolation rooms
<b>Received</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>
<b>Unobtained</b>			

*Table 8. Visual Representation of the Data that was Received or Unobtained for Built Environment Component for the Baseline Assessment of the NICU at the QEH.*

The unit can accommodate 24 patients. It has 13 working incubators and 10 cots. Two isolation rooms are present in the unit. The distance between beds ranges between 3 feet (91cm) or more, depending on the occupancy of the unit.

## 5. Recommendations

Reflecting on the analysis of the burden of neonatal infections and sepsis at the regional, country and facility level, it can be observed that it's a regional problem rather than a problem that one facility is faced with. The burden of infections and sepsis shows a positive trend in the LAC region and in Barbados. The NICU at the QEH particularly carries a great responsibility as it's the only facility that provided advanced medical care to neonates in Barbados. It also provides advanced medical care to sick neonates from other Eastern Caribbean countries (14). Hence, one of the recommendations is to implement an intervention that can be adapted to other countries in the LAC region.

The baseline assessment at the facility level looked at multiple factors that can prevent and reduce neonatal infections and sepsis. The WHO (2016) framework for IPC identifies neonatal infections as multifactorial problem and a combination of interventions are needed to reduce the burden of neonatal infections and sepsis at a facility level. Multimodal interventions are defined as *“strategies that comprises several elements or components (three or more; usually five) implemented in an integrated way with the aim of improving an outcome and changing behaviour”* (21). By using the concept of multimodal strategies, a recommendation could have been made to prioritize one of the care areas and focus on the core components of the framework. For example, a recommendation could have been made to focus on CVC line care and to review and update all of the guidelines that are older than three years, to ensure that all staff is trained on insertion and maintenance of CVCs at the time of hire and yearly thereafter, to continuously collect, monitor and evaluate CLABSI rates and to develop additional indicators related to CVC care, to audit compliance to the CVC bundles, to disseminate this information to the staff and to perform an assessment of the built environment, materials and equipment for CVC care (24). Nonetheless, all of the necessary information of the burden of neonatal infections and sepsis has not been identified and for many of the components, information was not obtained even though time allocated for the baseline assessment stage was extended. Discrepancies in the data collected were also observed. Hence, a recommendation is made to focus on the “Surveillance” component of the framework. A standardized surveillance tool, including a set of input, process and outcome

tools can help perform quality baseline assessments on the quality of neonatal infection and sepsis care in the future. This tool could also help to identify if an intervention is needed and potentially contribute to evaluations of other interventions.

## 5.1 Action Plan

The action plan for strengthening the surveillance system for quality of neonatal infection and sepsis care has been proposed (see Annex 8).

1. The first step is to review the literature and publications published by WHO to pool a potential list of indicators related to neonatal infection and sepsis care.
2. A preliminary list of indicators will be identified by a) removing duplicates b) discarding indicators that don't fit inclusion criteria c) modifying and merging indicators
3. The preliminary list of indicators will go through a review process of a Consensus Building Panel, composed of multiple experts from PAHO/WHO and facilities in the LAC region. During the first stage, the panel would give their expertise on the potential indicators and could suggest additional indicators through a survey developed by CLAP-SMR.
4. The feedback received from the first Consensus Building Panel will be analyzed and necessary changes will be made.
5. The Consensus Building Panel will give their expertise again in an online meeting to finalize the set of indicators for piloting
6. The indicators will be piloted in NICUs in the LAC region
7. The feasibility of the indicators will be evaluated

The first two stages of the action plan have been initiated and a preliminary list of eight indicators has been identified:

1. Input indicators
  - 1.1. Availability of up-to-date guidelines, protocols and standard operating procedures
  - 1.2. Records of availability of first- and second line antibiotics
  - 1.3. Proportion of healthcare staff who have received training in the recognition and management of suspected newborn infections at least once in the last 12 months
2. Output/process
  - 2.1. Proportion of newborns in the health facility for whom a blood culture was taken prior to starting antimicrobial treatment
  - 2.2. Knowledge of the correct antibiotic treatment of newborn sepsis

3. Outcome
  - 3.1. Differential frequency of early and late neonatal sepsis
  - 3.2. Proportionate mortality rate
  - 3.3. Case fatality rate

An example of a technical file and a data collection tool can be found for Input indicator 1.3” Proportion of healthcare staff who have received training in the recognition and management of suspected newborn infections at least once in the last 12 months” in annex 9.

## 6. Discussion

The first objective of this thesis was to identify the burden of neonatal infections and sepsis at a regional and country level. Data analysis from the three databases: WHO GHE 2019, IHME GBD 2019 AND PAHO Mortality Database allowed to observe consistencies in the burden of neonatal infections and sepsis in the LAC region and Barbados. The second objective of this thesis was to identify the burden and the main causes of neonatal infections and sepsis at a facility level. Data collected and analysed from the NICU at the QEH provided some insight into the issue, but also encountered difficulties in obtaining the data and discrepancies in the data collected. As a result, a recommendation to establish a surveillance system for quality of neonatal sepsis care in the LAC region has been made.

This is the first study that aimed to describe the burden of neonatal infections and sepsis in the LAC region and countries in the region. It identified that even though neonatal mortality is decreasing in the region, neonatal mortality due to infections and sepsis remains the same or increases. Proportional distribution of neonatal mortality due to infections and sepsis was similar in all three databases and it can be concluded that infections and sepsis is one of the main causes of neonatal deaths in the region. The data suggests that neonatal mortality due to infections and sepsis will represent a higher proportional distribution in the all-cause neonatal mortality in the future if actions to prevent it are not taken. These results were expected and follow the same pattern as the all-cause neonatal mortality and neonatal mortality due to infections and sepsis globally (2).

The differences in in all-cause neonatal mortality due to infections and sepsis between countries in the LAC region express great inequalities. The absolute measure of all-cause neonatal mortality has not decreased from 2000 to 2019 and the relative measure of all-cause neonatal mortality due to infections and sepsis has only decreased from 12.9 to 8.0 per 1,000



live births. Consensus for either increase or decrease in neonatal mortality due to infections and sepsis cannot be reached due to differences in the estimates from WHO GHE 2019 and IHME GBD 2019 databases. The WHO GHE 2019 reported a decrease in absolute measure of mortality due to infections and sepsis and IHME GBD 2019 database reported an increase in the measure between 2000 and 2019. Nevertheless, the inequalities for mortality due to infections and sepsis remain very high in the region – the country with the highest neonatal mortality due to infections and sepsis had either 392 or 453 more deaths per 100,000 live births than the country with the lowest mortality. It was beyond the scope of this study to explore if these inequalities in neonatal mortality due to infections and sepsis persist in other regionals as well. However, the Health Equity Report published in 2016 identified the need to narrow the inequity gap in neonatal care between the countries and within countries in the region (25). One course of action would be to include socioeconomic factors when collecting, monitoring and analysing data related to neonatal infections and sepsis.

In Barbados, all-cause neonatal mortality has decreased, yet neonatal mortality due to infections and sepsis has increased. The increase in the proportional mortality due to infections cannot be validated due to the different starting points in the estimates from the WHO GHE 2019 and IHME GHE 2019 databases, but currently it stands at either 12.0% or 16.0%. The estimates in the proportional mortality due to infections and sepsis fluctuate greatly. This is not due to great differences in mortality due to infections and sepsis yearly, but due to the fact that Barbados has a small population and generally low number of neonatal deaths.

Overall, the three sources used to identify the burden of infections and sepsis on neonatal mortality have provided useful insights into the situation in the LAC region and Barbados. The differences observed in the three databases might be due to three reasons. First of all, WHO GHE 2019 and IHME GBD 2019 provide neonatal mortality estimates. Hence, it could be that they overestimate neonatal mortality in the region. Secondly, PAHO Mortality Database uses data provided by countries in the region from their vital registration systems. Thus, lower reported neonatal mortality in the PAHO Mortality Database could be due to the underreporting of neonatal mortality by the countries in the region. Thirdly, all three databases use ICD-10 coding, but the composition of neonatal mortality causes is different in each database. This could be one of the explanations why the estimated NMR due to infections and sepsis was 0 deaths per 100,000 live births in some countries in the region in 2000 and 2019. It is also paramount to mention that the data analysed was from the countries in the WHO region of the Americas and not only the LAC region. The Americas also include two countries from the North America: Canada and United States of America. It's important to acknowledge that these

countries have one of the lowest NMRs due to all-causes and due to infections and sepsis. It indicates significant differences between the North America and the LAC region in terms of neonatal care and highlights the importance for the countries in the LAC region to strengthen their efforts in improving neonatal care, including care for infections and sepsis.

The baseline assessment performed at the facility level was paramount to understand the situation in the NICU at the QEH in order to recommend a facility-centered intervention. Instead, delays in data collection and analysis and inability to perform a physical audit in the unit were encountered due to the Covid-19 pandemic. A considerable amount of data requested was also not communicated. Nevertheless, a gap in data collection and analysis at a facility level was observed and the need to establish a surveillance system for quality-of-care indicators related to neonatal infections and sepsis in NICUs in the region was recognized. The suggestion is reinforced by the literature stating that in fact, fundamental structures need to be in place before any intervention is implemented. The authors of the Guidelines of Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level (2016) outlined a number of scientific articles that identified that just a surveillance system itself without an additional intervention can contribute to reduction of infections (21). Results from Schwab et al. (2016) also supported these findings (26). Further, the surveillance system can help highlight if quality of neonatal infection and sepsis care standards are implemented in the unit, identify what interventions and improvements are needed, and can help evaluate them (21).

## 7. Conclusion

This study concluded the high burden of neonatal infections and sepsis in the LAC region. In Barbados, and increase in neonatal infections and sepsis has already been observed, and the NICU at the QEH is taking steps into the right direction to address it. Implementing and improving the standards of quality of neonatal infections and sepsis care in facilities in the LAC region can be one of the many contributions to improve outcomes, save lives and to facilitate achievement of the SGD goal 3.2 by 2030. Further research on how the data received from the strengthened surveillance system for quality of neonatal infections and sepsis care is used to implement interventions and to achieve behavioural and system change will be needed.

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## Annex 1 ICD-10 Code Combinations used in WHO GHE 2019, IGME GHE 2019 and PAHO Mortality Database

### WHO GHE 2019:

Neonatal Deaths Causes	ICD-10 Codes
<b>Neonatal conditions</b>	<b>P00-P96 (minus P23, P37.3, P37.4)</b>
Preterm birth complications	P05, P07, P22, P27-P28
Birth asphyxia and birth trauma	P03, P10-P15, P20-P21, P24-P26, P29
Neonatal sepsis and infections	P35-P39 (minus P37.3, P37.4)
Other neonatal conditions	P00-P02, P04, P08, P50-P96
<b>Congenital anomalies</b>	<b>Q00-Q99 (minus Q86.0)</b>
Neural tube defects	Q00, Q05
Cleft lip and cleft palate	Q35-Q37
Down syndrome	Q90
Congenital heart anomalies	Q20-Q28
Other chromosomal anomalies	Q91-Q99
Other congenital anomalies	Q01-Q04, Q06-Q18, Q30-Q34, Q38-Q89 (excluding Q86.0)

### IHME GHE 2019:

Neonatal Deaths Causes	ICD-10 Codes
<b>Neonatal disorders</b>	<b>A40.1, B95.1, P00-P05, P07-P15, P19-P22, P24-P29, P36, P38-P39, P50-P61, P70-P72, P74, P75-P78, P80-P81, P83-P84, P90-P92, P94, P96.3-P96.4, P96.8-P96.9</b>
Neonatal preterm birth	P07.2-P07.3, P22, P25-P28, P61.2, P77
Neonatal encephalopathy due to birth asphyxia and trauma	P02-P03, P10-P15, P20-P21, P52, P90-P91
Neonatal sepsis and other neonatal infections	A40.1, B95.1, P36, P38-P39.9
Hemolytic disease and other neonatal jaundice	P55-P59
Other neonatal disorders	P00-P01, P04-P05, P07-P09, P19-P19, P50-P51, P53-P54, P60-P61.1, P61.3-P61.9, P70-P72, P74-P76, P78, P80-P81, P83-P84, P92, P94, P96.3-P96.4, P96.8-P96.9

<b>Congenital birth defects</b>	<b>G71.2, P96.0, Q00-Q07, Q10-Q15, Q17-Q18, Q20-Q28, Q30-Q45, Q50-Q56.4, Q63.3, Q64, Q65-Q87.89, Q89.8, Q90-Q93, Q95-Q99</b>
Neural tube defects	Q00-Q01, Q07.0
Congenital heart anomalies	Q20-Q28
Orofacial clefts	Q35-Q37
Down syndrome	Q90
Other chromosomal abnormalities	Q74.8, Q75.1, Q75.4, Q75.8, Q79.6, Q87-Q87.89, Q91-Q93, Q95.2-Q95.9, Q97, Q99
Congenital musculoskeletal and limb anomalies	Q65.2, Q65.8-Q66.1, Q68.1-Q68.2, Q68.6-Q74.3, Q74.9-Q75.0, Q75.5, Q75.9-Q76.4, Q76.8, Q79.8-Q79.9
Urogenital congenital anomalies	P96.0, Q50-Q52.2, Q52.4, Q52.6-Q52.9, Q54-Q55.2, Q55.2-Q56.4, Q64.1
Digestive congenital anomalies	Q38-Q38.0, Q38.3-Q38.4, Q38.6-Q43, Q43.1-Q45.8, Q79.0-Q79.59
Other congenital birth defects	G71.2, Q02-Q04, Q06-Q07.0, Q07.8-Q07.9, Q10-Q15, Q17-Q18, Q27.0, Q30-Q34, Q38.1-Q38.2, Q38.5, Q43.0, Q45.9, Q52.3, Q52.5, Q53, Q55.2, Q63.3, Q65.3-Q65.6, Q66.2-Q67.8, Q68.0, Q68.3-Q68.5, Q74.0, Q75.2-Q75.3, Q76.0, Q76.5-Q76.7, Q80-Q86.8, Q89-Q89.8, Q95.0-Q95.1

**PAHO Mortality Database:**

<b>Neonatal conditions</b>	<b>P00-P96</b>
Preterm birth complications	P05, P07, P22, P27-P28
Birth asphyxia and birth trauma	P03, P10-P15, P20-P21, P24-P26, P29
Neonatal sepsis	P35-P39
Other neonatal conditions	P00-P02, P04, P08, P23, P50-P96
<b>Congenital anomalies</b>	<b>Q00-Q99</b>
Neural tube defects	Q00-Q05
Cleft lip and cleft palate	Q35-Q37
Down syndrome	Q90
Congenital heart anomalies	Q20-Q28
Other chromosomal anomalies	Q91-Q99
Other congenital anomalies	Q06-Q18, Q30-Q34, Q38-Q89
Sudden infant death syndrome	R95
Other	A00-O99, V00-Y89
Ill defined	R00-R94, R96-R99

## Annex 2 Countries and Dependencies in the LAC Region & Counties in the WHO Region of the Americas

<b>33 countries in the LAC region</b>	<b>Countries in the WHO region of the Americas</b>
Antigua and Barbuda, Argentina	Antigua and Barbuda, Argentina
Bahamas, Barbados, Belize, Bolivia (Plurinational State of), Brazil	Bahamas, Barbados, Belize, Bolivia (Plurinational State of), Brazil
Chile, Colombia, Costa Rica, Cuba	Canada, Chile, Colombia, Costa Rica, Cuba
Dominica, Dominican Republica	Dominican Republic
Ecuador, El Salvador	Ecuador, El Salvador
Grenada, Guatemala, Guyana	Grenada, Guatemala, Guyana
Haiti, Honduras	Haiti, Honduras
Jamaica	Jamaica
Mexico	Mexico
Nicaragua	Nicaragua
Panama, Paraguay, Peru	Panama, Paraguay, Peru
Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname	Saint Lucia, Saint Vincent and the Grenadines, Suriname
Trinidad and Tobago	Trinidad and Tobago
Uruguay	United States of America, Uruguay
Venezuela (Bolivarian Republic of)	Venezuela (Bolivarian Republic of)
<b>15 dependencies or other territories in the LAC region</b>	
Anguilla, Aruba	
British Virgin Islands	
Cayman Islands, Curaçao	
Falkland Islands, French Guiana	
Guadeloupe	
Martinique, Montserrat	
Netherlands Antilles	
Puerto Rico	
Sint Maarten	
Turks and Caicos	
U.S. Virgin Islands	



## Annex 3 Data Collection Tool

Module 1: General Information			
Structural			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Number of professionals working in the NICU: medical team a) neonatologists b) medical doctors c) midwives, registered nurses d) auxillary nurses e) other medical staff; management a) ward managers; support staff a) housekeeping b) secretary c) social workers d) other	Workload, staffing and bed occupancy	Employee register	Important for descriptive reasons and for possible interventions
Staffing guideline	Workload, staffing and bed occupancy	Staffing guideline	Title, year of publication, level, endorsing body, target population, purpose, content
Number of life birth at QEH and number of those admitted to NICU	Workload, staffing and bed occupancy	Patient data register	Description, derivation of predischage neonatal death rate
Number of neonates admitted to the NICU yearly	Workload, staffing and bed occupancy	Patient data register	Description, adequate staffing according to patient workload
Length of stay	Workload, staffing and bed occupancy	Reports	Description, severity of patient conditions
Bed occupancy	Workload, staffing and bed occupancy	Reports	Bed occupancy should not exceed the standard capacity of the facility
Number of beds	Built environment, materials and equipment	Observation/interview/document	Capacity of the unit
Distance between beds	Built environment, materials and equipment	Observation/document	Ensures adequate spacing
Number of isolation rooms	Built environment, materials and equipment	Observation/interview/document	Description of the unit, appropriate number of rooms for isolation of suspected/confirmed cases
General Conditions of Neonates			
Information/indicator	WHO (2016) Component	Possible verifier	Comments/indicator
Admission of neonates by cause to the NICU		Report/ patient data register	Description of neonates / risk factors
Number of preterm neonates, gestational age, neonate weight, mechanical ventilation use, feeding intolerance etc.		Report/ patient data register	Description of neonates / risk factors
Outcomes			
Information/indicator	WHO (2016) Component	Possible verifier	Comments/indicator
Neonatal deaths by cause		Report/ patient data register/death registry	Description, severity of patient conditions
<b>Note:</b> data from the last 3 years is requested			

Module 2: IPC Organization			
<b>Availability &amp; characteristics of the surveillance system</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
Information system used, data collected & periodicity of data collection	Surveillance	Information system itself	Is Perinatal Information System (SIP) used?
Support (paper, electronic)	Surveillance	Information system itself	
<b>The Structure of the Infection Prevention and Control (IPC)</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
There is an official document designating those responsible for IPC in the facility	IPC programmes	Document signed by local authority	Infection preventionist to bed ratio
The functions for each person responsible are laid out	IPC programmes	Document signed by local authority	
<b>Evaluation</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
There are annual goals for IPC for the unit	Monitoring/audit and feedback	Official document of the institution/unit (program, plan, annual report)	
There is evidence that decisions are made to achieve the goals	Monitoring/audit and feedback	Minutes, reports, or intervention programs	
Goals are monitored and evaluated at least once a year by the ward/hospital managers	Monitoring/audit and feedback	Minutes, reports or annual report	Needed for improvement
<b>Education</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
There is an orientation program on IPC for new personnel and this program is implemented	Education and training	Written program that includes IPC standards, report on compliance with the program	Title, content, organizing entity, periodicity attendance
<b>Personnel</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
Is there personnel responsible for the IPC activities and HAI control in the unit?	Monitoring/audit and feedback	Interviews/certificates	Champions, role models can be a part of unit IPC
<b>Surveillance - Active Data Collection and Evaluation</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
If available: number of HAI infections: catheter-associated UTI, CVC related sepsis, pneumonia associated with mechanical ventilation, surgical site infections by type of surgery, puerperal endometritis by type of delivery IF NOT number of neonates treated with antibiotics (look at Component 2 - Surveillance - Active Data Collection and Evaluation)	Surveillance	Report/patient data register	
Annual analysis of HAI trends that identifies problems and proposes solutions	Monitoring/audit and feedback	Reports	
Number of outbreaks in the last 3 years	Surveillance; monitoring/audit and feedback	Outbreak report	
<b>Dissemination of Information</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
Periodic report with analysis, recommendations, and known distribution	Monitoring/audit and feedback	Report or bulletin and list of distribution	
Up-to-date information is available and known in the NICU	Monitoring/audit and feedback	Interview manager/staff/minutes of staff meetings	
<b>Note:</b> data from the last 3 years is requested			

Module 4: CVC			
<b>Guideline Availability</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
Is there a central line insertion guideline?	Guidelines	CVC insertion protocol	Title, year of publication, level, endorsing body, target population, purpose, content
Is there a central line maintenance guideline?	Guidelines	CVC maintenance protocol	Title, year of publication, level, endorsing body, target population, purpose, content
<b>Education &amp; Training</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
Is there a group of caregivers who are responsible for insertion of central line catheters?	Education and training	Certificates/interview	
Is the NICU team trained in maintenance and management of catheters and monitoring of adverse events associated with catheters, including infectious complications?	Education and training	Certificates/interview	Title, content, organizing entity, periodicity, attendance
<b>Monitoring &amp; Evaluation</b>			
<b>Information/indicator</b>	<b>WHO (2016) Component</b>	<b>Possible verifier</b>	<b>Comments</b>
Is regular monitoring of compliance to the protocols performed in the unit?	Monitoring/audit and feedback	Audit reports	
Are there indicators developed, monitored and evaluated periodically related to CVC associated infections?	Surveillance; monitoring/audit and feedback	Patient data/reports	CLABSI indicator should be used
<b>Note:</b> Data from last 3 years is requested			

Module 3: Hand Hygiene			
Product availability			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
How easily available is alcohol-based handrub in the NICU and type of hand rub used?	Built environment, materials and equipment	Interview/observation	Answers: a) not available b) available, but efficacy and tolerability have not been proven c) available in discontinuous supply d) available with continuous supply e) available with continuous supply and at the point of care in majority of situations f) available with continuous supply and at
Sink to bed ratio	Built environment, materials and equipment	Interview/observation	Minimum 1:10 and 1:1 in isolation rooms
Is there a continuous supply of clean, running water?	Built environment, materials and equipment	Interview/observation	
Are soap and paper towels available at each sink?	Built environment, materials and equipment	Interview/observation	
Guideline Availability			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Is there a hospital/unit specific guideline adapted by the NICU on hand hygiene?	Guidelines	Guideline on hand hygiene	Title, year of publication, level, endorsing body, target population, purpose, content
Is the guideline present (physically/online) at the unit and available to the staff?	Guidelines	Interview/observation	
Are new staff trained/familiarized with the guideline within a certain period of time?	Guidelines	Interview/observation	
Education & Training			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
How frequently does staff receive training regarding hand hygiene in the unit?	Education and training	Human resource records	Title, content, organizing entity, periodicity, attendance
Are initiatives to support local continuous improvement being applied to your unit (e.g. e-learning tools on hand hygiene, clinical meetings)?	Education and training	Interview/minutes of meetings	
Is a professional with adequate skills to serve as trainer for hand hygiene educational programmes active within the health-care facility/unit?	Education and training	Interview/certification	Champions, role models can be apart of hand hygiene education
Monitoring & Evaluation			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Are regular (at least annual) ward-based audits undertaken to assess the availability of handrub, soap, single use towels and other hand hygiene resources?	Monitoring/audit and feedback	Audit reports	
Is consumption of alcohol-based handrub and soap monitored regularly?	Monitoring/audit and feedback	Reports/purchase history	Standards: at least every 3 months, alcohol hand rub consumption at least 20l per 1000 patient-days
Is regular feedback of data related to hand hygiene indicators with demonstration of trends over time given to the staff and managers of the unit?	Monitoring/audit and feedback	Reports	Standards: at least every 6 months
Environment			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Are there posters explaining indications for hand hygiene & correct technique?	Built environment, materials and equipment	Observation/interview/poster	
Are there any other hand hygiene promotion methods undertaken at the unit?	Built environment, materials and equipment; education and training	Observation/interview	
Are other workplace reminders located at the unit (e.g. screensavers, stickers) ?	Built environment, materials and equipment	Observation/interview	
Are visitors informed and trained on the importance of hand hygiene (e.g. leaflet, verbal education)?	Built environment, materials and equipment; education and training	Interview/observation/information sheets	E.g. parent/visitor HH initiative: information sheets, posters, education & observations

**Note:** Data from the last 3 years is requested

Component 5: Breastfeeding			
Guideline Availability			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Do mothers practise breastfeeding in the unit?		Interview/patient data/indicators	
Is there a written breastfeeding/infant feeding policy covering all Ten Steps to successful breastfeeding and compliance with the Code as well as HIV and infant feeding?	Guidelines	Protocols/guidelines	BFHI; Title, year of publication, level, endorsing body, target population, purpose,
Is there a written policy addressing mother-friendly care at the facility/unit?	Guidelines	Protocol/guideline	BFHI; Title, year of publication, level, endorsing body, target population, purpose,
Are the guidelines easily accessible to the staff in the unit (physically/on the internet)?	Guidelines	Observation/interview	BFHI
Education & Training			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Is there a list of the staff members who care for mothers and/or babies and the numbers of hours of training they have received on required topics concerning BFHI?	Education and training	Staff training records and reports	BFHI
Is there a written curriculum for training given to hospital staff caring for mothers and babies on breastfeeding management, feeding of the non-breastfeeding infant, and mother-friendly care?	Education and training	Training curriculum	BFHI, Title, content, organizing entity, periodicity, attendance
Monitoring & Evaluation			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Are there breastfeeding and/or HIV and infant feeding committee(s) in the hospital?	Monitoring/audit and feedback	Official document/accreditation	BFHI
Is there a BFHI coordinator at the hospital?	Monitoring/audit and feedback	Official certificate	BFHI
Has the priority action recommended by the BFHI assessment in November 2017 to develop and implement procedures for monitoring the implementation of the BFHI to ensure recommended standards are maintained been developed?	Monitoring/audit and feedback	Minutes, reports, or intervention programs, BFHI monitoring tool	BFHI
Have other (steps specific) improvements recommended by the BFHI assessment in November 2017 been addressed?	Monitoring/audit and feedback	Minutes, reports, or intervention programs	BFHI
Has a re-assessment in 2 years time of the hospital on BFHI been carried out as recommended by the BFHI assessment performed in November 2017?	Monitoring/audit and feedback	BFHI re-assessment report	BFHI
Environment			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
What are the visiting hours for parents in the unit?	Built environment, materials and equipment	Interview	
Are there posters/leaflets in the unit to inform parents about breastfeeding?	Built environment, materials and equipment	Posters/leaflets/brochures	
Have special adaptations to the unit environment been done to facilitate breastfeeding e.g. ensurance of private space/armchairs/linen/curtains	Built environment, materials and equipment	Observation/interview	
Are materials to facilitate breastfeeding available at the unit e.g. recreational activities/books/songs/supplies for expression of milk	Built environment, materials and equipment	Observation/interview	

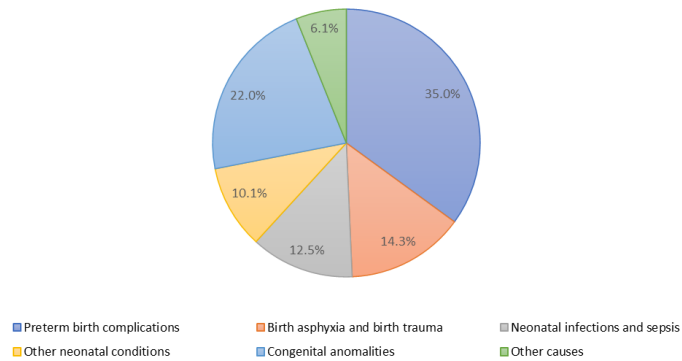
**Note:** Data from the last 3 years is requested

Module 6: KMC			
Guideline Availability			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Is KMC practiced in the unit?		Interview/patient data/indicators	
Is there a facility/unit guideline including KMC?	Guidelines	Protocols/guidelines	BFHI; Title, year of publication, level, endorsing body, target population, purpose, content
Are the guidelines easily accesable to the staff in the unit (physically/on the internet)?	Guidelines	Observation/interview	
Education & Training			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Does the staff receive regular training on KMC?	Education and training	Staff training records and reports	Title, content, organizing entity, periodicity, attendance
Monitoring & Evaluation			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
Is there a KMC coordinator at the facility?	Monitoring/audit and feedback	Official certificate	Champions and role models could also be included
Have indicators for KMC been developed?	Monitoring/audit and feedback	Minutes, reports, or intervention programs	
Are indicators for KMC regularly monitored and evaluated?	Monitoring/audit and feedback	Minutes, reports, or intervention programs	
Environment			
Information/indicator	WHO (2016) Component	Possible verifier	Comments
What are the visiting hours for parents in the unit?	Built environment, materials and equipment	Interview	Same question in "Bresstfeeding" module
Are there posters/leaflets in the unit to inform parents about KMC?	Built environment, materials and equipment	Posters/leaflets/brochures	
Have special adaptations to the unit environment been done to facilitate KMC e.g. ensurance of private space/armchairs/linen/curtains	Built environment, materials and equipment	Observation/interview	
Are materials to facilitate KMC available at the unit e.g. recreational activities/books/songs/socks and hats	Built environment, materials and equipment	Observation/interview	

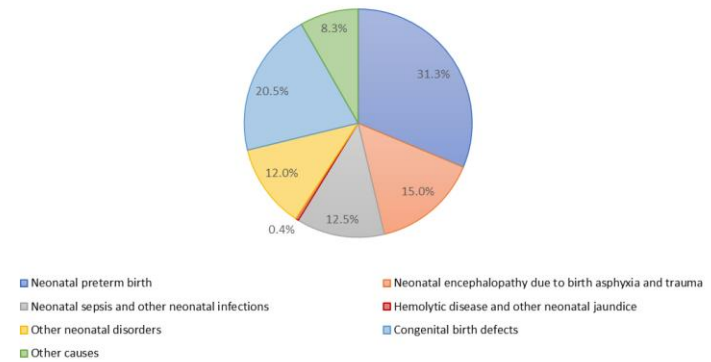
**Note:** Data from the last 3 years is requested

## Annex 4 Trends in Proportional Distribution of Neonatal Deaths by Cause in the Americas from WHO GHE 2019, IHME GBD 2019 and PAHO Mortality Database

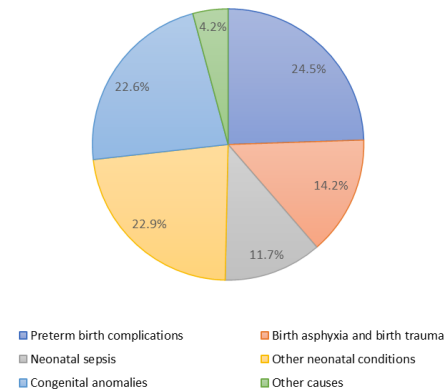
**WHO GHE 2019 Proportional Distribution of Neonatal Deaths by Cause in the Americas in 2019**



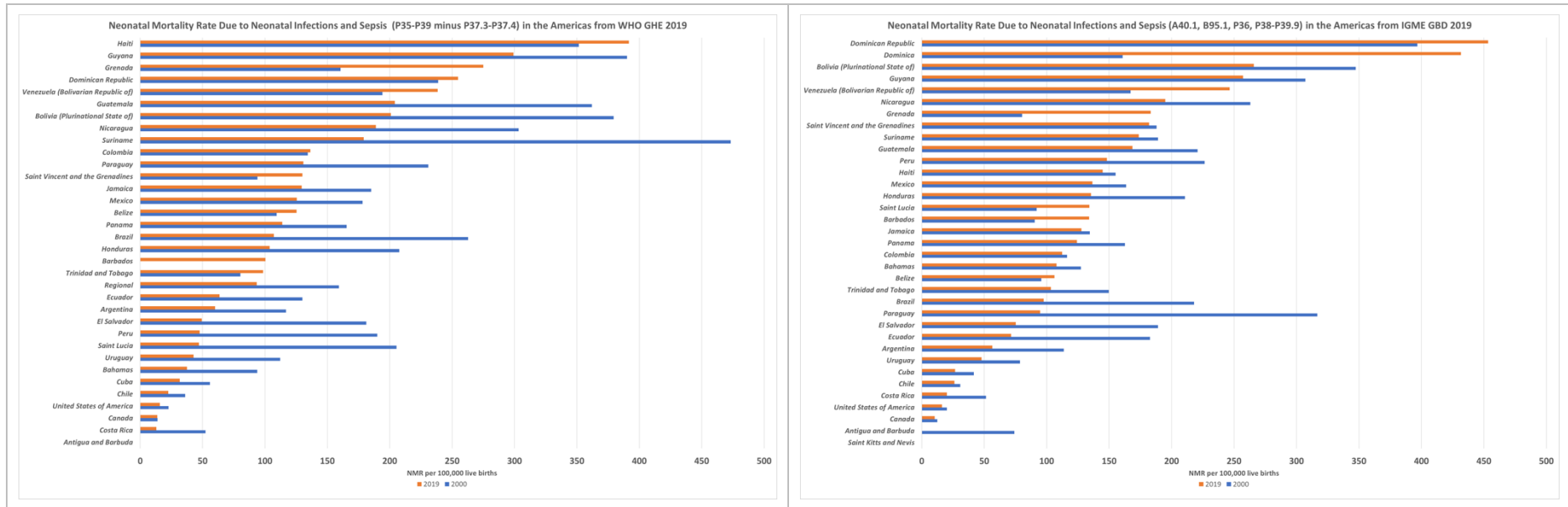
**IHME GBD 2019 Proportional Distribution of Neonatal Deaths by Cause in the Americas in 2019**



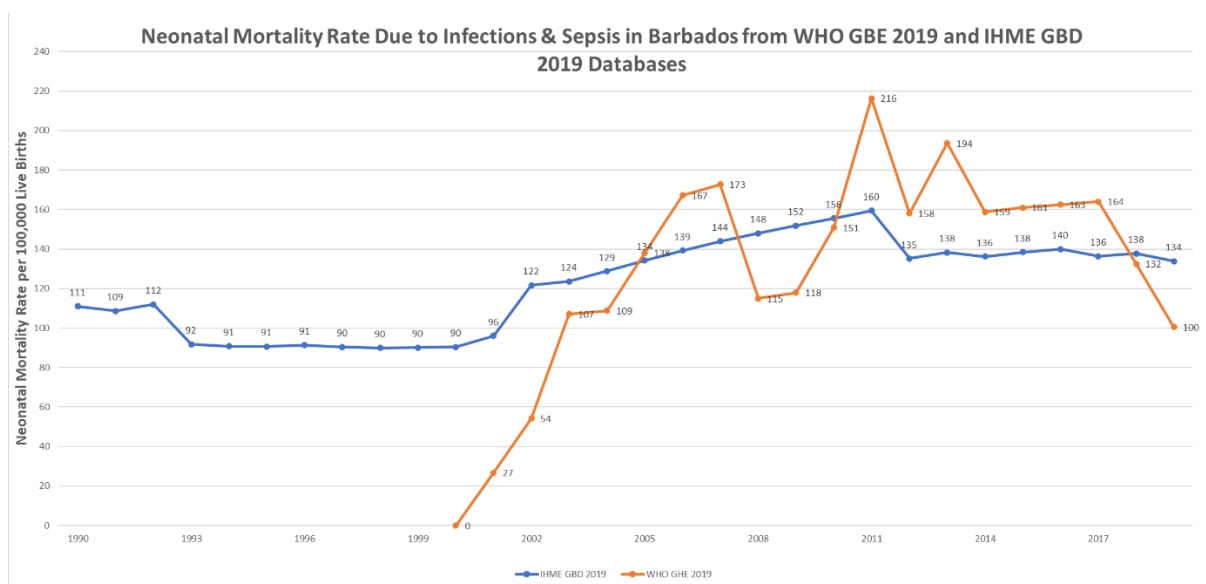
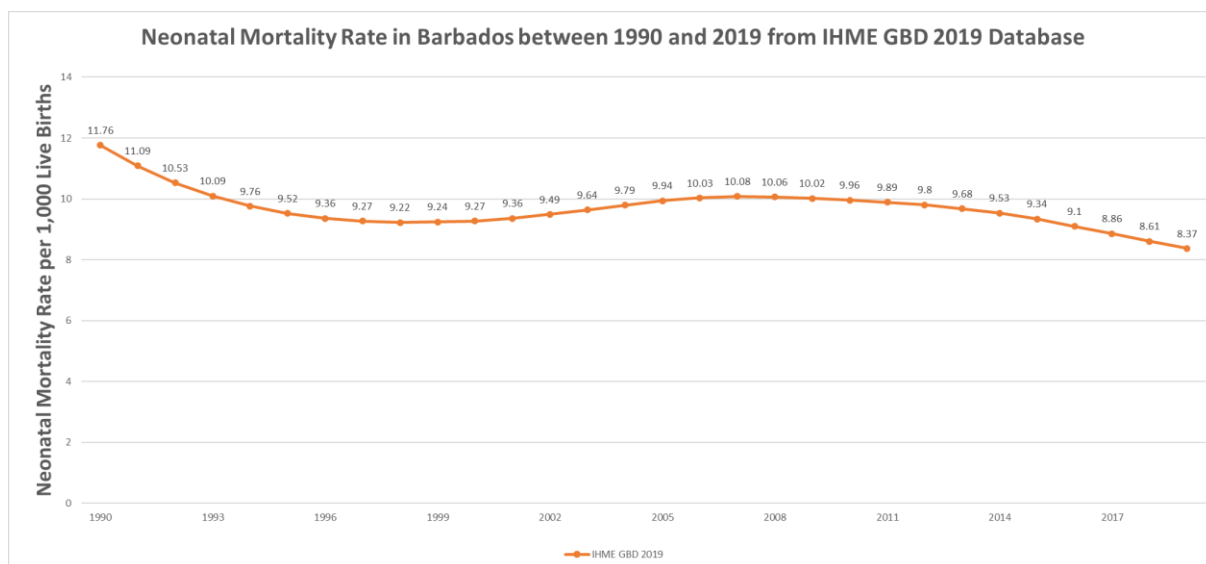
**PAHO Mortality Database Proportional Distribution of Neonatal Deaths by Cause in the Americas in 2017**



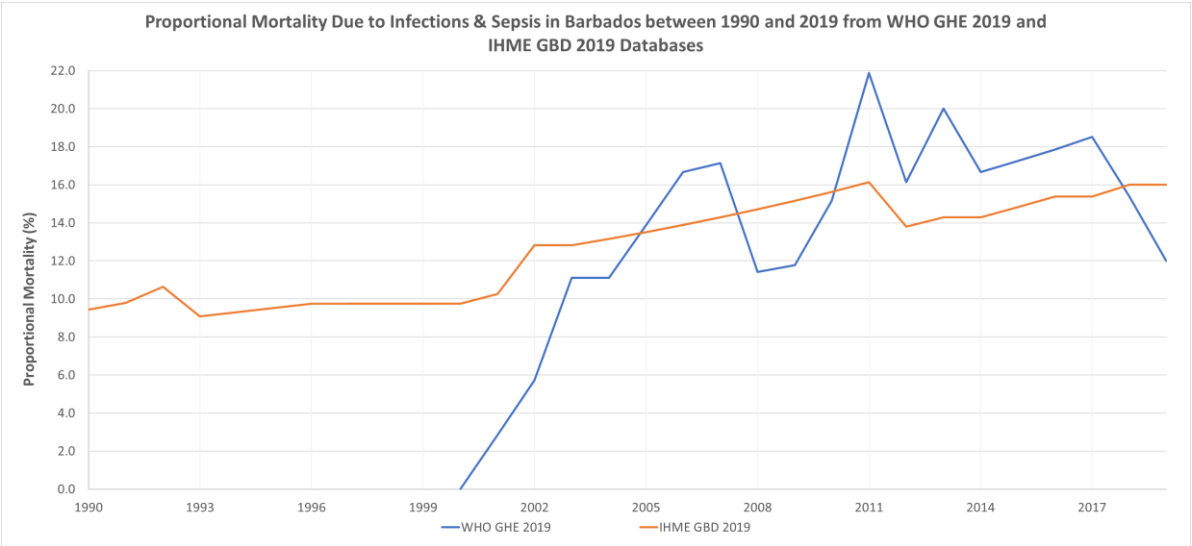
## Annex 5 Trends in Neonatal Mortality Rates Due to Neonatal Infections and Sepsis from WHO GHE 2009 and IHME GBD 2019 Databases



## Annex 6 Trends in all-cause Neonatal Mortality and Neonatal Mortality Due to Neonatal Infections and Sepsis in Barbados from WHO GHE 2019 and IHME GBD 2019 Databases



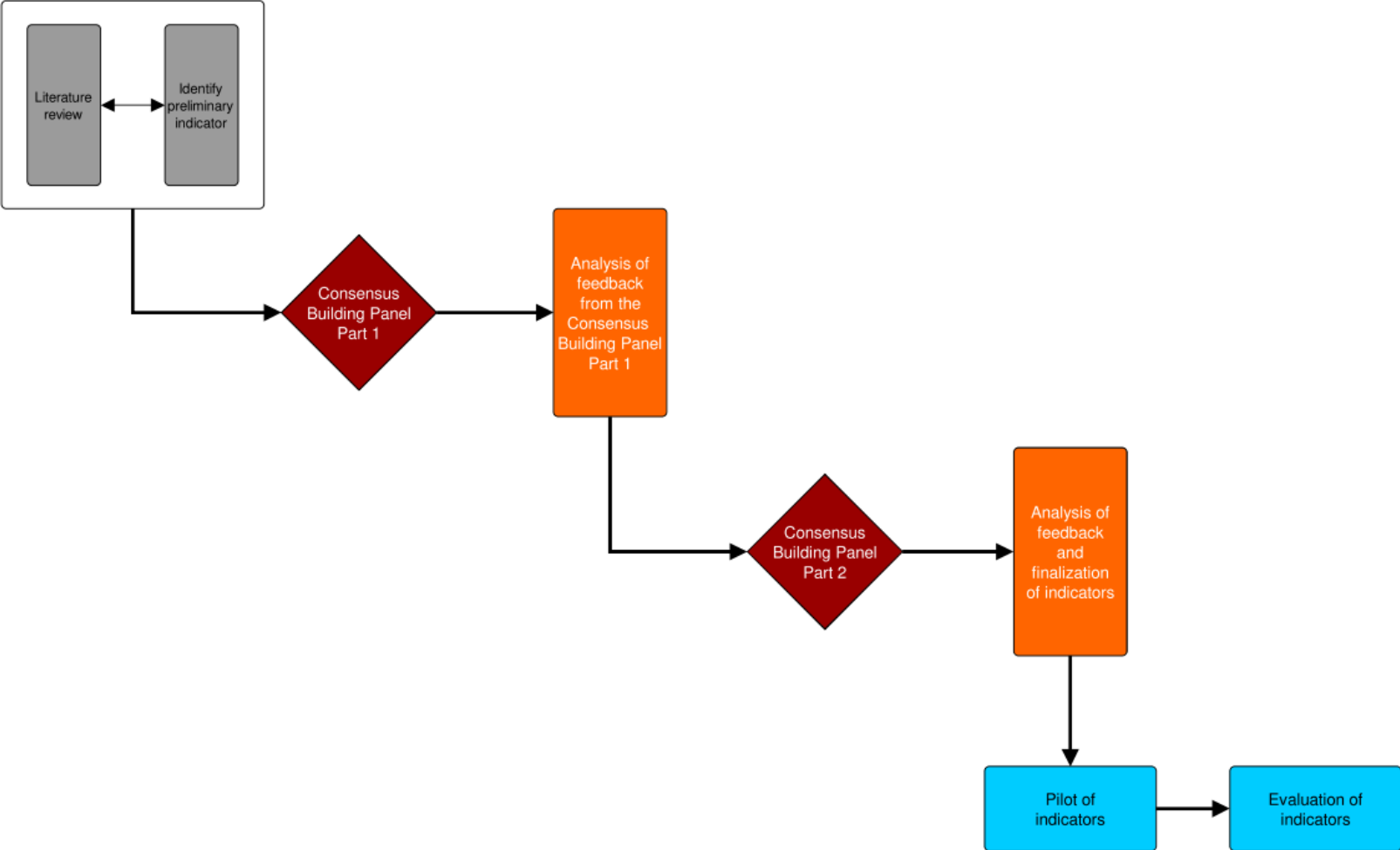




## Annex 7 Guidelines

Title	Year of Publication	Level	Endorsing Body	Target Population	Purpose	Content
<b>Booklet for Nursing Staff NICU</b>	Aug-01	Unit	Ward Management (Ward Sisters)	Nurses and midwives working at the NICU unit	Compiling objectives and guidelines for new nurses and midwives at the unit	Unit profile: 1. Welcome 2. QEH Objectives 3. Mission Statement 4. Philosophy of Nursing Service 5. NICU Philosophy 6. Objectives of the NICU 7. Description of the Unit (Services Provided, Monthly Meetings, Team Members, Job Descriptions) 8. Basic Principles of NICU 9. Parents' Club/Charity 10. Inventory List (Standard Inventory, Emergency Equipment, Ward Stock & Order Days) 11. Safety 12. Visiting (Feeding Times, Advocate, Discharge Planning, Religious Rights) 13. Feeding Fluids and Nutrition (Intravenous Feeding, Monitoring, Problems Associated with T.P.N., Enteral Feeding, Frequency Feeding, Complications of High Fluid Volumes) 14. Nursing Process (Pre-erm on Ventilatory Support)
<b>Continuing Education</b>	Feb-16	Facility	Nursing Services Department	Nurses and midwives working at the Queen Elizabeth Hospital	To ensure that nurses are afforded the opportunity to keep abreast of new trends in research, nursing practice and for the enhancement of professional growth and development.	Not accessed
<b>Insertion of Central Venous Lines and PICC Lines Bundle</b>	Jun-15	Facility	Infection Control	Healthcare staff involved in CVC and PICC insertions	Quality Improvement Purposes	1. Maximum Barrier Precautions 2. Facility-Approved Antiseptic 3. Catheter Site Selection 4. Daily Review of Line Necessity, with Prompt Removal of Unnecessary Lines 5. Dressing 6. Administration Sets, Needleless Systems and Parenteral Fluids 7. Documentation 8. Staff Education 9. Patient/family Education 10. Performance Improvement
<b>NICU Central Line Insertion Checklist</b>	Mar-18	Unit	NICU, Queen Elizabeth Hospital	Team members performing central line insertion	Quality Improvement Purposes	General Information, Pre-Procedure Verification, Time Out - Stop and Pause Immediately Before Procedure, Insertion Bundle Checklist, Post-Procedure, Line Location
<b>NICU Central Line Maintenance Checklist</b>	Mar-17	Unit	NICU, Queen Elizabeth Hospital	NICU staff (nurses & midwives) caring for patients with central lines	Quality Improvement Purposes	General Information, Maintenance Checklist (All Lines, PICC Lines)
<b>Breastfeeding Policy (including a statement addressing the International Code)</b>	Oct-17	Facility	Nursing Services	Staff in pediatric departments	To improve the hospital's breastfeeding policies and maternity care practices compliant with the WHO/UNICEF and the Barbados National Breastfeeding Policy	1. Philosophy 2. Goal 3. Introduction 4. Background 5. TEN Steps to Successful Breastfeeding 6. References
<b>Safe Management of Expressed Breast Milk</b>	Mar-20	Facility	Nursing Services	Nurses and midwives	To establish an environment where practices are consistent and permit for the safe and quality management and use of expressed breast milk	Purpose, Objectives, 1. Procedure (Collection of Breast Milk, Equipment, Labelling) 2. Cleaning the Equipment 3. Storage (Handling of Expressed Breast Milk, Disposal of Expressed Breast Milk) 4. Retrieval, Verification and Feeding 5. Addition of Breast Milk Fortifiers/Additives 6. Parent/Guardian Education 7. Documentation 8. Adverse Events. Guide to Storing Expressed Breast Milk

# Annex 8 Action Plan



## Annex 9 Input Indicator 1.3 Description and Data Collection Tool

<b>1.3 Indicator</b>	Proportion of healthcare staff who have received training in the recognition and management of suspected newborn infections at least once in the last 12 months
Definition of the indicator	This indicator is defined as the percentage of healthcare staff in the health facility who care for pregnant and postpartum women and newborns and who have received in-service training or regular refresher sessions in the recognition and management of suspected newborn infections at least once in the last 12 months.
Purpose of the indicator	This indicator serves the purpose of tracking if regular trainings and refresher sessions on newborn infection recognition and management are in place in the overall health facility education strategy. The indicator is consistent with the Core Component 3 “Education and Training” of Infection Prevention and Control Programmes at the facility level (WHO, 2016).
Calculation method	Numerator: number of healthcare staff in the health facility who care for pregnant and postpartum women and newborns and who have received in-service training and regular refresher sessions in the recognition and management of suspected newborn infections at least once in the last 12 months  Denominator: number of healthcare staff in the health facility who care for pregnant and postpartum women and newborns
Technical note	-
Type of indicator	Relative
Unit of measurement	Number of healthcare professionals who care for pregnant and postpartum women and newborns
Frequency of measurement	Annual
Disaggregation	Unit, job title
Data source	The main source of data is administrative data: training curriculum, course-outlines and attendance sheets
Limitations	Doesn't measure knowledge of the healthcare staff.
References	1. Standards for improving quality of care for small and sick newborns in health facilities. Geneva: World Health Organization; 2020. License: CC BY-NC-SA 3.0 IGO. 2. World Health Organization. (2016). Standards for improving quality of maternal and newborn care in health facilities. World Health Organization. <a href="https://apps.who.int/iris/handle/10665/249155">https://apps.who.int/iris/handle/10665/249155</a>

Please add the name of the unit and job titles. Then, fill in all of the tables. The in-service training or a refresher session must be received in the last 12 months. Include only healthcare staff who care for pregnant and postpartum women, and newborns.

	Unit A					Unit B				
	In-service training	Refresher session	In-service training + refresher session	Total staff	Proportion	Training	Refresher session	In-service training + refresher session	Total staff	Proportion
Job Title A										
Job Title B										
Job Title C										
Job Title D										
<b>Total</b>										