Arab American University

Faculty of Graduate Studies

Health Outcomes of Neonates Admitted to Palestinian Ministry of Health Neonatal Intensive Care Units and referred to Neonatal Intensive Care Units outside the Palestinian Ministry of Health in the West Bank in 2020

By

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This thesis was submitted in partial fulfillment of the requirements for a Master's degree in Health informatics

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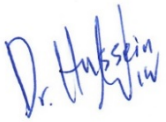
3. Dr. Hussein Jabareen	

Declaration

I certify that this thesis is submitted in fulfillment of the requirements for the degree of master's degree in health informatics. I, the undersigned is the presenter of this thesis, which has the title

" Health Outcomes of Neonates Admitted to Palestinian Ministry of Health Neonatal Intensive Care Units and referred to Neonatal Intensive Care Units outside the Palestinian Ministry of Health in the West Bank in 2020 "

I declare that the work presented in this thesis is my own work, except where otherwise acknowledged, and that this thesis as a whole or any part of it has not been previously submitted to obtain an academic degree or scientific research with any other educational or research institution.

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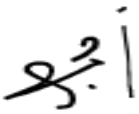
Signature: 

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Executive summary

The neonatal period is the first 28 days of a newborn's life that is the most critical period, where neonates face the most significant risk of death, especially in the first week of life. In 2019, globally, 47% of all under-five deaths occurred in the neonatal period. In 2019 in the West Bank, the reported infant mortality rate was 11.1 per 1,000 live births (870 cases). Based on the Palestinian Ministry of Health (PMoH) annual report, the top three causes of reported infant mortality were conditions in the perinatal period (e.g., low birth weight, prematurity, and complications regarding the placenta, cord, and membranes) (77%), congenital malformation (19%), and sudden infant death syndrome (3%).

This study examined the characteristics of the neonates admitted to neonatal intensive care units (NICU) in the governmental hospitals during the period from 1st January 2020 to the 31st of December 2020 as well as the health outcome of those neonates. In addition, the study examined all neonatal referrals to the NICUs in the non-governmental hospitals outside the Palestinian Ministry of Health (PMoH) in 2020. The study extracted data from both Avicenna HIS (Health Information System used and operated by the governmental hospitals) and e-Referral (Computerized system operated by the Service Purchase Unit in the Palestinian Ministry of Health). The data collected from the Avicenna system was extracted as excel files by executing proper SQL queries on the database by the database administrator to meet the research requirements. The extracted data were validated by the system administrator. Collected excel files were merged into one sheet by matching the unique patient identifier in all data files. The data collected from the e-referral system was imported as an excel sheet by a predefined report in the system. SPSS was used for data analysis.

Based on study findings, in 2020, 3146 neonatal admissions were registered in the Palestinian Ministry of Health (PMoH) NICUs (2963 neonates). Around 90% of admitted neonates to PMoH NICU were single births, 2.7% were IVF, and the readmission rate for the neonates in the NICUs in the PMoH hospitals was 5%. The top causes of admission to PMoH NICU were respiratory diseases, for observation, hematology (mostly jaundice), and sepsis. Low birth weight and prematurity were not the leading causes of admission to NICU to PMoH hospitals in 2020. More than half of the admitted newborns had average birth weight (61.4%) and were full-term babies (58.7%), around 41.2% were premature, and 35.6% of neonates had low birth weight. Most admitted neonates to the NICUs inside governmental hospitals were improved and discharged, while 8% died.

As to referrals to NICU outside MoH, in 2020, there were 1,913 referrals. There was no data available on the cause of the neonatal referrals outside PMoH, other than 90% of referrals were for emergency and follow-up. Only 0.6% of these referrals were issued by Service Purchase Unit, 57.2% were issued by the Palestinian governmental hospitals, and 42.2% by the non-governmental hospitals in the West Bank. Referral departments (the department that issue the referral request) were either the pediatric department or the NICU department. Top referral hospitals (the hospital that issue the referral request) in 2020 were Specialized Arab Hospital, Al Mizan, and Al Makased hospital. Around 68% of referrals outside PMoH were for treatments not found at PMoH neonatal units. Sepsis was among the top causes of admission to PMoH NICU that could have been prevented by applying early essential newborn care at the time of birth. Based on study findings, survival was high among neonates admitted to NICU; the mortality rate was less than that reported in previous studies in Ethiopia and Egypt; 8% vs. 14.4% and 29.1%, respectively. 18.8% of admitted and 10% of readmitted were for observation. If Normal Newborn Nursery units were

available in the PMoH hospitals, there would have been no need to admit the newborn to the NICU and save the incubators for critical cases. There was no data on morbidity, whether for neonates at PMoH NICU or at NICU outside PMoH.

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List of acronyms and abbreviations

AAUP	Arab American University Palestine
EJ	East Jerusalem
ELBW	Extreme Low Birth Weight
G6PD	Glucose-6-phosphate dehydrogenase
GA	Gestational Age
GI	Gastrointestinal
GS	Gaza Strip
HBW	High Birth Weight
HIE	hypoxic-ischemic encephalopathy
HIS	Health Information System
IRB	Institutional Review Board
IVF	In vitro fertilization
LBW	Low Birth Weight
MDG	Millennium Development Goal
MoH	Ministry of Health
NBW	Normal Birth Weight
NICU	Neonatal Intensive Care Unit
NIS	New Israeli Shekel
NRDS	Neonatal Respiratory Disorder Syndrome
PMC	Palestinian Medical Complex
PMoH	Palestinian Ministry of Health
RDS	Respiratory Disorder Syndrome
SDGs	Sustainable Development Goals
SQL	Structured Query language
VLBW	Very Low Birth Weight
WB	West Bank
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

There are 38 neonatal units with 484 incubators in Palestine: 27 units with 311 incubators in the West Bank (WB), 3 units with 54 incubators in East Jerusalem (EJ), and 8 units with 119 incubators in the Gaza Strip (GS). Around 60% (22/38) of the neonatal units, with about 366 incubators (75.6%) are non-governmental (Massad et al., 2020), which significantly affects the cost of neonatal care. Add to that; neonatal services are not equally distributed throughout Palestine. Most neonatal services are outside the GS, and most neonatal units in Gaza are levels 1 and 2 with limited resources. The only level 4 hospital in Palestine is Makased Hospital in EJ, which is inaccessible to patients from the WB and GS who require a permit that is not guaranteed. Additionally, in the WB, neonatal services are concentrated in the north and middle WB, which contributes to delays in accessing neonatal care due to checkpoints.

1.2 Problem statement

While reducing infant morbidity and mortality are among Palestinian Ministry of Health (PMoH) priority areas to reduce infant mortality and reduce the cost of neonatal referrals, to our knowledge, there is no data on the causes of admission/readmission and health outcome of neonates admitted to NICU at PMoH or of neonates referred to the NICUs outside PMoH to be able to strengthen neonatal health services in Palestine.

1.3 Study objectives

1. To assess the causes of neonatal admissions/readmissions to the intensive care units in the PMoH in the West bank.

2. To examine the health outcome of the neonates admitted to the NICUs in PMoH hospitals.
3. To examine factors associated with readmission in PMoH NICU.
4. To examine the causes of referrals to NICUs outside PMoH hospitals
5. To examine the estimated cost for those referrals to NICU outside PMoH in 2020.

1.4 Significance of the study

Given the global burden of preventable neonatal deaths, neonatal health has become a priority under the United Nations Sustainable Development Goals (SDGs). It cannot be stressed enough the importance to identify, understand, and address the causes of admissions and readmissions to the NICU and neonatal death, especially in low- and middle-income countries. This is the first study to assess causes of admitted/referred neonates to NICU at the Ministry of Health (MoH) and outside MoH neonatal units, length of stay, readmission, health outcomes, and estimated costs to improve MoH neonatal services as one of the strategies to reduce infant and neonatal mortality in Palestine and reduce costs of referrals.

1.5 Study hypothesis

Based on the literature review, we expected that factors associated with health outcomes among admitted/referred newborns to PMoH NICU in 2020 were shorter NICU length of stay, younger age, severely depressed health condition (Apgar One score and Apgar Five score <=3), multiple pregnancies, and smaller Gestational age. Factors associated with readmission were shorter NICU length of stay and smaller gestational age.

Chapter 2: Literature review

2.1 Introduction

The neonatal period is the first 28 days of a child's life that is the most critical period in the child's life (Pathirana et al., 2016). It is considered an integral indicator of future child survival and well-being, as well as sustainable social and economic development at the broader level. However, major challenges exist regarding the scaling up of service delivery and the enhancement of quality, integration, and continuity of neonatal care in Palestine. Healthcare delivery faces inequality resulting from disparities in the availability of healthcare services, which is due in part to the geopolitical segregation imposed by the presence of multiple checkpoints and the separation wall, as well as the inadequate distribution of services. East Jerusalem is isolated from the remainder of the WB, and for Palestinians living in the WB and the GS, EJ is largely inaccessible. The GS has been under siege for over 13 years. In addition, the fragmented health sector is another significant barrier to health services, where most delivery and neonatal services are outside of the Palestinian Ministry of Health (Massad et al., 2020).

2.2 Causes of admission

Neonatal intensive care unit (NICU) care can be lifesaving, but it is also expensive, common, and can cause harm (Braun et al., 2020). Previous Studies reported different causes of neonatal admission to the NICU: medical (e.g. low gestational age, , low birth weight, birth asphyxia, respiratory infections, fever, congenital anomalies, jaundice, hypoglycemia), and surgical. Based on a retrospective cohort study of NICU utilization in China from January 1, 2010, through December 31, 2018, among the 39 220 newborns, 12.2% were admitted to the NICU. Neonates admitted to the NICU had lower gestational age (22-29 weeks), and low birth weight (Braun et al., 2020). In Bangladesh, based on a retrospective hospital data between January 2017 and December

2018, prematurity and infection were the main reasons for admission (52.7% and 20%, respectively), followed by birth asphyxia (12%) and neonatal jaundice (6.8%) (Tajkia et al., 2019). A study in Nigeria of health outcomes of 572 infants admitted to the NICU in 2010- 2011, the main causes of admission were neonatal infections (37.1%), prematurity (20.1%), and birth asphyxia (11.5%) (Tajkia et al., 2019).

As to causes of NICU admission in the region, in a study of health outcome of 826 infants admitted to the NICU in Egypt, the most prevalent indications of admission to NICU were neonatal jaundice (35.8%), infection (22.5), prematurity (19.6%), hypoxic-ischemic encephalopathy (HIE) (12.2%), respiratory distress syndrome (RDS) (9.6%), congenital heart disease (CHD) (5.3%), transient tachypnea of the newborn (TTN) (4.8%), chromosomal or congenital anomalies (4.8%) (Seoud et al., 2005). A cohort study in Al-Bashir Hospital in Amman, Jordan, between 2010 and 2011, found that the top two leading causes of admission to the NICU were the RDS (67%) and Prematurity (52%) (Sivasubramaniam et al., 2015). In 2020, 52% of late preterm (LPT) newborns in 2 large hospitals in Egypt were admitted to the NICUs, the morbidity associated with LTP were Jaundice, RDS, hypoglycemia, and convulsions (Algameel et al., 2020).

2.2.1 Preterm

Infants born preterm are also at high risk of developing morbidities such as sepsis, necrotizing enterocolitis (NEC), intraventricular hemorrhage (IVH), periventricular leukomalacia (PVL), retinopathy of prematurity (ROP), and bronchopulmonary dysplasia (BPD) (Jiang et al., 2020).

2.2.2 Respiratory disorders

Respiratory Disorder Syndrome (RDS) is the most common morbidity for premature infants (infants with gestational age less than 37 weeks). Neonatal RDS (NRDS) is a critical clinical syndrome responsible for both high neonatal mortality and morbidity (Najafian, 2020). A recent

study held in Cyprus over 18-months in 2020 and 2021 for neonates admitted to the NICUs, found that 41% of the neonates were diagnosed with NRDS (Stylianou-Riga et al., 2021). Another study conducted by King Abdul-Aziz University Hospital in Saudi Arabia found that 1.6% of the neonates were admitted to NICU with a diagnosis of RDS, the specifications of those neonates were low birth weight, lower APGAR scores at one and five minutes, 5.1% of those neonates died at this group (Alfarwati et al., 2019).

2.2.3 Neonatal jaundice

Neonatal Jaundice is the top leading cause of hospital readmission for neonates and the most medical condition that requires attention (Hansen, 2019). A study conducted in Bloemfontein, South Africa in 2018, shows that 55.2% of healthy term neonates developed neonatal jaundice, and the most common risk factor associated with it was the normal vaginal delivery (Brits et al., 2018). Common causes associated with neonatal jaundice: neonatal sepsis, ABO incompatibility, glucose-6-phosphate dehydrogenase deficiency, and low birth weight (Ho, 1992).

2.2.4 Neonatal sepsis

Most of the estimated 4 million neonatal deaths per year occur in low- and middle-income countries. Three conditions: infection, birth asphyxia, and consequences of premature birth/low birth weight, are responsible for majority of these deaths. More than one-third are estimated to be due to severe infections, and a quarter are due to the clinical syndrome of neonatal sepsis/pneumonia. Case fatality rates for neonatal infections remain high among both hospitalized newborns and those in the community. Because sick newborns present with nonspecific signs and symptoms, a clinical diagnosis of neonatal sepsis is difficult in even the most sophisticated settings. Many factors contribute to the high mortality due to infections, including under-recognition of illness, delay in care seeking at the household level, and lack of access to both

appropriately trained health workers and to high quality services to manage sepsis (Qazi & Stoll, 2009).

The incidence rate of neonatal sepsis is still unspecified in most countries even the most recent studies show marked heterogeneity. However, WHO global report 2017, estimated the number of annual neonatal sepsis cases worldwide was between 1.3 to 3.9 million cases, with 400.000 to 700.000 annual deaths (W.H.O, 2017). Most cases are disproportionately where from low and middle-income countries with a high percentage of infectious diseases (Brown, 2021). Based on WHO, 84% of neonatal deaths are preventable by early diagnosis or appropriate clinical management (W.H.O, 2017).

2.3 Neonatal readmission

Although there is no standard definition of NICU discharge readiness, it usually depends on both the baby's clinical condition and the caregiver's confidence and competence in caring for the infant after discharge (Smith et al., 2013). Families are often not adequately prepared for the hospital discharge of their newborn, contributing to poorer infant outcomes, and increased health-care utilization after discharge (Smith et al., 2013). While some readmissions may be precautionary to monitor the infant for suspected disease and some are preventable (Metcalfe et al., 2016), readmissions and emergency department visits are proxy indicators of the quality of health care in terms of discharge planning, and transition of care between inpatient and outpatient providers. Around 3% of infants will be readmitted to the NICU following discharge (Metcalfe et al., 2016). Term infants account for the majority (around 90%) of readmissions (Ambalavanan et al., 2020). Recent studies in 2021 showed that while the neonatal readmission rates in the United States (US) decreased to less than 1%, other countries still have a global concern with neonatal readmission rates greater than 10% (Hensman et al., 2020b). In Saudi Arabia, from 2010 to 2011, 1.3% of the

discharged neonates were readmitted to the hospital or emergency department within the first seven days (Bawazeer et al., 2021b). In China, the overall readmission rate in the 30 days after discharge was 2.4% (Braun et al., 2020).

The most frequently reported causes of infant readmission were: early discharge, fever, feeding problems (Bawazeer et al., 2021b), dehydration, diarrhea, infections, gastrointestinal problems, Jaundice and cesarean delivery (Hensman et al., 2020b), sepsis and viral/respiratory issues (Metcalfe et al., 2016)., or to surgical (PEG related problems, V-P shunt related issues, hernia repair) causes, or and inadequate parental involvement in neonatal care (Tejas N et al., 2017). Based on a randomized control trial in Iran in 2010, parental involvement with neonatal care was associated with decreasing the likelihood of neonatal readmission (Bastani, 2015).

The length of hospital stay for newborns and mothers after uncomplicated deliveries has decreased and has become commonplace worldwide. In the United States, the mean length of stay reported in 1992 was 2.6 days and declined to 1.1 days in 1995 for vaginal deliveries (Farhat & Rajab, 2011). However, decreases in newborn length of stay may result in substantial increases in morbidity (Lock M, 1999). The American Academy of Pediatrics has expressed concern about early discharge and has developed guidelines emphasizing that early discharge be individualized and that strict discharge criteria be used to avoid the most common complications, namely, neonatal hyperbilirubinemia, sepsis and dehydration (Lock M, 1999). Based on a retrospective cohort study of 1875322 newborns admitted to the NICU between 2003-2010 in Canada, readmission rates are lowest following a 1–2-day stay following a vaginal birth and a 2–4-day stay following a caesarean birth (Metcalfe et al., 2016). Another study in Canada found that an increased readmission rate was associated with a shorter neonatal hospital stay, especially for conditions that may not have symptoms during the first three days of life (Lee et al., 1996). In

Lebanon, a prospective cohort study among 478 babies admitted to the NICU between September 209 and March 2020, found that hospital discharge at any time ≤ 48 hours significantly increases the risk for readmission as well as the risk for readmission due to hyperbilirubinemia (Farhat & Rajab, 2011).

2.4 Health outcomes of infants admitted to the NICU

Although the global number of newborn deaths declined from 5 million in 1990 to 2.4 million in 2019, children face the most significant risk of death in their first 28 days of life. Worldwide, in 2018 there was 2.5 million neonatal deaths (Eyeberu et al., 2021). In 2019, globally, 47% of all under-five deaths occurred in the newborn period, (Newborns: Improving Survival and Well-Being, 2020a). In 2017, an estimated 2.5 million newborns died in the first month of life - approximately 7,000 every day - about 36 percent died the same day they were born, and close to three-quarters of all newborns died in the first week of life (Tajkia et al., 2019). Around three-quarters of neonatal deaths occur during the first week of life and most interventions to prevent these deaths need to be delivered within a very short time frame (Oza et al, 2014). As to the reported neonatal mortality rates in the region, for the year 2020, the neonatal mortality rate in Jordan and Egypt was 8.8 and 10.3 death per 1000 live birth, while it reached 1.9 death per 1000 live birth in Israel (Eyeberu et al., 2021). In the West Bank and Gaza for the same period, the neonatal mortality rate reached 10.3 death per 1000 live birth (PHIC, 2021).

Among the determinants of mortality and morbidity among infants admitted to the NICU: low birth weight, multiple pregnancies, small for gestational age (SGA), Apgar score <7 at 5 min, and prematurity (infant born before 34 weeks gestation) (Kong et al., 2016), birth complications (mainly intrapartum hypoxia), and congenital abnormalities (Cooper, 2014). Based on vital registries of 194 countries between 2000 and 2013, out of the 2.8 million neonatal deaths in 2013,

0.99 million deaths (uncertainty range: 0.70–1.31) were estimated to be caused by preterm birth complications, 0.64 million (uncertainty range: 0.46–0.84) by intrapartum complications and 0.43 million (uncertainty range: 0.22–0.66) by sepsis and other severe infections. Preterm birth (40.8%) and intrapartum complications (27.0%) accounted for most early neonatal deaths while infections caused nearly half of late neonatal deaths (Oza et al, 2014). As shown in Figure 1, preterm birth complications were the leading cause of death among neonates in the Millennium Development Goal (MDG) region in 2013, Southern Asia has the highest risk of preterm death (11.9 neonatal deaths per 1000 live births), and Sub-Saharan Africa with (9.5 neonatal deaths per 1000 live births).

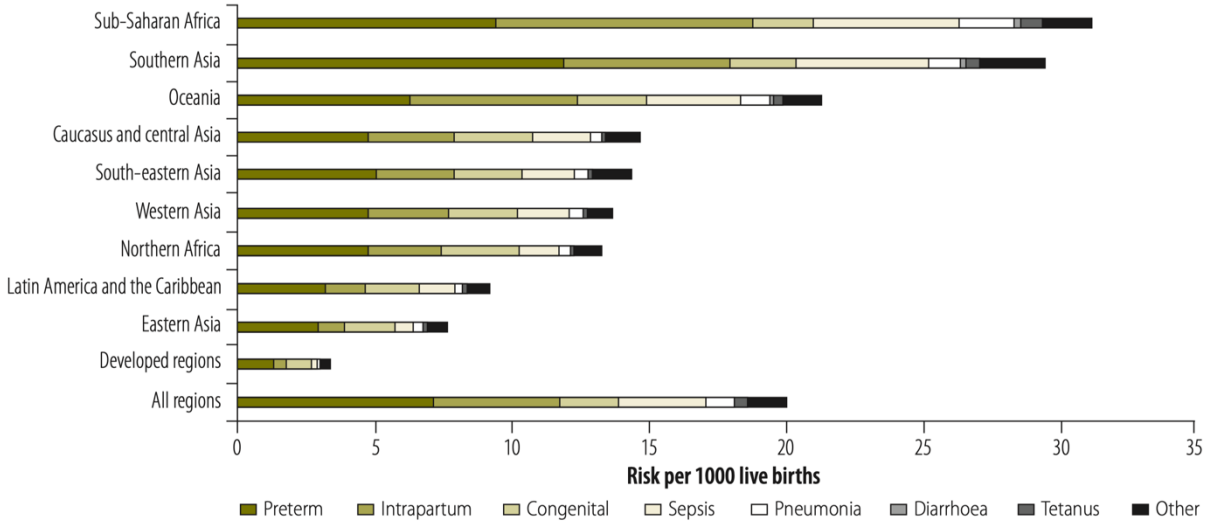

Figure 1: Cause-specific risk of neonatal death by Millennium Development Goal region in 2013. (Oza et al, 2014)

In the US, based on a retrospective study of extremely low birth weight (<1000 g) and small gestational age (<27 weeks), 22.3% died post NICU discharge (de Jesus et al., 2012). In a study of mortality among 5192 infants admitted to the NICU in Canada, APGAR score <7 at 5 minutes, presence of congenital anomalies, low gestational age were associated with neonatal deaths (Lee et al., 2004).

In China, based on a cohort study that followed all infants less than 34 weeks' gestation to 25 NICUs between May 2015 and April 2016, of the 8,065 newborns, the rate of mortality was 4%, sepsis 14%, necrotizing enterocolitis 3%, intraventricular hemorrhage/periventricular leukomalacia 7%, retinopathy of prematurity 2%, and bronchopulmonary dysplasia 9% (Jiang et al., 2020). Based on another study in China between 2013 and 2014, of preterm neonates in 15 NICU hospitals, 58.5 % had respiratory distress syndrome, 12.5 % bronchopulmonary dysplasia, 3.9 % necrotizing enterocolitis, 15.4 % intraventricular hemorrhage, 5.4 % retinopathy of prematurity, 28.4 % patent ductus arteriosus, and 9.7 % sepsis (Kong et al., 2016).

In Bangladesh between 2017 and 2018, out of the 262 neonates admitted to the NICU, 78.6% were improved and discharged, 1.1% were referred for urgent cardiac intervention and 3.9% died. Prematurity, neonatal infection and birth asphyxia were the major causes of neonatal mortality (Tajkia et al., 2019). A study in Nigeria of health outcomes of 572 infants admitted to the NICU in 2010- 2011, out of the 572 neonates, 19.4% died. About three quarters (76.5%) of the mortalities occurred in the first week of life with 46.4% of these occurred in the first 24 hours. The common causes of mortality were prematurity (43.2%), birth asphyxia (18.0%) and neonatal infections (17.1%) (Tajkia et al., 2019). In Ethiopia, a study over 3 years neonatal mortality in the NICU was 14.4% during that period. The leading causes of death were sepsis, LBW, and prematurity (Eyeberu et al., 2021). Based on another study in Ethiopia that was conducted among 834 randomly selected infants in NICUs in 2020, neonatal mortality was 14.4% (95% CI:11.9,16.7). Factors associated with neonatal mortality were neonates of mothers with multiple pregnancy [AOR = 2.87, 95% CI (1.08,7.61)], neonates delivered at the health center [AOR =5.05, 95%CI: (1.72,14.79)], low birth weight [AOR = 4.01, 95%CI (1.30,12.33)], having perinatal asphyxia

[AOR =3.85, 95%CI: (1.83,8.10)], and having early-onset neonatal sepsis [AOR = 3.93, 95%CI: (1.84,8.41)] (Eyeberu et al., 2021).

As to the region, in Egypt, 20% of the newborns need to be admitted to NICUs (about 500.000 per year), due to the shortage of NICUs availability in Egypt (especially in the governmental hospitals), about 16 neonatal death per 1.000 live birth are registered monthly (Egypt Without Disease, n.d.) (Algameel et al., 2020). Based on a study in Egypt in 2005, the overall mortality rate for the 826 neonates admitted to the NICUs was 29.1%. The mortality rate was 69.4% for infants with birth weight less than 1000 g. 2.1% of the deaths occurred within the first 24 hours of NICU admission, 15.8 % within 2 days, 29.2% within 3 days, and 91.3% within 12 days. Only 8.75% of deaths occurred after the first month of NICU admission. The leading causes of death were infection, RDS, hypoxic-ischemic encephalopathy (HIE), and congenital anomalies (G. Hany, 2021).

In Jordan, based on the study conducted between 2010-2011, the mortality rate for the admitted neonates to the NICU was 8.7%, and the top leading diagnoses were RDS (87%) and prematurity (87%), with an average gestational age of 30 weeks (Sivasubramaniam et al., 2015). In 2019 in the West Bank, the reported infant mortality rate was 11.1 per 1,000 live births (870 cases), and the stillbirth rate was 3.6 per1,000 total births (284 cases) (PHIC, 2019). In Gaza in 2019, the infant mortality rate was 10.7 per 1,000 live births, and was no reporting of stillbirths (PHIC, 2019). Based on the MoH annual report, the top three causes of reported infant mortality were conditions in the perinatal period (e.g., low birth weight, prematurity, and complications regarding the placenta, cord, and membranes) (77%), congenital malformation (19%), and sudden infant death syndrome (3%) (PHIC, 2019).

Chapter 3: Study methodology

3.1 Introduction

This chapter describes the study's methodology: the study population, study design, sampling strategies, data collection, ethical considerations, data analysis, and study limitations.

3.2 Study design

Secondary data analysis of MoH hospital data and referral data. Medical records were retrieved from Avicenna HIS data from the 11 governmental hospitals with NICUs. Those hospitals cover the whole regions (North, Middle, and South) of the West Bank. Referral data were collected from the e-Referral system operated by the Service Purchase Unit. For both systems, the data were collected for the period between 1st of January and 31st of December 2020.

3.3 Study population

The study covers all the regions in Westbank (North, Middle, and South). The study population is all the live births admitted to neonatal intensive care units (NICUs) in the Palestinian Ministry of Health (PMoH) hospitals and all live births referred outside PMoH in 2020. In 2020, there were 3146 admissions for 2963 unique neonates, and 1913 referrals to NICUs outside PMoH. Data were extracted from all hospitals operated by the Palestinian Ministry of Health (Except Almuhtaseb hospital in Hebron, since they don't have Avicenna HIS at the hospital) for the study period (1st January 2020 to 31st December 2020) and have neonatal intensive care unit (NICU). Appendix A lists all the hospitals and NICU bed counts participating in the study by region and district.

3.3.1 Inclusion criteria

- All the live births admitted/readmitted to the PMoH NICUs with age up to 28 days in 2020.
- Neonates referred to NICU outside PMoH hospitals in 2020.

3.4 Data collection

All the data used in this research were imported from two systems used by the Palestinian Ministry of Health (MOH) in all governmental hospitals, the Avicenna health information system (HIS) and the e-Referral system. The data collected from the Avicenna system was extracted as excel files by executing proper SQL queries on the database by the database administrator to meet the research requirements, then the extracted data were validated by the system administrator. Collected excel files were merged into one sheet by matching the unique admission identifier in all data files. The data collected from the e-referral system was imported as an excel sheet by a predefined report in the system.

The data collected from the two systems couldn't be matched and merged together due to the SPU regulations and limitations, where the referral number was considered to be personal data and not available to the researcher.

Data cleaning was performed by the researcher and database administrator to remove the duplicated records, irrelevant observations, and incomplete data elements. Also, the process included fixing the structural errors, and filtering out unwanted outliers.

3.5 Study variables

3.5.1 Outcome variables

Health outcome: Measured based on discharge note in the Avicenna hospital database: Improved and discharged, discharged against doctor's approval, referred, died.

Readmission: Readmitted to the neonatal unit within the neonatal period, based on Avicenna database. Measured as a binary variable (Yes/No).

Cost of referrals: Estimated costs based on referral database.

3.5.2 Independent variables

Gestational age: measured as both a continuous variable and categorical: Full Term (>37 weeks), moderate to late preterm (32-37 weeks), very preterm (28-30 weeks), extremely preterm (<28 weeks).

Birth weight: measured as a continuous variable and categorical. High Birth Weight (≥ 4.0 kg), Normal Birth Weight (≥2.5 kg < 4.0 kg), Low Birth Weight (1500 to <2500 g), Very Low Birth Weight (1000 to < 1500 g), Extremely Low Birth Weight (< 1 000 g)

Apgar One score and Apgar Five score: measured as categorical variables: excellent condition (7-10), moderately depressed (4-6), severely depressed (0-3)

Diagnosis: with the help of a neonatologist, all diagnosis was grouped into the following categories: Respiratory Disorders, for Observation, Hematology, Sepsis, Congenital Anomaly, Central Nervous System, Gastrointestinal, Mother Disease, Syndromes.

Invitro fertilization: measured as a binary variable based on hospital Avicenna data

Multiple pregnancies: measured as a binary variable based on hospital Avicenna data (Yes/No)

Length of stay: Estimated by subtracting the date of discharge from data of admission. Measured as a continuous variable.

3.6 Data analysis

Descriptive data analysis was conducted using SPSS to estimate means and percentages, in addition to univariate data analysis using chi-square and t-test for univariate analysis and logistic regression to examine factors associated with readmission.

3.7 Ethical consideration

The data collection was approved by the MoH (Appendix B), and the study protocol was approved by MoH Ethics Review Committee and by the Arab American University-Palestine (AAUP) IRB Review Committee. Several measures were taken to protect confidentiality:

- Data was anonymous; no personal data were collected, e.g. ID, name, address … etc).
- To protect the privacy of hospitals, data analysis and dissemination were done at the aggregated level

Chapter 4: Study findings

The registered number of live births in governmental hospitals in WB in 2020 was 32,057. Among them, 9.2% (2,963) unique neonatal were admitted to the NICUs in PMoH with a total of 3146 admissions.

4.1 Neonates admitted/referred to the PMoH NICUs (those born in or out of PMoH hospitals)

4.1.1 Sample characteristics

Table 1 shows the characteristics of the neonates admitted to the NICUs in the PMoH hospitals. 56% of the admitted neonates were males and 44 were females. The average mother's age of the neonates admitted to the NICUs in the PMoH hospitals was 27 years. More than half of the admitted newborns were from Nablus and Hebron.

Most admissions were single births (90%) and were not in-vitro fertilization (IVF) babies. Almost half of the admissions were delivered through cesarean. The average age of neonates admitted to the PMoH NICUs was 1.8 days age.

Table 1: Sample Characteristics of neonates admitted to PMOH NICUs, (N=3146)

Family characteristics	
Mother's age (Mean (min, max))	27.47 (15, 48)
District	N (%)
- Nablus	944 (30.0%)
- Hebron	568 (18.1%)
- Tulkarm	408 (13.0%)
- Jenin	405 (12.9%)
- Salfeet	270 (8.6%)
- Bethlehem	180 (5.7%)
- Ramallah	122 (3.9%)
- Tubas	54 (1.7%)

Family characteristics

- Qalqilya	43 (1.4%)
- Jerusalem	26 (0.8%)
- Jericho	9 (0.3%)
- Unknown	117 (3.7%)

Child characteristics

Age at Admission (Mean (min, max)) in days	1.79 (0, 28)
Sex	N(%)
- Male	1768 (56.2%)
- Female	1378 (43.8)
Birth Type	
- Normal Birth	1610 (51.2%)
o without Epidural	1479 (47.0%)
o with Epidural	131 (4.2%)
- Cesarean Section	1536 (48.8%)
o with Local Anesthesia	961 (30.5%)
o with General Anesthesia	575 (18.3%)
Single/Multiple birth	
- Single	2830 (90%)
- Multiple Births	316 (10%)
o Part of twins	291 (9.2%)
o Part of triplets	21 (0.7%)
o Part of Quadruplets	4 (0.1%)
IVF	77 (2.4%)

Table 2 shows the distribution of NICU beds and admissions in the Palestinian MoH hospitals. As shown in Table 2, out of a total of 117 NICU beds in the Palestinian MoH hospitals, Rafidia hospital has the largest count of NICU beds and admissions with 30 beds and 1003 admission in 2020, being a referral hospital, while Jericho has only one portable incubator which is used only for transferring the neonates to other hospitals, that explains the zero count of admissions in Jericho hospital.

Table 2: Distribution of NICU beds and admissions to PMoH hospitals in 2020, (N=3146)

Hospital	District	NICU beds count	Admissions (N (%))
Rafidia Governmental Hospital	Nablus	30	1003 (31.9%)
Alia Governmental Hospital	Hebron	24	435 (13.8%)
Palestinian Medical Complex	Ramallah	15	123 (3.9%)
Dr Khalil Suliman Governmental Hospital	Jenin	14	377 (12%)
Thabet Thabet Governmental Hospital	Tulkarm	11	409 (13%)
Darwish Nazzal Governmental Hospital	Qalqilya	6	35 (1.1%)
Al-Hussien Governmental Hospital	Bait Jala	5	188 (6%)
Martyr Yaser Arafat Hospital	Salfeet	5	311 (9.9%)
Yatta Governmental Hospital	Hebron	4	132 (4.2%)
Tubas Turkish Governmental Hospital	Tubas	3	133 (4.2%)
Jericho Governmental Hospital	Jericho	1 (Portable)	0 (0%)

4.1.2 Clinical characteristics

Table 3 shows the clinical characteristics of the neonates admitted to the Palestinian MoH hospitals in 2020. The length of stay for the neonates admitted to the PMoH NICUs varied from 0 to 154 days with an average of 6.75 days. More than half of the neonates were delivered with a full-term gestational age (GA) (58.7%), and within the normal birth weight range (61.4%). Only 35.6% of neonates had low birth weight. About 84% of the neonates had an excellent APGAR 1 score condition, and 94% had an Excellent APGAR 5 score condition.

Table 3: Clinical characteristics of the neonates admitted to the Palestinian MoH hospitals in 2020 (N=3146)

Indicator	**Mean (Min, Max)**
Length Of Stay (days)	6.75 (0, 154)
Weight (KG)	2.706 (0.300, 7.000)
Weight Category	N (%)
- HBW (≥ 4.0 kg)	96 (3.1%)
- NBW (≥2.5 kg < 4.0 kg)	1931 (61.4%)
- Low Birth Weight	
o LBW (1500 to <2500 g)	875 (27.8%)
o VLBW (1000 to < 1500 g)	175 (5.6%)
o ELBW (< 1 000 g)	69 (2.2%)
Gestational Age (GA) (weeks)	36.39 (14, 43)
GA Categories	N (%)
- Full Term (>37 weeks)	1684 (58.7%)
- Moderate to Late Preterm (32-37 weeks)	816 (28.4%)
- Very Preterm (28-30 weeks)	293 (10.2%)
- Extremely Preterm (<28 weeks)	76 (2.6%)
APGAR 1 Score	7.49 (0, 10)
APGAR 1 Score-Category*	N (%)
- Excellent condition (7-10)	2305 (84.7%)
- Moderately depressed (4-6)	343 (12.6%)
- Severely depressed (0-3)	74 (2.7%)
APGAR 5 Score*	8.39 (0,10)
APGAR 5 Score Category	
- Excellent condition (7-10)	2449 (94%)
- Moderately depressed (4-6)	123 (4.7%)
- Severely depressed (0-3)	34 (1.3%)

- *APGAR 1 Score based on data from 2721 (74%)*
- *APGAR 5 Score based on data from 2605 (58%)*
- *APGAR Score Category (UNICEF, 2018).*

As shown in Figure 2, the top 5 causes of admission were respiratory disorders (44%) (mostly RDS, and transient tachypnea of the newborn), admission for observation (18.2%), hematology disorders (16.4%) (mostly jaundice), sepsis (13.8%), and congenital anomalies (4%).

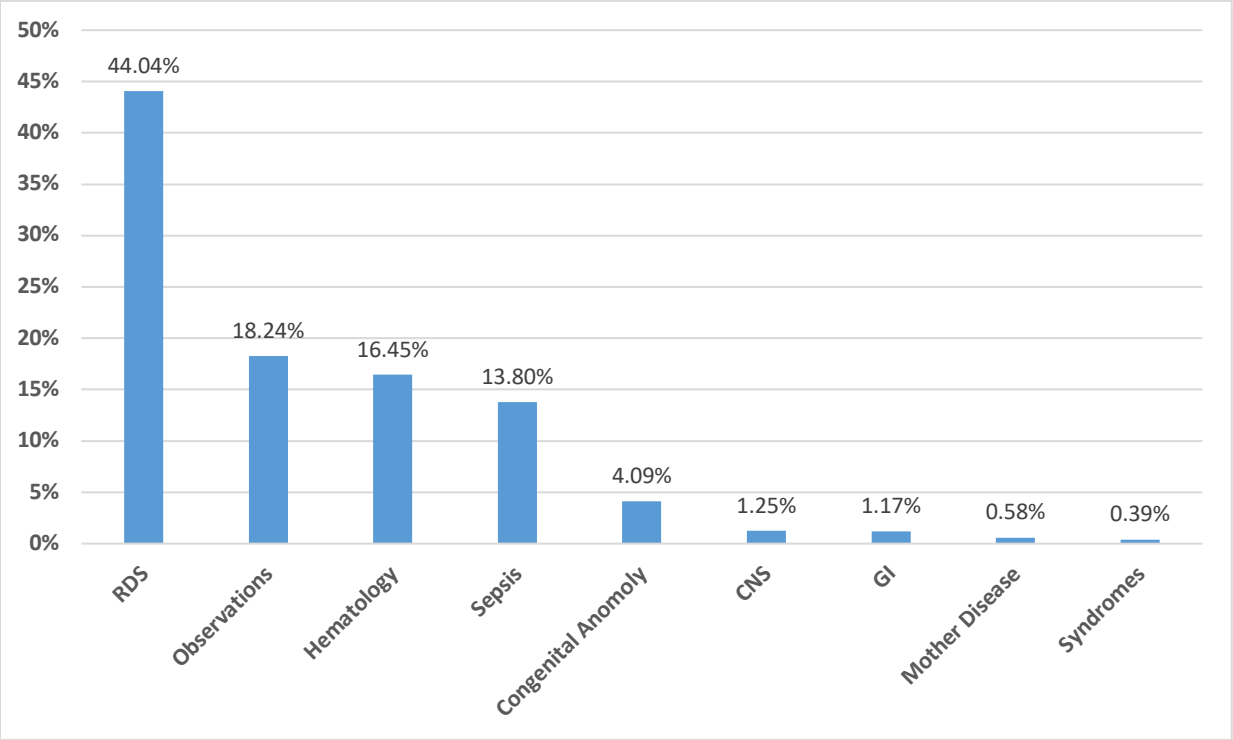

Figure 2: Top 5 causes of admission among neonates admitted to PMoH neonatal units, 2020 (3146)

4.1.3 Neonates admitted to the NICU unit under 500 grams or under 24 weeks

According to the WHO classifications, babies born with a weight less than 500g or gestational age less than 24 weeks are classified as abortion. Two cases were registered in the WB governmental hospitals during the year 2020 (one newborn weighed 300 gm, and the other one had a gestational age of 14 weeks).

4.1.4 Readmission

As shown in Table 4, 16.7% of admissions to the PMoH NICU units in 2021 were readmissions. Based on bivariate analysis, shorter length of stay at NICU, older newborn babies at admission, and higher gestational age were associated with an increased likelihood of readmission. Based on logistic multivariate regression analysis, controlling for age at admission, hematology diagnosis upon admission and higher birth weight was associated with an increased likelihood of readmission.

Table 4: First Admission VS Readmission, (N=3146), 2020

	First admission	**Readmission**	**p-value**
	Mean (SD)	Mean (SD)	
Child age (days)	1.32 (3.97)	8.8 (7.60)	0.000
Gestational age	32.46 (14.8)	37.34 (2.34)	
Birth weight	2.69 (0.81)	2.8 (.66)	
Length of Stay	6.94 (11.09)	3.83 (6.55)	0.000
Birth weight	N (%)	N (%)	.003
- HBW (≥ 4.0 kg)	87 (2.9%)	9 (4.8%)	
- NBW (≥2.5 kg < 4.0 kg)	1808 (61.1%)	123 (65.8%)	
- LBW (1500 to <2500 g)	822 (27.8%)	54 (28.9%)	
- VLBW (1000 to < 1500 g)	174 (5.9%)	1 (.5%)	
- ELBW (< 1 000 g)	69 (2.3%)	-	
Birth type	N (%)	N (%)	.546
- Normal	1523 (51.4%)	88 (47%)	
- Cesarean	1437 (48.5%)	99 (52.9%)	
ApgarOneScore	N (%)	N (%)	.044
- Excellent condition (7-10)	2162 (84.3%)	143 (91.7%)	
- Moderately depressed (4-6)	332 (12.9%)	11 (7.1%)	
- Severely depressed (0-3)	72 (2.8%)	2 (1.3%)	
ApgarFiveScore	N (%)	N (%)	.335
- Excellent condition (7-10)	2301 (93.8%)	148 (96.7%)	
- Moderately depressed (4-6)	119 (4.9%)	4 (2.6%)	
- Severely depressed (0-3)	33 (1.3%)	1 (.7%)	
Mother Age	27.4 (5.9)	28 (6.1)	1.78
District	N (%)	N (%)	.000
- Nablus	856 (30.1%)	88 (48.4%)	
- Hebron	564 (19.8%)	4 (2.2%)	
- Jenin	384 (13.5%)	21 (11.5%)	
- Tulkarm	368 (12.9%)	40 (22%)	
- Salfeet	252 (8.8%)	18 (9.9%)	

	First admission	Readmission	p-value
- Bethlehem	170 (6.3%)	1 (.5%)	
- Ramallah	122 (4.3%)	-	
- Tubas	50 (1.8%)	5 (2.7%)	
- Qalqilia	39 (1.4%)	4 (2.2%)	
- Jerusalem	25 (0.9%)	1 (.5%)	
- Jericho	9 (0.3%)	-	
Health Outcome	N (%)	N (%)	.008
- Improved	2379 (80.4%)	168 (89.8%)	
- Died	248 (8.4%)	3 (1.6%)	
- Discharge/transfer to an (other) hospital – non (MOH) hospital	165 (5.6%)	7 (3.7%)	
- Discharged against medical advice/discharge at own risk	131 (4.4%)	9 (4.8%)	
- Discharge to another MOH-hospital	32 (1.1%)	-	
- Admitted to same hospital	5 (0.2%)	-	
Diagnosis Category	N (%)	N (%)	.000
- Respiratory Disorders	1107 (46%)	23 (14.4%)	
- Observation	452 (18.8%)	16 (10%)	
- Hematology	340 (14.1%)	82 (51.2%)	
- Sepsis	326 (13.5%)	29 (18.1%)	
- Congenital Anomaly	99 (4.1%)	6 (3.8%)	
- CNS	31 (1.3%)	1 (0.6%)	
- GI	29 (1.2%)	1 (0.6%)	
- Mother Disease	15 (0.6%)	2 (1.3%)	
- Syndromes	8 (0.3%)	-	

4.1.5 Health outcome of neonates admitted to MoH NICU

As shown in Figure 3, based on the hospital discharge note, 80% of the neonates admitted to the NICUs in the PMoH hospitals got improved and discharged, while 8% died. 6% of the neonates admitted to the NICUs in the PMoH hospitals were referred to non-MoH hospitals and 4% were discharged against medical advice (discharged at own risk), while only 2% were admitted to the same hospital or discharged to another governmental hospital.

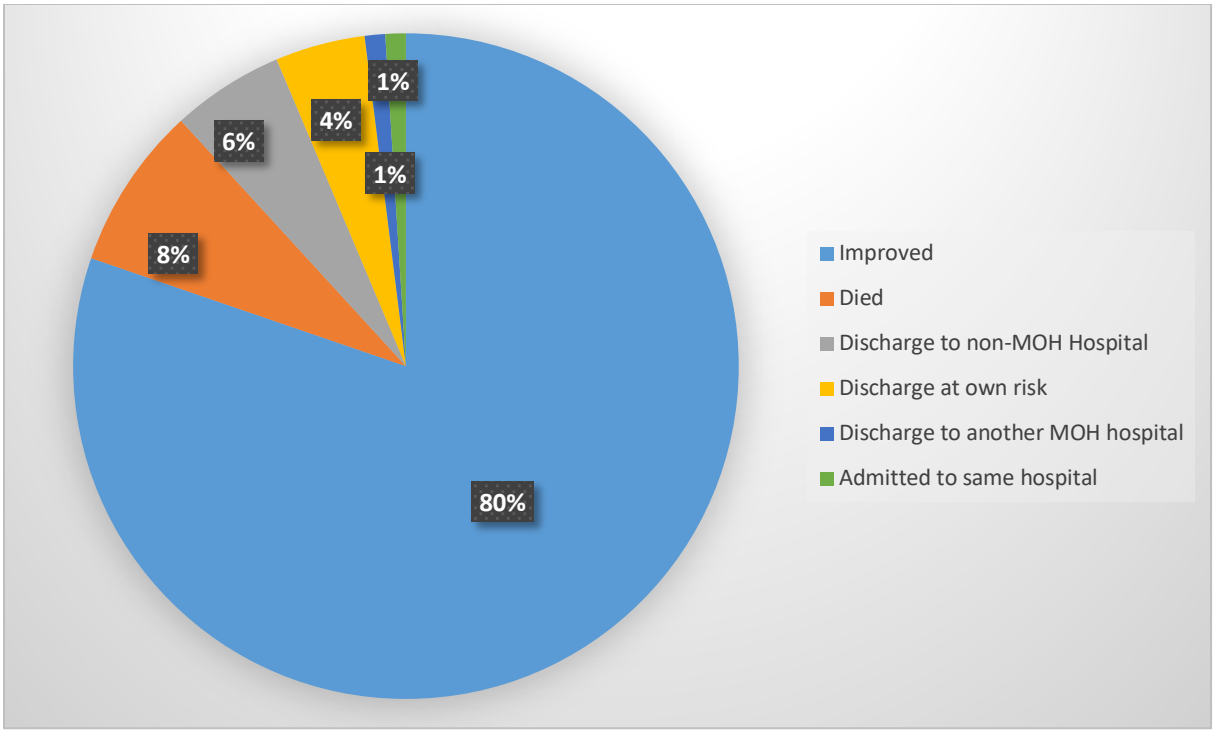

Figure 3: Health outcomes of neonates admitted to MoH NICUs, (N=3146), 2020

4.1.5.1 Health outcomes of admitted neonates to the NICU unit by pregnancy type

Based on Table 5 health outcomes of IVF neonates were better than those for non-IVF newborns. Around 97.4% of the IVF pregnancy babies were improved and discharged, and 2.6% died. Around 64.9% of the IVF babies were part of twins. 78% of the IVF deliveries were cesarean and 47.9% were moderate to late preterm GA.

Table 5: health outcomes of neonates admitted to the PMoH NICUs by Pregnancy type (IVF vs Normal), N=3146, 2020

	IVF (N=77)	**Normal (N= 3069)**	**P-Value***
Discharge Type	N (%)	N (%)	.014
• Improved	75 (97.4%)	2471 (80.5%)	
• Died	2 (2.6%)	249 (8.1%)	
• Admitted to same hospital	0 (0%)	5 (0.2%)	
• Discharge to an (other) MOH-hospital	0 (0%)	32 (1%)	
• Discharge/transfer to non-PMoH hospital	0 (0%)	172 (5.6%)	
• Discharged against medical advice / discharge at own risk	0 (0%)	140 (4.6%)	

	IVF (N=77)	Normal (N= 3069)	P-Value*
GA Category			.000
• Full Term	11 (15.1%)	1673 (59.8%)	
• Moderate to Late Preterm	35 (47.9%)	781 (27.9%)	
• Very Preterm	26 (35.6%)	267 (9.5%)	
• Extremely Preterm	1 (1.4%)	75 (2.7%)	
Birth Type			.000
• Normal	17 (22%)	1593 (51.9%)	
• Cesarean	60 (78%)	1476 (48.1%)	
Single/Multiple Pregnancy			.000
• Single Birth	20 (26%)	2810 (91.6%)	
• Part of Twins	50 (64.9%)	241 (7.9%)	
• Part of Triplets	7 (9.1%)	14 (0.5%)	
• Part of Quadruplets	0 (0%)	4 (0.1%)	

** p-Value is based on the chi-square test.*

4.2 Neonates referred to non-MoH hospitals

Table 6 describes the characteristics of neonates referred to NICUs outside MoH hospitals, In 2020, there were 1,913 neonatal referrals issued to NICUs outside the PMoH hospitals, with a total estimated cost of 26,664,597 NIS cost, and an average cost of 13938 NIS per case. As shown in Table 6, 57% of the referred neonates were males and 43% were females, Hebron has the most referring district responsible for 29% (569 cases) of the referrals.

Only 57.1% of the referrals were issued from PMoH hospitals and the rest were issued from non-governmental hospitals. Around 88.6% of referred cases were referred to the West Bank hospitals, while 11.4% were referred to Jerusalem hospitals.

Table 6: Sample characteristic of neonates referred outside PMoH NICUs, (N=1913), 2020

Characteristics	
District	**N (%)**
- Hebron	569 (29.7%)
- Jenin	251 (13.1%)
- Ramallah	173 (9.0%)
- Bethlehem	171 (8.9%)
- Nablus	158 (8.3%)
- Jerusalem	152 (7.9%)
- Tulkarm	133 (7.0%)
- Salfeet	69 (3.6%)
- Qalqilya	67 (3.5%)
- Gaza	58 (3.0%)
- Jericho	56 (2.9%)
- Tubas	48 (2.5%)
- Unknown	8 (0.4%)
Sex	
- Male	1091 (57%)
- Female	822 (43%)
Referring Facility Type / Referral Source	
- Governmental	1107 (57.9%)
- Non-Governmental	806 (42.1%)
Referral Facility Locality	
- West Bank	1694 (88.6%)
- Jerusalem	219 (11.4%)

4.2.1 Referring facility

As shown in Table 7, the top referring hospitals (the hospital that issue the referral request) were Specialized Arab Hospital, Alia Hospital, Jenin Hospital, and Palestine Medical Complex.

Table 7: Referring facilities to non-MoH hospitals

Referring facility	N(%)
Specialized Arab Hospital	209 (10.9%)
Alia Hospital – Hebron	183 (9.6%)
Jenin Hospital	179 (9.4%)
Palestine Medical Complex- (PMC Ramallah)	161 (8.4%)
Primary Health Care Directorate - Jerusalem	125 (6.5%)
Al Mezan Hospital - Hebron	103 (5.4%)
Rafidia Hospital - Nablus	84 (4.4%)
Al-Ahli Hospital -Hebron	84 (4.4%)
Al Makassed Hospital	81 (4.2%)
Tulkarem Hospital	78 (4.1%)
Beit Jala Hospital	75 (3.9%)
Istishari Arab Hospital	68 (3.6%)
Palestinian National Authority	58 (3%)
Al Etihad hospital	58 (3%)
Nablus Specialty Hospital	57 (3%)
Red Crescent Hospital for Kids - Hebron	48 (2.5%)
Holy Family Hospital- Bethlehem	48 (2.5%)
Yatta Hospital	46 (2.4%)
Almohtaseb Hospital	33 (1.7%)
Al-Razi Hospital	31 (1.6%)
Jericho hospital	23 (1.2%)
Tubas Hospital	22 (1.2%)
Qalquilia Hospital	16 (0.8%)
Service Purchase Unit West Bank	12 (0.6%)
Salfit Hospital	12 (0.6%)
H- clinic	10 (0.5%)
Al Israa Specialized Hospital	7 (0.4%)
Arab care Center / Zain Company Hospital	2 (0.1%)

4.2.2 Referrals outside PMoH hospitals by referring medical department

As shown in Figure 4, most referrals were issued from NICU units.

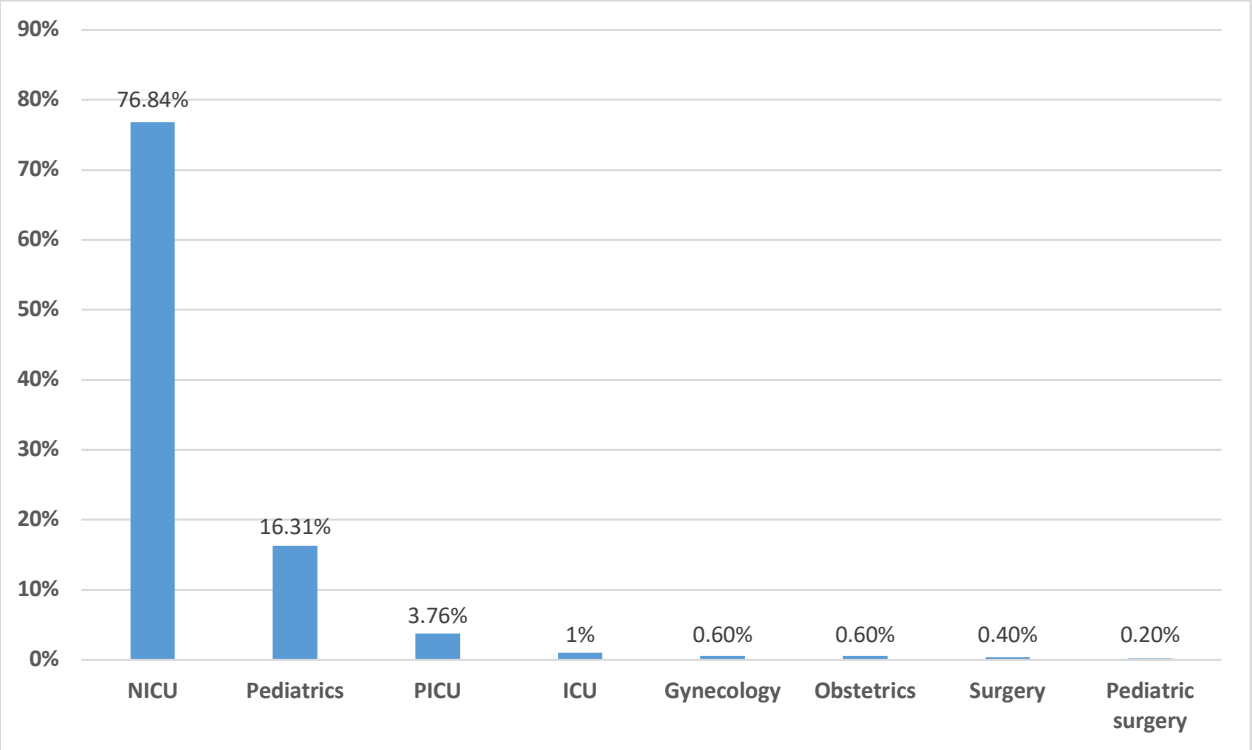

Figure 4: Referrals by referring department

4.2.3 Referral facility

As shown in Table 8, All neonatal units in the referral facilities (hospitals where neonates are referred to) in the Westbank were between level 2 and level 3, and the only level 4 unit was in Al-Makased hospital in East Jerusalem. There were 1913 referrals for NICUs outside PMoH hospitals in 2020. The top referral hospitals in 2020 were Specialized Arab Hospital, Al Mizan, and Al Makased hospital. Almost 55% of referrals were to level 2M neonatal units that do not have neonatologists or medical or surgical specialties.

Table 8: non-PMoH Referral hospitals and their levels, N = 1913, 2020

Referral facility	level	N(%)
Specialized Arab Hospital	2M*	265 (13.9%)
Al Mezan Hospital - Hebron	2M	220 (11.5%)
Al Makassed Hospital	4	218 (11.4%)
Al Etihad hospital	2M	189 (9.9%)
Istishari Arab Hospital	2M	178 (9.3%)
Al-Razi Hospital	2M	173 (9%)
Al-Ahli Hospital -Hebron	3	140 (7.3%)
H-clinic	2M	112 (5.9%)
Caritas Baby Hospital	3	104 (5.4%)
Red Crescent Hospital for Kids - Hebron	3	103 (5.4%)
Holy Family Hospital- Bethlehem	3	83 (4.3%)
Al Israa Specialized Hospital	2	60 (3.1%)
Nablus Specialty Hospital	2M	57 (3%)
Arab care Center / Zain Company Hospital	2M	9 (0.5%)
Red Crescent Society Hospital -Jerusalem	3	1 (0.1%)
Red Crescent Society Hospital -Al Bireh	3	1 (0.1%)

** M stands for Modified*

4.2.4 Causes of referral to non-PMoH hospital

As shown in Figure 5, more than half of referrals outside PMoH were for treatments not found at PMoH neonatal units. About 19% of the referrals were for follow-up, and only 0.84% were for emergency cases. Availability of beds and long waiting time have only about 9% of the referrals.

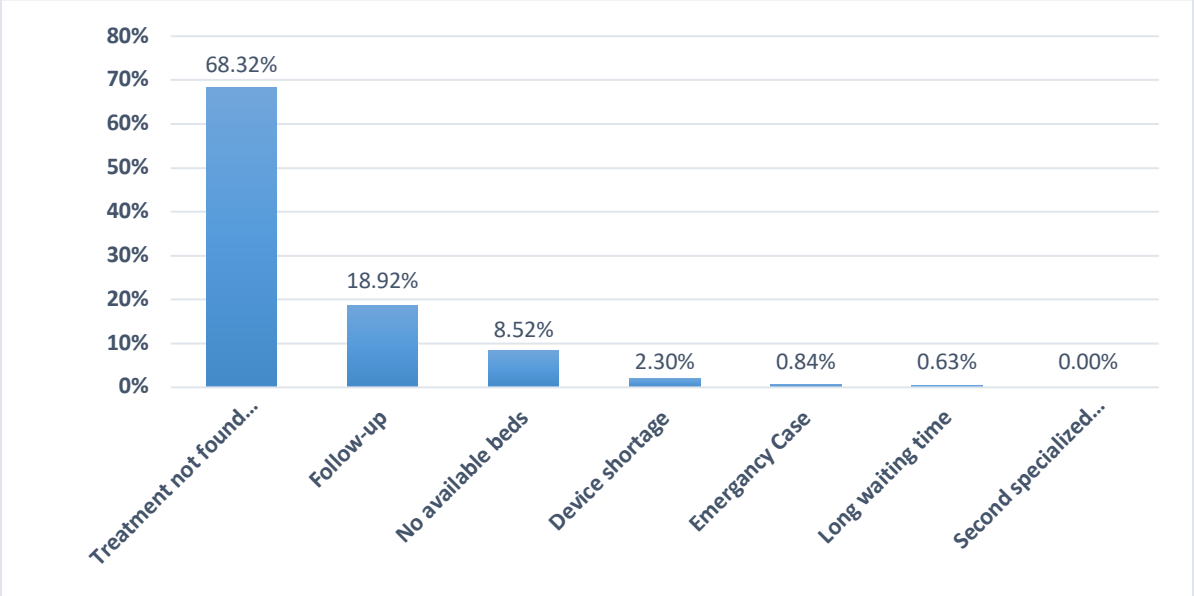

Figure 5: Referrals by referring cause

4.2.5 Referral outside MoH hospitals by type of referral

Figure 6 describes the percentage of referrals by referral type, about 90% of the referrals outside PMoH hospitals were for an emergency and follow-up, while only 10% of the referrals were for non-emergency.

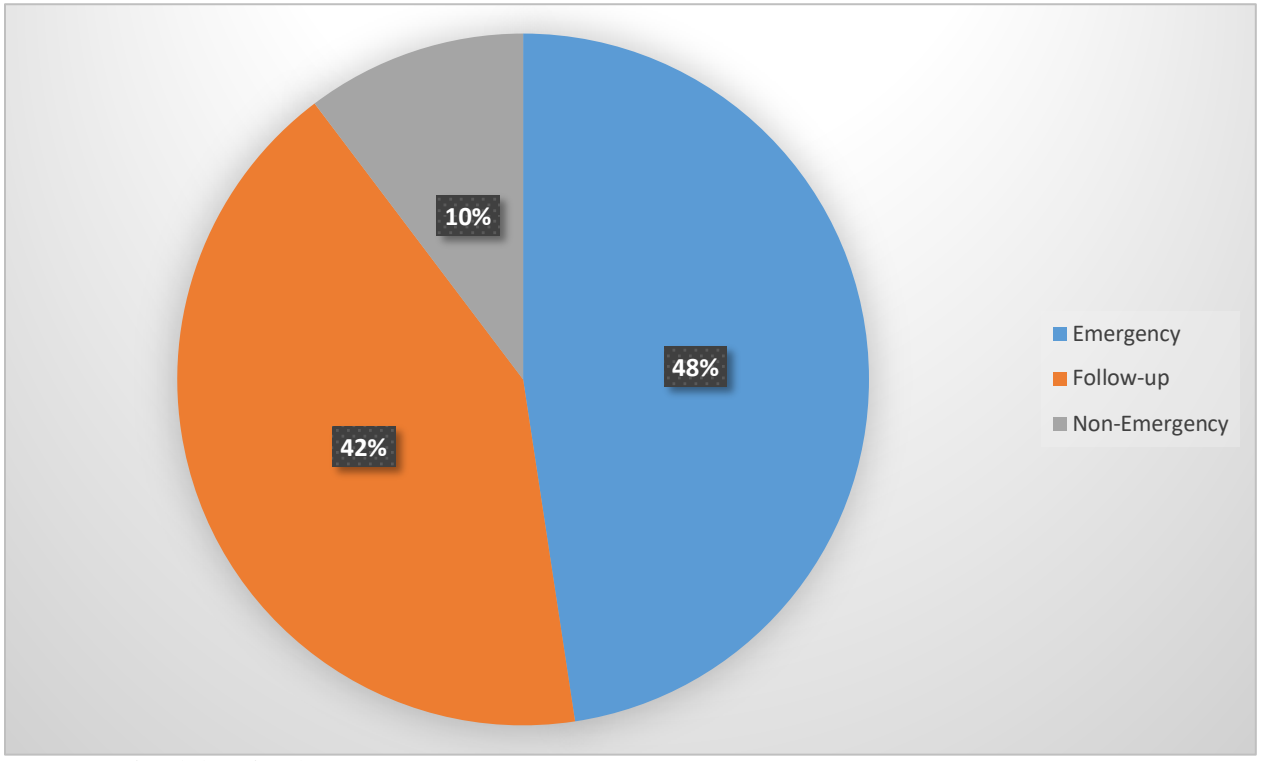

Figure 6: Referrals by referral type

4.2.6 Estimated cost of neonatal referrals to non-MoH hospitals by referral reason

As shown in Table 9, the highest estimated cost of referrals to non-MoH hospitals was for treatments not found at PMoH hospitals which also have the most percentage of referrals (Figure 5). The total estimated costs of referrals for NICU in 2020 were 26,664,595 ILS. Follow-up has the highest average cost per referral.

Table 9: Cost of referrals by referral reason, 2020

Referral Reason	Mean (Min, Max) (ILS)	Total Cost (ILS) (%)
Treatment not found In PMoH hospital	12,990 (334, 145919)	16,977,983 (63.67%)
Follow-up	17,491 (108, 45855)	6,332,008 (23.74%)
No available beds	16,723 (1566, 49942.8)	2,725,881 (10.22%)
Emergency Case	14,641 (720, 44631)	234,270 (0.87%)
Second specialized opinion for final diagnosis	11,652 (1350, 46980)	104,875 (0.39%)
Device/Equipment Shortage	5,297 (675, 24300)	233,068 (0.87%)
Long Waiting Time	4,709 (1350, 25650)	56,510 (0.21%)

4.2.7 Estimated cost of neonatal referrals to non-MoH hospitals by referral type

Table 10 demonstrates the estimated referral cost by referral type. The highest estimated cost of referrals to non-MoH hospitals was for follow-up (58.67% of total costs) which also has the highest average cost per referral.

Table 10: cost by referral type, 2020

Referral Type	Mean (Min, Max)	Total Cost (ILS) (%)
Follow-up	19,411 (108, 81000)	15,645,340 (58.67%)
Emergency	9,429 (334, 70164)	8,580,858 (32.18%)
Non-Emergency	12,377 (702, 145919)	2,438,397 (9.14%)

Chapter 5: Discussion and recommendations

5.1 Discussion

Based on PMoH data, most admitted and referred neonates to PMoH NICU were single births and not invitro neonates. This could be explained by births from multiple pregnancies and invitro being in the non-governmental NICUs. Few of the admitted/referred neonates were from Jerusalem, as most have Israeli health insurance and go to hospitals in EJ. Almost one-third of admitted/referred neonates were from Nablus, while only 18% were from Hebron, which the later has twice the population size. This could be explained by the fact that NICUs are concentrated in the north, so parents may opt to send their newborns in need to NICU to non-governmental hospitals close to them. Almost one-third of admissions were to Rafidia hospital being a referral hospital.

In contrast to previous studies, low birth weight and prematurity were not the main causes of admission to PMoH NICUs in 2020, as more than half of the admitted newborns had normal birth weight (61.4%) and were full-term babies (58.7%). Surprisingly, prematurity was not even listed among the top leading causes of admission. This could be explained by data inaccuracy, reporting the underlying cause of death as prematurity complications rather than prematurity.

Only two cases of "abortion' were admitted to the NICU. This is explained by the guideline that these neonates do not receive invasive procedures, only the minimum, so they are not referred to NICU.

Readmission was high and of public health concern. In 2016, globally, it was 2.2%. Factors associated with readmission were the baby age at admission, diagnosis category, and weight category, as found in the previous study where all admissions were before 9 days. Half of readmitted was for hematology (mostly Jaundice). Among the factors associated with readmission was neonatal hematology diagnosis among admission. Anemia and thrombocytopenia (low blood

platelet count) occur frequently in preterm neonates. Thrombocytopenia is common during sepsis. While thrombocytopenia may be present at birth due to intrauterine disorders, it is commonly detected after birth due to bacterial infection (Ree & Lopriore, 2019). Furthermore, sepsis was among the top causes of admission. Sepsis could have been prevented by applying early essential newborn care at the time of birth.

About 18.8% of admitted and 10% of readmitted were for observation. If Normal Newborn Nursery units were available in the PMoH hospitals, there would have been no need to admit the newborn to the NICU and save the incubators for critical cases.

Most admitted neonates improved and were discharged, while 8% died. The mortality rate was less than that reported in previous studies in Ethiopia and Egypt; 8% vs 14.4% respectively. As expected, compared to non-IVF newborns, a higher proportion of IVF newborns were preterm and from multiple pregnancies, and none were discharged against medical advice. Interestingly, the mortality rate was higher among non-IVF newborns.

Almost one-third of referrals to NICU outside PMoH were from Hebron. This can be explained by the fact that NICU units in the south are at level 2. Surprisingly, only 3% of referred cases outside PMoH hospitals were from Gaza, given that there is no level 4 hospital in Gaza and no specialized services for critically ill newborns. Even Jericho hospital has only one portable incubator but still has the lowest referrals count, which refers to the fact that the newborns who need to be admitted to the NICU are being referred to another nearby MoH hospital (mainly PMC).

Only 0.6% of referrals outside PMoH were issued by Service Purchase Unit in the West Bank, as 90% of referrals were for emergency and follow-up. That is why the referral department was either the pediatric department or NICU department.

Only 11.4% of referrals were for Makased hospital, although the most frequent cause of referral was that treatment was not found at PMoH hospitals. This could be explained by an inability to get a permit to go to Jerusalem, unavailability of beds at Makased Hospital, or the referral was based on the availability of beds rather than the availability of specialized services.

5.2 Study limitations

The study has several limitations. First, due to the Service Purchase Unit rules and restrictions, the patient referral number was considered personal data; therefore, we could not merge data from both systems; the e-Referral system and Avicenna HIS to be able to extract the gestational age of the referred neonate. Second, the researcher did not have access to actual costs for NICU referrals, only estimated costs. Third, the researcher was unable to collect data on health outcomes of the referred neonates to hospitals outside PMoH. Fourth, poor quality of data, e.g., as to the health condition of the admitted newborns, based on Apgar One score and Apgar Five score, most admitted/referred neonates had an excellent condition (7-10). Fifth, missing important data that is supposed to help in examining the quality of care at NICUs, e.g. not all neonates had Apgar score 1 and Apgar score 5, and 21% did not have diagnosis upon admission. Sixth, there was no data on the health outcome of referred cases outside PMoH. Sixth, there was no data on background characteristics, clinical characteristics, and health outcomes of referred neonates outside PMoH, which hinders the analysis of the assessment of the effectiveness of the referral process.

5.3 Recommendations

The study has several recommendations at the policy and hospital levels:

Policy level

- Establish Normal Newborn Nursery units in all PMoH Hospitals for neonates who only need observation to increase the availability of beds in the NICU
- Collect data on morbidity in addition to mortality to strengthen neonatal health services in Palestine
- Collect data on morbidity and mortality of referred neonates outside PMoH to measure the effectiveness of referrals
- Due to the geopolitical context in Palestine, it is vital to improving the capacity of regional referral hospitals in the north, middle, and south West Bank to reduce referrals outside PMoH and improve morbidity and mortality of newborns.
- Need to add morbidity indicators in addition to morbidity to the discharged note
- Input data on Avicenna HIS should be restricted by adding more validation rules to ensure data accuracy and completeness (on both sides front-end, and database) as follow: APGAR One and Five Scores while not accepting a score of 10, birth weight with the same measurement scale (Gram, KG), final diagnosis and gestational age should be required fields.

Hospital level

- Monitoring of administrative data in terms of accuracy and completeness.
- Systematic analysis of health outcome data to examine the quality and accuracy of data and the impact of interventions and opportunities to strengthen neonatal services
- Need to mandate completion of important indicators like diagnosis and Apgar score
- Investigate the high percentage of readmission and its impact on the health outcome of neonates.
- Investigate the better health outcome (improved vs dead) among IVF babies despite having lower birth weight and being from multiple pregnancies.
- Sepsis was among the top causes of admission to NICU. Need to enforce adherence to WHO early essential newborn care guidelines (World Health Organization, 2014).

5.4 Future work

To carry out a cohort study to examine health outcomes of neonates discharged from neonatal intensive care units at the Palestinian Ministry of Health in 2020 to identify the prognosis one year after discharge.

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Appendices

Appendix A: List of PMoH hospitals included in the study

Hospital	Beds Count	District	Region
Alia Governmental Hospital	24	Hebron	South
Yatta Governmental Hospital	4	Hebron	South
Al-Hussien Governmental Hospital	5	BeitJala	South
Rafidia Governmental Hospital	30	Nablus	North
Tubas Turkish Governmental Hospital	3	Tubas	North
Dr Khalil Suliman Governmental Hospital	14	Jenin	North
Thabet-Thabet Governmental Hospital	11	Tulkarm	North
Martyr Yaser Arafat Hospital	5	Salfeet	North
Darwish Nazzal Governmental Hospital	6	Qalqilia	North
Palestinian Medical Complex (PMC)	15	Ramallah	Middle
Jericho Governmental Hospital	1 (Portable)	Jericho	Middle

Appendix B: PMoH approval on study protocol

STATE OF PALESTINE

Ministry of Health

Engineering & Computer Unit

دولـــــــة فلســـــــطين

وزارةالصحـــــــة

وحدةالهندسة و الحاسوب

Date: 24/9/2020 :التاريخ

Ref :.E & C U / 81 :الرقم

معالي وزيرة الصحة حفظها الله

د.مي سالم الكيلة المحترمة

تحية طيبة و بعد ،،

الموضوع : معدلات المراضة والوفيات لحديثي الولادة الذين تم إدخالهم إلى وحدات العناية المركزة (الحاضنات) في المستشفيات الحكومية في الضفة الغربية

يرجى علم معاليكم بأن الموظف أمجد عطاالله من وحدة الهندسة و الحاسوب ملتحق ببرنامج الدراسات العليا في الجامعة العربية الأمريكية ضمن تخصص المعلوماتية الصحية ، حيث يقوم بعمل دراسة تهدف إلى معالجة الفجوة في المعرفة بالنتائج الصحية لحديثي الولادة الذين تم ادخالهم الى وحدات العناية المكثفة للأطفال الخدج (NICU) في المستشفيات الحكومية المطبقة للنظام المحوسب (HIS) في الضفة الغربية ؛ لتمكين أصحاب القرار من تحديد الفرص و الوقوف على التحديات التي تواجه تحويل المواليد إلى مستشفيات القطاع الخاص، و تقييم تأثير التدخلات الصحية لتحسين النتائج الصحية للمواليد الخدج في وحدات العناية المكثفة (NICU).

و عليه يرجى من معاليكم الموافقة على جمع البيانات المتعلقة بالمواليد المدخلين إلى وحدات العناية المكثفة للأطفال الخدج NICU من كل من النظام المحوسب و تطبيق التحويلات لتحليلها و الاستفادة منها لأغراض الدراسة و البحث.

مع الاحترام ،،

مدير عام وحدة الهندسة و الحاسوب

علي الحلبي

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الملخص

فترة حديثي الولادة هي أول 28 يومًا من حياة المولود وهي الفترة الأكثر خطورة ، حيث يواجه الأطفال حديثي الولادة مخاطر الموت الأكثر خطورة خاصة في الأسبوع الأول من الحياة. في عام 2019 ، عالميا ، بلغ 47٪ من جميع وفيات الأطفال دون سن الخامسة في فترة حديثي الولادة. في عام 2019 في الضفة الغربية ، بلغ معدل وفيات الرضع 11.1 لكل 1000 ولادة حية (870 حالة). استنادًا إلى التقرير السنوي لوزارة الصحة الفلسطينية، كانت الأسباب الثلاثة الأولى لوفيات الأطفال المبلغ عنها هي الظروف المحيطة في فترة ما حول الولادة (على سبيل المثال ، انخفاض الوزن عند الولادة ، الخداج ، والمضاعفات المتعلقة بالمشيمة والحبل والأغشية) (77٪) والتشوه الخلقي (19٪) ومتلازمة موت الرضع المفاجئ (3٪).

تناولت هذه الدراسة خصائص الأطفال حديثي الولادة الذين تم إدخالهم إلى وحدات العناية المركزة لحديثي الولادة في المستشفيات الحكومية خلال الفترة من 1 يناير 2020 إلى 31 ديسمبر 2020 وكذلك النتائج الصحية لهؤلاء الأطفال. بالإضافة إلى ذلك ، تناولت الدراسة جميع تحويلات الطبية لحديثي الولادة إلى وحدات العناية المركزة لحديثي الولادة في المستشفيات غير الحكومية خارج وزارة الصحة الفلسطينية في عام 2020. استخلصت الدراسة البيانات من كل من نظام المعلومات الصحية Avicenna HIS (الذي تستخدمه وتديره المستشفيات الحكومية) و التحويلات الإلكترونية (نظام محوسب تديره وحدة شراء الخدمة في وزارة الصحة الفلسطينية). تم استخراج البيانات التي تم جمعها من نظام Avicenna كملفات excel عن طريق تنفيذ استعلامات SQL المناسبة على قاعدة البيانات من قبل مسؤول قاعدة البيانات لتلبية متطلبات البحث. تم التحقق من صحة البيانات المستخرجة من قبل مسؤول النظام. تم دمج ملفات Excel المجمعة في ورقة واحدة عن طريق مطابقة معرف المريض الفريد في جميع ملفات البيانات. تم استيراد البيانات التي تم جمعها من نظام التحويلات الطبية الإلكترونية على هيئة صحيفة Excel بتقرير محدد مسبقًا في النظام. تم استخدام SPSS لتحليل البيانات.

بناءً على نتائج الدراسة ، في عام 2020 ، تم تسجيل 3146 حالة دخول حديثي الولادة في وحدات العناية المركزة لحديثي الولادة التابعة لوزارة الصحة الفلسطينية (2963 وليداً). حوالي 90٪ من الولدان الذين تم قبولهم في وحدات العناية المكثفة في مستشفيات وزارة الصحة كانوا من المواليد الأحاديين ، و 2.7٪

كانوا من التلقيح الاصطناعي ، وكان معدل إعادة الإدخال للولدان في وحدات العناية المركزة لحديثي الولادة في مستشفيات وزارة الصحة ٥٪. كانت الأسباب الرئيسية للقبول في وحدات العناية المكثفة في مستشفيات وزارة الصحة هي أمراض الجهاز التنفسي ، للملاحظة ، وأمراض الدم (اليرقان في الغالب) ، والإنتان. لم يكن انخفاض الوزن عند الولادة والخدج من الأسباب الرئيسية للقبول في وحدات العناية المكثفة في مستشفيات وزارة الصحة للعام 2020. وكان أكثر من نصف الأطفال حديثي الولادة الذين تم قبولهم لديهم متوسط وزن عند الولادة (61.4٪) وكانوا أطفالًا كاملي المدة (58.7٪) ، وكان حوالي 41.2٪ منهم الخدج ، وكان 35.6٪ من الولدان يعانون من نقص الوزن عند الولادة. تم تحسين وخروج معظم الولدان الذين تم قبولهم في وحدات العناية المركزة لحديثي الولادة داخل المستشفيات الحكومية ، بينما توفي 8٪.

فيما يتعلق بالإحالات إلى وحدات العناية المكثفة خارج وزارة الصحة ، في عام 2020 ، كان هناك 1913 إحالة. لم تكن هناك معطيات حول سبب إحالات الولدان خارج مستشفيات وزارة الصحة ، فيما عدا 90٪ من الإحالات كانت للطوارئ والمتابعة. 0.6٪ فقط من هذه الإحالات صادرة عن وحدة شراء الخدمات ، و 57.2٪ صادرة عن المستشفيات الحكومية الفلسطينية ، و 42.2٪ صادرة عن المستشفيات غير الحكومية في الضفة الغربية. كانت أقسام الإحالة (القسم الذي يصدر طلب الإحالة) إما قسم طب الأطفال أو قسم وحدة العناية المركزة لحديثي الولادة. كانت أهم مستشفيات الإحالة (المستشفى الذي يصدر طلب الإحالة) في عام 2020 هي المستشفى العربي التخصصي ، والميزان ، ومستشفى المقاصد. حوالي 68٪ من الإحالات خارج مستشفيات وزارة الصحة كانت للعلاجات غير الموجودة في وحدات حديثي الولادة في مستشفيات وزارة الصحة. كان الإنتان من بين الأسباب الرئيسية للقبول في وحدات العناية المكثفة في مستشفيات وزارة الصحة والتي كان من الممكن منعها من خلال تطبيق رعاية الأطفال حديثي الولادة الأساسية المبكرة في وقت الولادة. بناءً على نتائج الدراسة ، كان معدل البقاء على قيد الحياة مرتفعًا بين الولدان الذين تم قبولهم في وحدات العناية المكثفة. كان معدل الوفيات أقل مما ورد في الدراسات السابقة في إثيوبيا ومصر ؛ 8٪ مقابل 14.4٪ و 29.1٪ على التوالي. 18.8٪ من المقبولين و 10٪ من المعاد قبولهم كانوا للملاحظة. إذا كانت وحدات حضانة الأطفال حديثي الولادة متوفرة في مستشفيات وزارة الصحة ، فلن تكون هناك حاجة لقبول المولود الجديد إلى وحدات العناية المكثفة وحفظ الحاضنات للحالات الحرجة. لم تكن هناك بيانات عن المراضة ، سواء لحديثي الولادة في وحدات العناية المكثفة في مستشفيات وزارة الصحة أو في وحدات العناية المكثفة خارج وزارة الصحة.