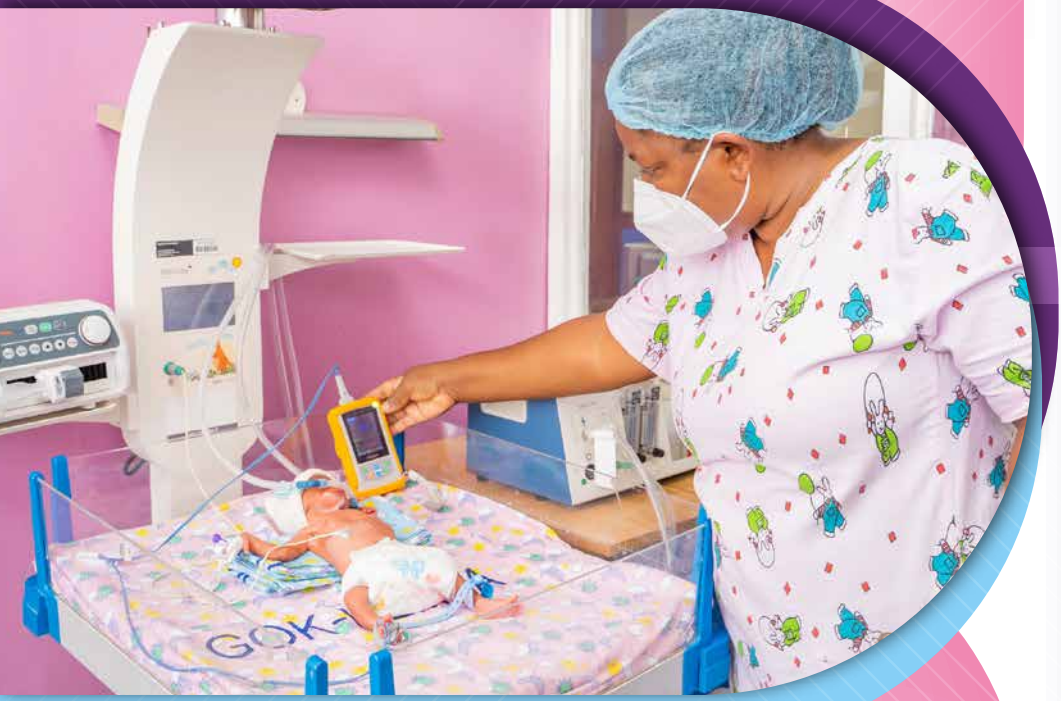
Ministry of Health

REPUBLIC OF KENYA

Management of Apnoea of Prematurity



National Guideline

MOH 2023

Management of Apnoea of Prematurity

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Ministry of Health

2023

TABLE OF CONTENTS

Foreward		**VI**
Acknowledgement		**VII**
Executive Summary		**VII**
List of Abbreviations		**X**
Definition of Terms		**XI**
Chapter 1 :	CASE DEFINITION, CLASSIFICATION AND PATHOGENESIS OF APNOEA OF PREMATURITY	1
	Introduction	2
	Case Definition	2
	Classification of Apnoea of Prematurity	2
	Pathogenesis of Apnoea of Prematurity	3
	Factors Implicated in The Pathogenesis of Apnoea of Prematurity	3
	Central Mechanisms	4
	Neonatal Breathing - Biphasic Response To Hypoxia	4
Chapter 2:	DIAGNOSIS, MONITORING AND COMPLICATIONS OF APNOEA OF PREMATURITY	6
	Introduction	7
	Diagnosis	7
	Monitoring of Vital Signs in At-Risk Neonates	8
	Complications of Apnoea of Prematurity	9
Chapter 3:	NON PHARMACOLOGICAL AND PHARMACOLOGICAL TREATMENT MODALITIES FOR APNOEA OF PREMATURITY	10
	Treatment Modalities for Apnoea of Prematurity	11
	Non-Pharmacologic Treatment	11
	Pharmacological Treatment	16
	Drug Interactions	19
	Therapeutic uses of Caffeine	19
	Other Beneficial Effects of Caffeine	19
	Other Possible Effects	20
	Caffeine Citrate In Management of Apnoea of Prematurity	20
	Formulation of Caffeine Citrate	21
	Administration	21
	Compatibility	22
	Contraindications to Caffeine Citrate Administration	22
	Documentation	22

	Storage	22
	Side Effects of Caffeine Citrate	22
	How to Safely Give Caffeine Citrate	25
	Dosing Charts for Different Formulations of Caffeine Citrate	26
	Discontinuation of Caffeine Citrate And Follow-Up	27
	Discharge Plan	27
Chapter 4:	USE OF BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE (bCPAP) IN THE MANAGEMENT OF AOP	29
	Introduction	30
	Modes of bCPAP Delivery	31
	Bubble Continuous Positive Airway Pressure (bCPAP)	31
	Mechanism of Action/Function of Bubble CPAP	31
	Components and Device Assembly	32
	bCPAP can be Provided	33
	Contraindications of bCPAP	34
	Initiation of bCPAP	34
	Preparing The Baby For bCPAP	35
	Monitoring of The Neonate	36
	Feeding of Babies on bCPAP	37
	Complications of bCPAP	40
	Infection, Prevention & Control	41
Chapter 5	PULSE OXIMETRY IN THE MANAGEMENT OF APNOEA OF PREMATURITY	42
	Introduction Pulse Oximetry	43
	Conditions That May Cause Hypoxemia In Neonates	43
	Devices Used For Pulse Oximetry	43
	Parts of A Pulse Oximeter	45
	How A Pulse Oximeter Works	46
	Preparing And Monitoring Babies On Pulse Oximeter	47
	Prepare The Baby For Pulse Oximetry	48
	Special Considerations in Newborns	49
	Causes of Inaccurate Readings	49
	Titration and Weaning off Of Oxygen	50
	Handling and Maintenance of the Pulse Oximeter	50
APPENDIX I:	Hand Washing Job Aid	53
APPENDIX II:	New Ballard Score	54
APPENDIX III:	Categorization of Neonatal Patients.	56

APPENDIX IV:	Blender Charts	57
APPENDIX V:	Manual Cleaning and High Level Disinfection	59
APPENDIX VI:	Setting The Flows for a Specific Percent Oxygen Delivered to Patient	63
APPENDIX VII:	Newborn Monitoring Chart	64
APPENDIX VIII:	List of Materials and Equipments Required for The Training	65
APPENDIX IX:	The Suspected Adverse Drug Reaction Notification Forms	66
APPENDIX X:	Scope of WHO recommendations for care of the preterm or low-birth weight infant	67
References		68
List of Contributors		71

LIST OF TABLES

Table 1:	Vital Sign Parameters (For Monitoring Preterm Neonates at Risk of AOP)	9
Table 2:	Mechanism of Action of Treatment Modalities for Apnoea of Prematurity	11
Table 3:	Mechanism of Action and Effects of Caffeine Citrate (16)	16
Table 4:	Properties of caffeine citrate	17
Table 5:	Available formulations of caffeine citrate	21
Table 6:	Dosing of caffeine citrate	21
Table 7:	Side effects of caffeine citrate	22
Table 8:	Dosing Chart for caffeine citrate 10mg/1ml formulation.	26
Table 9:	Dosing Chart for caffeine citrate 20mg/1ml formulation.	27
Table10:	Checklist for machine and for baby preperation	34
Table11:	Complications and Preventions	40

LIST OF FIGURES

Figure 1:	Trends in under 5, infant and neonatal mortality in Kenya from 1989 to 2022	VIII
Figure 2:	Pathogenesis of Apnoea of Prematurity	3
Figure 3:	Central Mechanisms	4
Figure 4:	Specific contributory causes of apnoea	8
Figure 5:	How to perform tactile stimulation.	12
Figure 6:	Positioning of the airway	12
Figure 7:	Parts of a suction tube	13
Figure 8:	Suctioning procedure	13

Figure 9:	Fitting mask over face	14
Figure 10:	Kangaroo mother care (KMC) baby positioning.	15
Figure 11:	Represents the three mechanisms of actions of caffeine citrate.	17
Figure 12:	Drug interactions of caffeine citrate	19
Figure 13:	Prevention of Apnoea of Prematurity Using Caffeine Citrate Prophylaxis Algorithm	23
Figure 14 :	Treatment of Apnoea of Prematurity Using Caffeine Citrate Algorithm	24
Figure 15:	How CPAP stimulates the respiratory drive	31
Figure 16:	Face mask	32
Figure 17:	Nasal Prongs	32
Figure 18:	Diagram of a bubble CPAP Machine	33
Figure 19:	Choose the most snuggly fit hat	35
Figure 20:	Making a hat from a stockinette	35
Figure 21:	Safely secured orogastric tube	36
Figure 22:	Supporting respiratory efforts - Use of oxygen and continuous positive Airway Pressure (CPAP)	38
Figure 23:	Flow chart for weaning bCPAP	39
Figure 24:	Complications of CPAP	41
Figure 25:	Benchtop Pulse oximeter	44
Figure 26:	Handheld pulse oximeter	44
Figure 27:	Fingertip pulse oximeter	44
Figure 28:	Vital Signs Monitor	45
Figure 29:	Parts of a pulse oximeter	45
Figure 30:	Neonatal probe	45
Figure 31:	Pulse Oximeter Connector	46
Figure 32:	How a Pulse oximeter works	46
Figure 33:	Preparing the pulse oximeter	47
Figure 34:	Correctly attach and secure the probe on the selected side	48
Figure 35:	Pulse Oximeter Signal Tracing	49
Figure 36:	Confirming the device reading with manual assement of the pulse rate	49
Figure 37:	Handling of the Pulse Oximeter	51
Figure 38:	Troubleshooting some common problems in Pulse oximetry	52

FOREWORD

Kenya has achieved significant reduction in mortality among children aged below 5 years, but newborn deaths remain unacceptably high. Of note from 2014 to 2022, the under-five mortality rate decreased from 52 to 41 deaths per 1,000 live births, and infant mortality rate from 39 to 32 deaths per 1,000 live births. However, neonatal mortality decreased at a slower rate from 22 to 21 deaths per 1,000 live births (1). Neonatal deaths account for 66 percent of total infant mortality and 51 percent of total under-five mortality. There is therefore need for reinvigorated commitment to enable the country meet the Sustainable Development Goals (SDGs) neonatal mortality rate target of 12 deaths per 1,000 live births by 2030.

Most neonatal deaths (75%) occur during the first week of life (2). Preterm birth, birth asphyxia and neonatal sepsis are the leading causes of neonatal mortality. Majority of these deaths can be prevented and treated by implementing scalable, high-impact, evidence-based interventions. By leveraging on the increased coverage of skilled delivery in Kenya (89%), we have a great opportunity to strengthen the provision of essential new-born care and quality of care for high-risk new-borns (1).

Preterm and low birth weight infants have a 2- to 10-fold higher risk of mortality than infants born at term and with normal birth weight (3). Hence the care of preterms and low birth weight infants remains a national priority. Infants who are born prematurely are at significant risk of apnoea. The incidence of apnoea of prematurity is inversely proportional to gestational age. Essentially, nearly all pre- terms less than 28 weeks' gestation, 85% of pre-terms born at 30 weeks' gestation and 20% of those born at 34 weeks' gestation develop apnoea of prematurity (4).

In line with the 2022 WHO recommendations for care of the preterm or low birth weight infant (3), Kenya has championed the development of management of apnoea of prematurity guideline, which is critical for all secondary level newborn units in Kenya. Through a step-wise approach, the guideline expounds on the prevention and treatment of apnoea of prematurity using caffeine citrate. Other aspects, such as the use of bubble continuous positive airway pressure therapy and pulse oximetry in neonates have been included.

It is my hope that this guideline will lay a strong foundation for increased investments towards caffeine citrate commodity security and strengthen the availability of essential equipment and supplies in the newborn units. Most importantly, the scale up of recommended practice in the prevention and treatment of apnoea of prematurity will enable the country to accelerate the reduction of neonatal mortality.

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ACKNOWLEDGEMENT

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Our sincere gratitude goes to all the members of the guideline development team, led by consultant neonatologists, paediatricians, clinical officers, paediatric critical care nurses, neonatal nurses and nurse midwives. Many thanks to the referral hospitals at the national and country level for supporting the participation of the core team through the guideline development process.

Special thanks to Kenyatta National Hospital (KNH) for their vital role and significant contributions, including incorporating lessons learned from the Caffeine Citrate study. Heartfelt gratitude to Moi Teaching and Referral Hospital (MTRH) for blending insights from its Newborn Intensive Care Unit (NICU) protocol, and providing critical lessons learned from practical experience as a result of their consistent use of Caffeine Citrate. Both national referral hospitals also offered invaluable expertise from neonatologists, implementation scientists, and neonatal nurses. We appreciate their cooperation without which the entire exercise could not have been successfully completed.

Special thanks go to Clinton Health Access Initiative (CHAI) for effectively supporting this process through technical and financial support. We specifically appreciate the support of Betty Wariari, who steered this process in close collaboration with the Ministry of Health. We also appreciate the support of Dr. Audrey Chepkemoi, Dr. Leah Moriasi, Dr. Emelda Manguro, Hannah Wanjiku, Zainab Kioni, Christine Ironde, Charles Makuyi and Jael Wachia for their support in consolidating the content of this guideline.

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EXECUTIVE SUMMARY

Preterm birth (i.e <37 weeks' gestation) is the leading cause of neonatal mortality and is associated with long-term physical, neurodevelopmental, and socioeconomic effects. The estimated global preterm prevalence in 2020 was 9·9%, translating to 13·4 million preterm livebirths. This means, 1 in 10 babies worldwide is born prematurely, that's an estimated one baby every two seconds (5),(6).

Preterm birth is a global problem, however, inequalities in preterm survival rates around the world are glaring. In Sub-Sahara Africa where a significant number of preterm births occur, preterms account for approximately 40% of neonatal deaths (7). More than 90% of extreme preterms born in low income countries die within the first few days of life compared to 10% of extreme preterms born in high income countries. There is therefore need to address inequalities in preterms survival rates in Sub-Sahara Africa(5),(6).

According to the 2022 Kenya Demographic Health Survey (KDHS), there has been no measurable change in neonatal mortality rates from 2014 to 2022, as shown in *Figure 1*. The high neonatal mortality of 21 deaths per 1,000 live births accounts for 51% of total under-five deaths nationally (1). Prematurity is the top driver of neonatal mortality in Kenya, therefore improving the care of preterms is a priority in accelerating the reduction of neonatal death.

There has been commendable increase in the uptake of skilled birth delivery in Kenya at 89% (1), however there are many missed opportunities within the health system to improve preterm birth outcomes. As such, programmatic investments to prevent preterm birth and ensure evidence-based quality care are key for Kenya to achieve the global sustainable development goal (SDG) of 12 deaths per 1000 live births by 2030.

Neonatal deaths account for 51% of the total under 5 deaths in Kenya

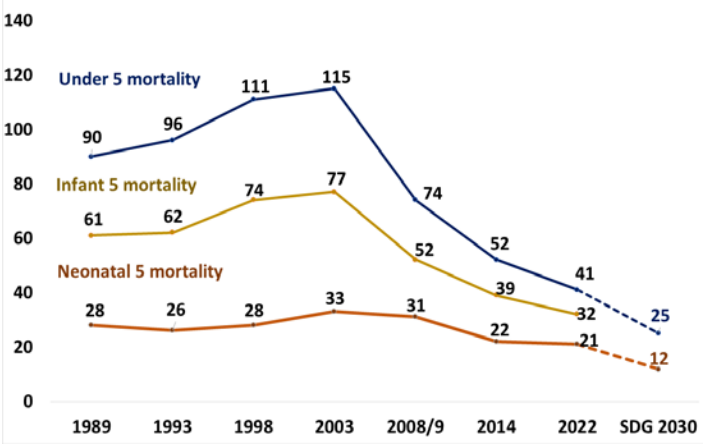


Figure 1: Trends in under 5, infant and neonatal mortality in Kenya from 1989 to 2022 (1)

In 2022, WHO published new recommendations on care for preterm or low birth weight infant in order to improve their short- and long-term outcomes. The recommendations, which emphasize on simple and effective interventions are divided into three categories (*See Appendix* X). These are:

1. Promotive and preventive care – for example immediate Kangaroo mother care (KMC) after birth, thermal care, early initiation of breast feeding, developmental care and immunization.
2. Care of complications – for example resuscitation, use of continuous positive airway pressure along with life-saving commodities such as oxygen and Methylxanthines (caffeine citrate).
3. Family involvement and supportive routine care – for example family involvement and support and home visits by trained health care worker to follow up on the care of preterms (3).

In alignment with the above WHO recommendations, the Ministry of Health prioritized the development of Management of Apnoea of Prematurity national guidelines as a critical component in strengthening the survival, health and growth of preterms (3). Apnoea of prematurity - the cessation of breathing lasting more than 20 seconds or less associated with bradycardia, central cynosis and/or desaturation – can result in respiratory failure, neuro-developmental impairment or death (4). This guideline prioritizes high impact evidence-based interventions. It will enable health care workers to prevent and treat apnoea of prematurity using caffeine citrate. In summary, the guideline clearly outlines the pharmacological and non pharmacological management of apnoea of prematurity such as the use of caffeine citrate, bubble Continuous Positive Airway Pressure (bCPAP) and KMC.

For effective uptake of the management of apnoea of prematurity national guideline in Kenya, strong commitment at the national and county level in rolling out recommended interventions is paramount. County governments should prioritize budgeting and inclusion of these interventions in their annual work plan and their five-year County Integrated Development Plan (CIDP). Resource allocation in strengthening the management of preterms should be guided by the health system pillars. Hence, there is need for strong leadership and governance from the national, county, health facility and community level. Of importance, prioritizing the procurement of caffeine citrate, equipping New Born Units with essential equipment such as bCPAP, pulse oximeters with neonatal probes and laboratory reagents required for the diagnosis of other causes of apnoea is crucial. For effective quality of care, counties should ensure that they comply with the Ministry of Health human resource for health norms and standards guidelines and capacity building initiatives. An effective health information system is also important in improving quality of care for preterms.

In addressing commodity security gaps, the Ministry of Health is supporting rigorous market shaping efforts, which are yielding great progress in strengthening the availability of affordable caffeine citrate. Overall, effective implementation of this guideline requires close collaboration with key departments and divisions within the ministry of health, associations, government partners, research and training institutions. Additionally strong community linkages are key in supporting the follow-up of all preterms post discharge to ensure the short- and long-term positive outcomes are sustained.

LIST OF ABBREVIATIONS

AOP	Apnoea of Prematurity
b/m or	Breaths per minute
bpm	Beats per minute
bCPAP	Bubble continuous positive airway pressure
BVM	Bag Valve Mask
cAMP	Cyclic adenosine monophosphate
CAP Trial	Caffeine for Apnoea of Prematurity Trial
CNS	Central nervous system
CO_2	Carbon dioxide
CRP	C-Reactive protein
CSF	Cerebrospinal fluid
CYP	Cytochrome P450 enzymes
EBM	Expressed Breast Milk
FCC	Family Centered Care
FHG	Full haemogram
FIO_2	Fraction of Inspired Oxygen
GA	Gestational Age
GABA	Gamma-aminobutyric acid
GI	Gastrointestinal
HR	Heart rate
IV	Intravenous
IVH	Intra Ventricular hemorrhage
KMC	Kangaroo mother care
LED	Light emitting diodes
LMP	last menstrual period
NCPAP	Nasal continuous positive airway pressure
NEC	Necrotizing Enterocolitis
NGT	Nasogastric Tube
O_2	Oxygen
OGT	Orogastric Tube
PDA	Patent ductus arteriosus
PMA	Post menstrual age
PPM	Planned Preventive maintenance
PO	Per oral
PR	Pulse Rate
PRBC	Packed red blood cells
PSU	Power Supply Unit
RBS	Random blood sugar
ROP	Retinopathy of prematurity
RR	Respiratory Rate
SPO_2	Saturation of peripheral oxygen

DEFINITION OF TERMS

1. **Apnoea:** Cessation of respiratory airflow.
2. **Cyanosis:** Bluish discoloration of the tissues that results when the absolute levels of deoxygenated hemoglobin in the capillary bed exceeds 3g/dl.
3. **Prematurity:** Gestational age below 37 completed weeks.
4. **Desaturation:** This is when the oxygen bound to one's hemoglobin falls below 90%.
5. **Hypoxemia:** An abnormally low level of oxygen in the blood.
6. **Hypoxia:** Inadequate oxygen in tissues for normal cell and organ function. Results from hypoxemia.
7. **Chemoreceptors:** Sensors that detect changes in CO_2, O_2, and Ph.
8. **Hypercapnia:** Abnormally high level of carbon dioxide in the blood.
9. **SaO_2:** Arterial oxygen saturation when measured by gas analysis.
10. **SpO_2:** Arterial oxygen saturation when measured by a pulse oximeter.

CHAPTER 1

CASE DEFINITION, CLASSIFICATION AND PATHOGENESIS OF APNOEA OF PREMATURITY

CASE DEFINITION, CLASSIFICATION AND PATHOGENESIS OF APNOEA OF PREMATURITY

INTRODUCTION

Apnoea of Prematurity (AOP) is a common problem among preterm infants, particularly extremely premature infants (8).

The incidence of AOP is inversely related to gestational age. About 90%-100% of the extremely low birth weight (≤ 1,000 g) newborn population are reported to have AOP (9).
The incidence of AOP in newborns born at 30–34 weeks' gestation ranges from 20%- 85% whereas the incidence is 10% in neonates born beyond 34 weeks' gestation (10). A relationship has been shown between delay in resolution of apnoea and bradycardia beyond 36 weeks' corrected gestational age and a higher incidence of an unfavorable neurodevelopmental outcomes (11). Recent data has demonstrated that hypoxic episodes of at least 60 seconds duration are associated with an unfavorable neonatal outcome in preterm infants (10, 12)

CASE DEFINITION

Apnoea of Prematurity (AOP) is defined as cessation of breathing for ≥ 20 seconds or shorter respiratory pauses <20 seconds that are associated with bradycardia (<100 beats/minute), central cyanosis, and/or desaturation (Saturations <90%) and pallor in neonates born at <37 weeks' gestation and with no underlying disorders causing apnoea (4).
Note: (AOP should not be confused with periodic breathing)

Periodic breathing is a pattern of regular breathing alternating with pauses in respiration of at least 3 seconds, persisting through at least 3 cycles of breathing. The duration lasts less than 20 seconds and is not associated with bradycardia or hypoxemia (4).

CLASSIFICATION OF APNOEA OF PREMATURITY

Apnoea is classified as central, obstructive, or mixed depending on the presence of continued inspiratory efforts and upper airway obstruction.

- **Central apnoea**- occurs in 40% of cases. It is caused by decreased CNS stimuli to respiratory muscles. Respiratory effort and airflow cease simultaneously. Inspiratory efforts (chest wall movement and airflow) are absent.
- **Obstructive apnoea** – occurs in 10% of cases. It is caused by pharyngeal instability, neck flexion or nasal obstruction. Inspiratory efforts persist but are ineffective in the presence of upper airway obstruction. There is presence of chest wall movement but no airflow.
- **Mixed apnoea**- occurs in 50% of cases. It has a mixed etiology. It is characterized by upper airway obstruction with inspiratory efforts that precedes or follows central apnoea.

PATHOGENESIS OF APNOEA OF PREMATURITY

Neonatal breathing is controlled by the respiratory center which receives afferent input from central chemoreceptors, peripheral chemoreceptors and respiratory muscles (9).

AOP is a developmental disorder usually of physiologic immaturity of respiratory control and upregulated inhibitory neurotransmitters, e.g., GABA and adenosine.

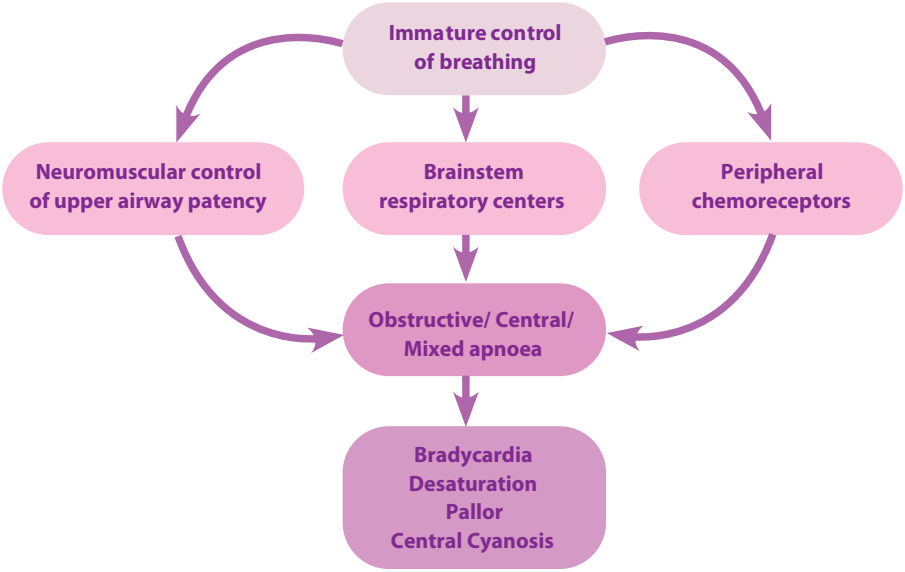


Figure 2: Pathogenesis of Apnoea of Prematurity

FACTORS IMPLICATED IN THE PATHOGENESIS OF APNOEA OF PREMATURITY

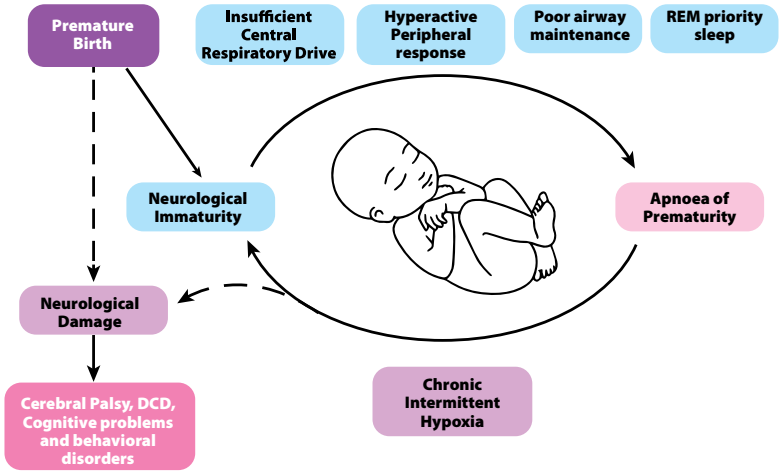
Peripheral Reflex Pathways
Laryngeal chemoreflex
Increased carotid body activity
Decreased carotid body activity
Excessive bradycardic response

Central Mechanisms
Decreased central chemosensitivity
Hypoxic ventilatory depression
Upregulated inhibitory neurotransmitters
Delayed central nervous system development

(Eichenwald EC, Committee on Fetus and Newborn, American Academy of Pediatrics: Apnoea of prematurity. Pediatrics 137(1), 2016. doi: 10.1542/peds. 2015-3757) (1)

CENTRAL MECHANISMS

Central chemosensitivity to high CO_2 is diminished in preterm infants and this relative "insensitivity" is directly proportional to the level of prematurity.



Adapted from (Max Williamsom. M. et al.; Apnoea of prematurity and neurodevelopmental outcomes: current understanding and future prospects for research : Front. Paediatrics, 25 october 2021) (8)

Figure 3: Central mechanism of AOP

Response to hypoxia which is mediated by peripheral chemoreceptors may be completely blunted in infants born extremely preterm. Excessively compliant chest wall and low lung volume predispose premature infants to hypoxia (9).

NEONATAL BREATHING - BIPHASIC RESPONSE TO HYPOXIA

When exposed to a hypoxic gas challenge, the expected response is an increase in the minute ventilation (respiratory rate and tidal volume). The ventilatory response to hypoxia after birth in premature infants elicits an initial transient increase in respiratory rate and tidal volume that lasts for 1-2 minutes, followed by a late, sustained decline in spontaneous breathing (9).

Adapted from Erickson G, Dobson NR, Hunt CE. Immature control of breathing and apnoea of prematurity: The known and unknown. J Perinatol. 2021;41(9): 21112123. doi:10. 1038/s41372-021-01010-z (4)

KEY TAKEAWAY POINTS

1. Apnoea of Prematurity (AOP) is the cessation of breathing for ≥ 20 seconds or shorter respiratory pauses <20 seconds that are associated with bradycardia (<100 beats/ minute), central cyanosis, and/or desaturation in neonates born at <37weeks' gestation and with no underlying disorders causing apnoea.
2. Apnoea of prematurity is classified into three types: Central apnoea, Obstructive apnoea and Mixed apnoea.
3. Apnoea of prematurity occurs in preterm babies and the incidence is inversely proportional to gestational age.
4. AOP is a developmental disorder usually of physiologic immaturity of respiratory control and upregulated inhibitory neurotransmitters.

CHAPTER 2

DIAGNOSIS, MONITORING AND COMPLICATIONS OF APNOEA OF PREMATURITY

DIAGNOSIS, MONITORING AND COMPLICATIONS OF APNOEA OF PREMATURITY

INTRODUCTION

During the first few days of life, premature infants encounter problems with temperature regulation, acquisition of oral feeding skills, and the normal control of respiration (13).

Initial newborn stabilization is needed including airway clearing, breathing- initiate bCPAP support, IV access, blood glucose, feeding (IV or Oral) and keeping warm to maintain a temperature of 36.5^{0}C – 37.5^{0}C.

Neonates at risk of AOP should be identified by correct assessment of gestational age using LMP in addition to:

1. Ballard score done at birth (Unreliable >4 days old) (Appendix II) (14).
2. 1st Trimester Obstetric ultrasound

If gestational age is less than 34 weeks give prophylactic caffeine citrate.

DIAGNOSIS

A cessation of breathing in a premature neonate <37 weeks' gestational age for 20s or longer, or a shorter pause accompanied by bradycardia <100b/m, cyanosis or pallor or desaturation (4). This diagnosis can be made either by clinical observation or by continuous cardiorespiratory monitoring.

Apnoea of prematurity is a diagnosis of exclusion. It is made after excluding other causes of apnoea such as (15);

i. **Metabolic;** hypoglycemia, hypocalcemia, hyponatremia, hypernatremia, acid-base disorders
ii. **Temparature instability:** hypothermia, hyperthermia.
iii. **Central nervous system;** Seizures, Intraventricular hemorrhage, brain trauma, congenital malformations, hypoxic injury.
iv. **Airway;** Airway obstruction
v. **Cardiovascular;** Anemia, Hypotension, Hypertension, Patent ductus arteriosus.
vi. **Drugs;** Maternal drugs, general anesthesia and sedatives e.g., phenobarbital,
vii. **Pain;** Acute or chronic pain
viii. **Gastrointestinal;** Abdominal distension, intestinal perforation,
ix. **Infections;** sepsis, necrotizing enterocolitis, meningitis
x. **Respiratory;** Aspiration, pulmonary hemorrhage

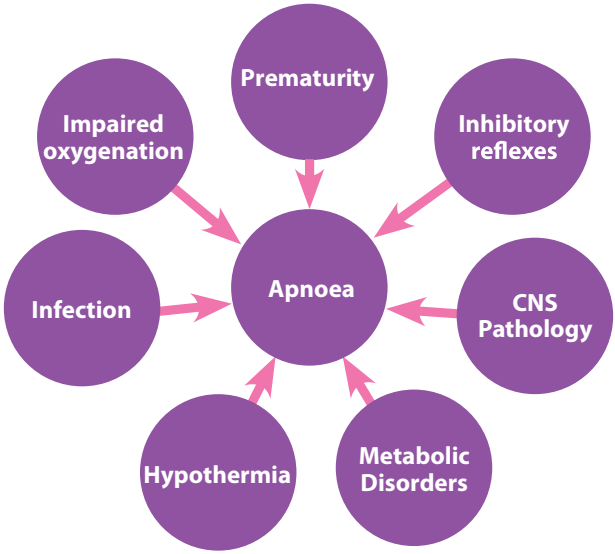


Figure 4: Specific contributory causes of apnoea (16)

- In addition to observation of apnoea, take a quick history, vital signs and clinical assessment ensuring the airway is patent
- The following investigations should also be done for a neonate that develops an apnoeic episode to exclude other causes of apnoea:
  - Random blood sugar (age less than 72hr ≥2.6mmol/l, age more than 72hrs ≥3.3mmol/l)
  - Electrolytes: Calcium, sodium, potassium, phosphate
  - Blood gas analysis if available
  - Cranial ultrasound to check for intraventricular bleeds
  - Full hemogram : check for anemia and features of infection
  - Blood culture
  - Acute phase reactants e.g. C-reactive protein and procalcitonin

MONITORING OF VITAL SIGNS IN AT-RISK NEONATES

Definition

The act of observing, checking and documentation of the breathing pattern and associated physiological changes of apnoea of prematurity.

Aim.

To provide appropriate monitoring according to the severity of illness (17)

Risk

Inappropriate monitoring of preterm neonates will delay recognition of AOP and appropriate interventio

- Vital signs that are monitored and alarms limits are in the table below (If a neonatal blood pressure cuff available, blood pressure should also be monitored)

Table 1: Vital Sign Parameters (For Monitoring Preterm Neonates at Risk of AOP)

Vital sign	Normal Range	Comments (Set high priority alarms)
Heart rate	120 – 160 bpm	Lower limit 99 bpm Upper limit 180 bpm
Respiratory rate	40 – 60 b/m	RR Lower limit 30 b/m Upper limit 70 b/m
Oxygen saturation	90 – 95 %	Lower limit 89% Upper limit 96% (No upper limit for patients on room air)
Temperature	36.5 - 37.5 ^{0}C	Lower limit 36.4^{0}c Upper limit 37.6^{0}c

- Continuous cardiorespiratory monitoring and clinical observation is ideal to monitor heart rate, respiratory rate, oxygen saturation, pallor and cyanosis.
- Change oximeter probe site every 3 hours to prevent skin injury.
- Cardiorespiratory monitoring should continue for 5 days after stopping caffeine citrate.

COMPLICATIONS OF APNOEA OF PREMATURITY

Monitor and check for complication of AOP. They can be acute or chronic .

Acute Complications	Chronic Complications
Hypoxia	Neurodevelopmental impairment i.e., cognitive dysfunction, behavioral disorders, cerebral palsy
Bradycardia	Retinopathy of prematurity
Respiratory failure	Bronchopulmonary dysplasia
Increased risk of NEC	
Death	

KEY TAKEAWAY POINTS

1. Early obstetric ultrasound and Ballard score is important for recognition of neonates at risk of AOP.
2. The diagnosis of AOP can be made through clinical observation and cardiorespiratory monitoring.
3. AOP is a diagnosis of exclusion.
4. Continuous monitoring of preterm neonates at risk and with AOP is vital in early identification and mitigation of complications and caffeine citrate side effects.

CHAPTER 3

NON PHARMACOLOGICAL AND PHARMACOLOGICAL TREATMENT MODALITIES FOR APNOEA OF PREMATURITY

NON PHARMACOLOGICAL AND PHARMACOLOGICAL TREATMENT MODALITIES FOR APNOEA OF PREMATURITY

TREATMENT MODALITIES FOR APNOEA OF PREMATURITY

There are several modalities in the treatment of AOP. Each of them act via different mechanism of actions as shown in the table 2

Table 2: Mechanism of Action of Treatment Modalities for Apnoea of Prematurity

	TREATMENT	MECHANISM OF ACTION
1	Tactile stimulation	Produces excitatory, non-specific neuronal action in the brainstem centre which promotes respiratory work.
2	Positioning the head	Reduces work of breathing and airway obstruction.
3	bCPAP	Reduces work of breathing by maintaining functional residual capacity and splinting the airway.
4	Oxygen administration, PRBC transfusion	Improves the respiratory drive and improves tissue oxygenation.
5	Caffeine	Increases the diaphragmatic contractility and stimulates the central nervous system respiratory centre.
6	KMC	Offer improvement in vital physiological parameters. (18)

NON-PHARMACOLOGIC TREATMENT

Once an apneic episode occurs the following treatment interventions should be done in addition to essential newborn care:

Perform hand hygiene (*see appendix I for steps of hand hygiene*)

1. Perform tactile stimulation. Using any of the skills shown below .

Thumb tip squeeze

Thumb rub


Whole hand squeeze


One or more fingers rub


Tapping


Tickling

Figure 5: How to perform tactile stimulation.

2. Follow the ABC structured approach as follows;

a) Ensure safety and shout for help

b) Airway

- To assess if the child has an airway or breathing problem you need to know:
  - Is the airway obstructed?
  - Is the baby breathing?
  - Is the baby having severe respiratory distress?
  - Does the baby have central cyanosis?
- If the child is not breathing or if the airway appears obstructed, you must first open and clear the airway by:

i) Position the neck in a sniffing position. DO NOT FLEX OR HYPEREXTEND.


Hyperextended


Sniffing


Flexed

Figure 6: Positioning of the airway

ii) **Clear the airway in the presence of secretions:** suction to clear starting with the mouth then followed by the nose. Avoid deep and vigorous suctioning. Suction only as far as you can see using a suction pressure of 80 - 100mm/hg. Suction for 10seconds and allow the baby 30 seconds to breath.

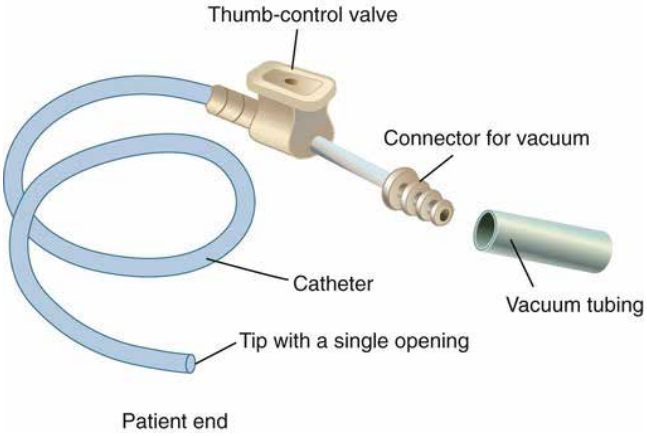
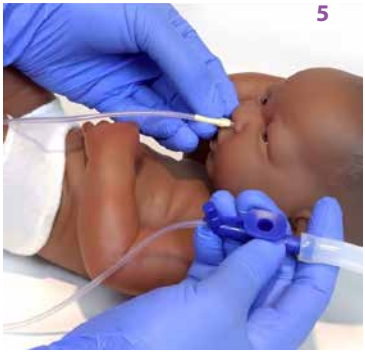


Figure 7: Parts of a suction tube

1&2 – Connecting suction tube

3 - Sizing suction tube

Suctioning mouth



Suctioning nostrils

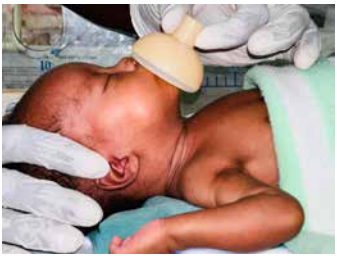
Figure 8: Suctioning procedure

b) Breathing

Assess the baby's breathing and if gasping or no breathing, start ventilation with bag and mask. Ensure correct placement of the mask and the use of correct mask size.

Right size and position of mask

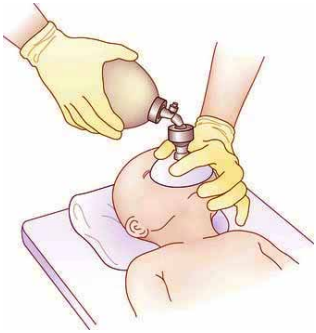
Mask held too low



Mask too small

Mask too large

Pull the jaw forward towards the mask with the index finger and the thumb holding the mask in C-E Grip".



American Academy of Pediatrics and the American Heart Association; Short J, editor: Textbook of neonatal resuscitation, ed 5, Elk Grove, IL, American Academy of Pediatrics, 2006, pp 3–16.

Figure 9: Fitting mask over face

If breathing is labored, administer oxygen and initiate bubble continuous positive airway ventilation **(bCPAP).**

c) Circulation

i) Initiate intravenous fluids based on the weight and day of life if unstable. (As per the comprehensive newborn protocol)

ii) If stable, initiate enteral feeds as per the comprehensive newborn protocol.

3. Keep the baby warm and maintain a body temperature of 36.50C – 37.50C.

Other management

i. Do RBS, Electrolytes (Calcium, Magnesium, Sodium, Potassium), FHG, Blood culture, CRP and a cranial ultrasound to rule out other causes of apnoea.

ii. Correct hypoglycemia if present by administering 2mls/kg of 10% Dextrose.
   - Hypoglycemia is defined as RBS <2.6mmol/L in the first 72 hours of life, <3.3mmol/L after 72 hours of life).

iii. Initiate IV antibiotics (Crystalline Penicillin and Gentamicin).

iv. Prepare for administration of caffeine citrate which is the drug of choice in the management of apnoea of prematurity.

v. **Ensure continuous monitoring of the neonate is done.**

vi. **Initiate kangaroo mother care (KMC) early when feasible.**

Figure 10: Kangaroo mother care (KMC) baby positioning.

NOTE: When the patient fails to respond to the above measures, escalate or refer immediately for further management/specialized care including intubation and mechanical ventilation for the neonate with persistent apneic attacks.

4. Practice family centered care

i) Inform the mother (caregiver) about apnoea of prematurity in layman terms.

ii) Describe to the mother (caregiver) in layman terms, how to identify common danger signs associated with AOP that include; Pallor, Cyanosis, cessation of breathing.

iii) Explain all the treatment modalities and their safety in simple terms

iv) Answer any questions/concerns they may have.

v) Ensure the baby is on continued treatment e.g. oxygen via nasal prongs 1L/min, kept warm etc. as you explain all the above to the mother (caregiver).

vi) Keep the mother (caregiver) updated on the baby's progress.

PHARMACOLOGICAL TREATMENT

CAFFEINE CITRATE

Caffeine citrate a methylxanthine, is the drug of choice for the prevention and treatment of apnoea of prematurity. Caffeine Citrate has a wide therapeutic index and longer half-life compared to theophylline and aminophylline, hence allowing for once daily administration.

In alignment with 2022 WHO guidance on the care of the preterm (< 37 weeks' gestation) caffeine citrate is recommended for;

- The treatment of apnoea in preterm infants.
- The extubation of preterm infants born less than 34 weeks' gestation.
- Caffeine Citrate is used for the prevention of apnoea in preterm infants born < 34 weeks' gestation (3).

Caffeine stimulates the respiratory center, sensitizing it to hypercapnia leading to: increase in respiratory rate and tidal volume, improved pulmonary blood flow, better carbon dioxide sensitivity , and enhanced diaphragmatic function and breathing pattern.

Table 3: Mechanism of Action and Effects of Caffeine Citrate (19)

Mechanism of Action	Effects
Adenosine Receptor Antagonist Inhibits receptors A1 and A2a.	• Stimulates the respiratorycentre • Increases sensitivity to CO_2
Phosphodiesterase Inhibitor Inhibitor of phosphodiesterase preventing the breakdown of cAMP leading to accumulation of cAMP.	• Stimulates the CNS Increases O_2 consumption
Active Intracellular Calcium Mobiliser Caffeine binds to calcium channels and releases calcium from intracellular sites. It inhibits voltage sensitive calcium channels and may inhibit neurotransmission.	• Enhances diaphragmatic contractility. • Increases skeletal muscle tone

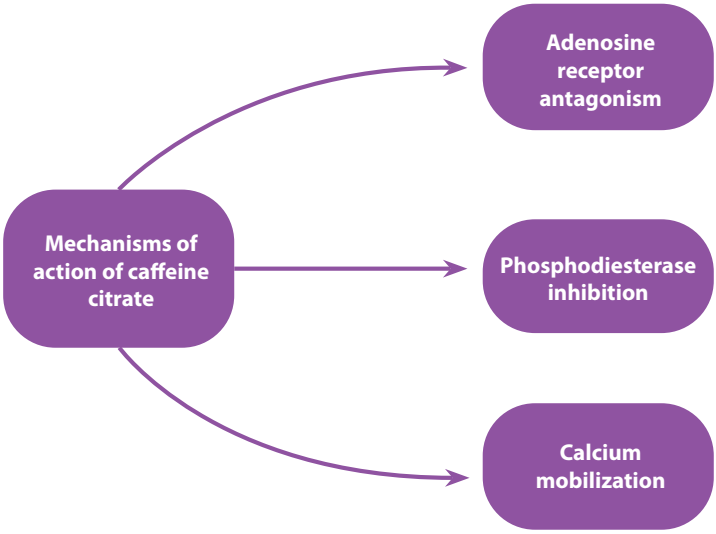


Figure 11: Represents the three mechanisms of actions of caffeine citrate.

Table 4: Properties of caffeine citrate

Properties of Caffeine Citrate		Clinical significance
Absorption	• Caffeine citrate is rapidly and completely absorbed orally with almost no first pass metabolism.	Enables per oral administration Oral administration is recommended unless contraindicated
Metabolism	• Metabolised by cytochrome P450 mono-oxygenase • The metabolism of caffeine citrate is slower in preterm neonates. • It is metabolized by enzymes in the liver whose maturity progresses with increasing gestational age.	Caffeine citrate is susceptible to interact with those drugs which are a substrate for, or inhibit or induce, this hepatic enzyme.
Plasma half life	• 40 – 230 hours (mean 103 hours)	Enables once daily dosing
Therapeutic level	• 5 – 25 mg/L {wide therapeutic window}	Better safety profile

Routine blood levels	• Not required	Does not require routine monitoring of blood levels
Toxic level (mg/L)	• >40 – 50	Better safety margin
Peak plasma concentration	• Almost the same for both oral and intravenous route • It is reached within thirty minutes to two hours.	Makes oral route the preferred mode of administration due to ease of administration
Bioavailability	• The bioavailability of oral dose is not disturbed by concomitant feeds.	
Interconversion	• 3% to 8% converted to theophylline via CYP1A2	
Elimination	• Excreted unchanged or N-demethylation via CYP P450 liver methyltransferase pathway. • Mainly excreted unchanged by the kidneys. • 86% unchanged in urine • The clearance increases non-linearly with increasing post-natal age, reaching a plateau at 120 days. • The volume of distribution increases linearly with increasing weight. • The elimination half-life starts to decrease from birth and reaches the adult values at 60 weeks' post-conception age.	
CSF level	Similar to plasma concentrations	Treats central apnoea of prematurity well since it is well distributed and CNS concetration are similar to the concetration in blood
Clearance (L/kg/hr)	0.002 – 0.017.	

Adapted from: Abdel-Hady, H. (2015). Caffeine therapy in preterm infants. World Journal of Clinical Pediatrics, 4(4), 81. https://doi.org/10.5409/wjcp.v4.i4.81

DRUG INTERACTIONS

The biotransformation of caffeine citrate occurs in the liver mainly by microsomal cytochrome P 450 monooxygenase (CYP1A2) and partially by xanthine oxidase.

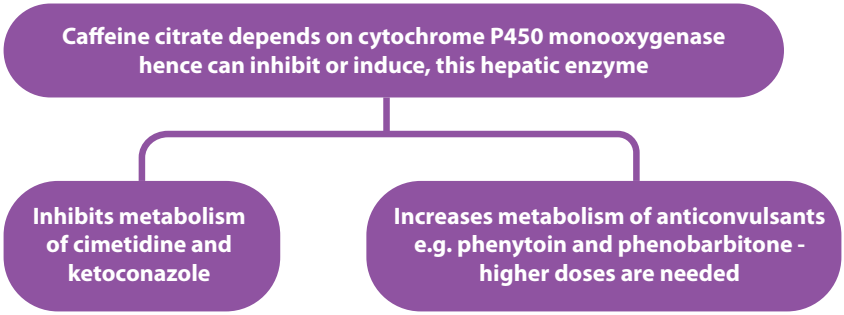


Figure 12: Drug interactions of caffeine citrate

THERAPEUTIC USES OF CAFFEINE

i) **Apnoea**

- Reducing apnoea of prematurity - the most important therapeutic value of caffeine.
- Caffeine is also effective in other causes of apnoea like post-operative apnoea, general anes- thesia-related apnoea, viral infection related apnoeas, and apnoeas associated with apparent life-threatening events.

ii) **Ventilation**

- Reduces post-extubation failure.

OTHER BENEFICIAL EFFECTS OF CAFFEINE

i) **Bronchopulmonary dysplasia**

Caffeine has been shown to reduce the incidence of bronchopulmonary dysplasia in preterm infants.

ii) **Intermittent hypoxia**

Caffeine has been shown to significantly reduce the number of intermittent hypoxic episodes up to 36 weeks' postmenstrual age [PMA].

iii) **Patent ductus arteriosus [PDA]** (20)

Caffeine use has been associated with PDA closure.

iv) **Neurodevelopmental outcome**

Prolonged caffeine intake may have a neuroprotective effect, presumably by up-regulating adenosine A1 receptors.

The CAP trial showed reduced likelihood of death, clinical disability and neurocognitive impairment at 18 months PMA in infants weighing less than 1250g when caffeine was used from day 3 until 34 weeks' PMA (20).

v) **Retinopathy of prematurity**

The CAP trial showed reduced incidence of severe retinopathy of prematurity in caffeine group when compared to placebo (5.1% vs. 7.9% with adjusted odds ratio 0.61). (20)

OTHER POSSIBLE EFFECTS

i) **Renal effect** - Caffeine induces diuresis by enhancing renal blood flow as well as glomerular filtration rate. It also increases creatinine clearance and urinary calcium excretion.

ii) **Effect on growth** - Caffeine leads to less weight gain in the first 3 weeks due to increased oxygen consumption and energy expenditure.

iii) **GI effects** - Caffeine increases gastric secretions and reduces lower esophageal sphincter tone (19).

iv) **Inflammatory role** - Caffeine has an anti-inflammatory role via reduction of cytokines like interleu- kin-6 and tumor necrosis factor-alpha and increment of interleukin-10.

v) **Cardiac effects** - Caffeine stimulates the myocardium and increases heart rate, cardiac output, stroke volume as well as mean arterial blood pressure.

CAFFEINE CITRATE IN MANAGEMENT OF APNOEA OF PREMATURITY

Caffeine citrate is used for both prevention and treatment of Apnoea of Prematurity.

i) **Prophylactic caffeine**

- Timing: Give as soon as possible after birth (best effect if given within the first 3 days).
- Who to give: All preterms age <34 weeks' gestation regardless of respiratory support provided.
- Route: Administered orally or IV [**Note:** Oral route is recommended]

ii) **Therapeutic caffeine**

- Timing: Give after a diagnosis of apnoea of prematurity has been made
- Who to give: Preterms aged <37weeks' gestation (not already on prophylactic caffeine) with:
  - Repeated apnoeas per day
  - Experiencing an event requiring bag and mask ventilation
  - Prior to elective extubation.
  - Unscheduled extubation
  - Post-anesthetic event.
- Route: Administered orally or IV [Oral route is recommended]

FORMULATION OF CAFFEINE CITRATE

Different formulations of caffeine citrate have been included in the recently updated Kenya Essential Medicines List (KEML, 2023).

Table 5: Available formulations of caffeine citrate

Drug	Formulation	Packaging
IV/PO Caffeine Citrate	20mg/ml	Ampoule
IV/PO Caffeine Citrate	10mg/ml	Ampoule
PO Caffeine Citrate	10mg/ml	Oral Solution

Table 6: Dosing of caffeine citrate

	Dose	Route	Frequency
Loading dose	20mg/kg	**Oral route is recommended** unless contraindicated. Administer with feeds. If oral route is contraindicated, give IV as an infusion over 30min. **Do not administer caffeine citrate intramuscularly**	As a stat dose Can repeat dose in case of persistent apnoea within 24 hrs
Maintenance	Start at 5mg/kg/day once daily, given within 24hrs after the loading dose with the next scheduled treatment Increase to 10mg / kg/day in case of continued occurrence of apnoea.	Oral route is recommended unless contraindicated. IV as an infusion over 10min **Do not administer caffeine citrate intramuscularly**	Once every 24 hours

NOTE: Oral Caffeine is contraindicated in neonates with tracheo-esophageal fistula, necrotizing enterocolitis and intestinal obstruction.

ADMINISTRATION

i). Oral Administration

- This does not require dilution.
- **Administered with trophic/daily feeds** to reduce gastric irritation.

NB: Trophic feeds are low volume feeds, usually 20ml/kg/d, started within the first day of life but preferrably within 6 hours of life. (21)

ii). Intravenous Administration

- Check the drug before administration. The IV solution is usually clear and colourless.
- **DO NOT** use if the solution is cloudy, discoloured, has particles or has expired.

- **Dilution:** As per manufacturers instructions.
- Administer intravenous loading doses as an infusion over at least 30 minutes.
- Administer intravenous maintenance doses as an infusion over 10 minutes.
- Monitor heart rate. Withhold dose if the heart rate exceeds 180 b/m at rest.

COMPATIBILITY

- It is compatible with dextrose and normal saline.
- At Y-site, it is compatible with dopamine, fentanyl, heparin, amino acids and fat emulsions.
- At Y-site, it's incompatible with Acyclovir, frusemide, glyceryl trinitrate and ibuprofen lysine.

CONTRAINDICATIONS TO CAFFEINE CITRATE ADMINISTRATION

- Kernicterus
- Congenital heart disease with arrhythmia

DOCUMENTATION

- After administration of the caffeine citrate, tick and sign, indicating the time given, stating whether AM or PM, on the treatment sheet.
- Document the reason for any modification on the patient's prescription and Medication Administration Record or patient notes/cardex (e.g., dose increment).

STORAGE

- Shelf life is 3 years from the date of manufacture.
- It is stable at room temperature (15 to 30ºC).
- Once the ampoule is opened, use it immediately and discard the undiluted unused portion, because it is preservative-free.

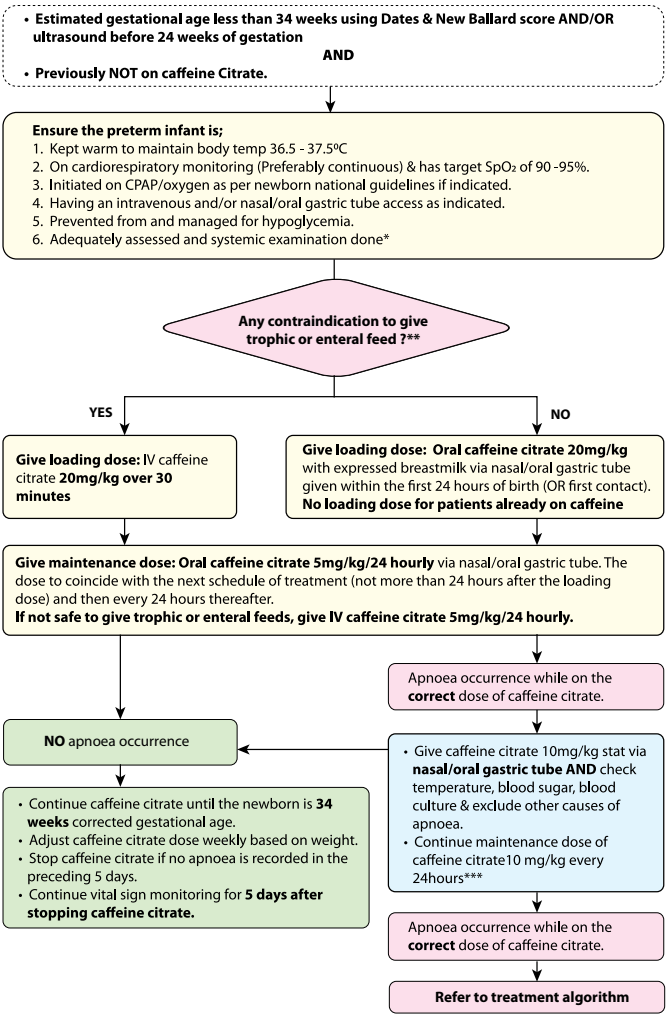
SIDE EFFECTS OF CAFFEINE CITRATE

Caffeine citrate has a wide therapeutic window, measuring drug serum levels is not necessary (21, 22).

Table7: Side effects of caffeine citrate

Side effect	Minimize occurrence	Mitigation
Tachycardia	Proper dose calculation And correct administration	Exclude other causes of tachycardia e.g., hyperthermia, discomfort etc., and if it's persistent adjust the dose downwards i.e., from 10mg/kg to 5mg/kg: consider withholding caffeine citrate if there is a persistent HR>180 b/m.
Feeding	Ensure caffeine citrate is administered with feeds to reduce gastric irritation.	Give once daily
Jitteriness and agitation	Ensure the correct dose	

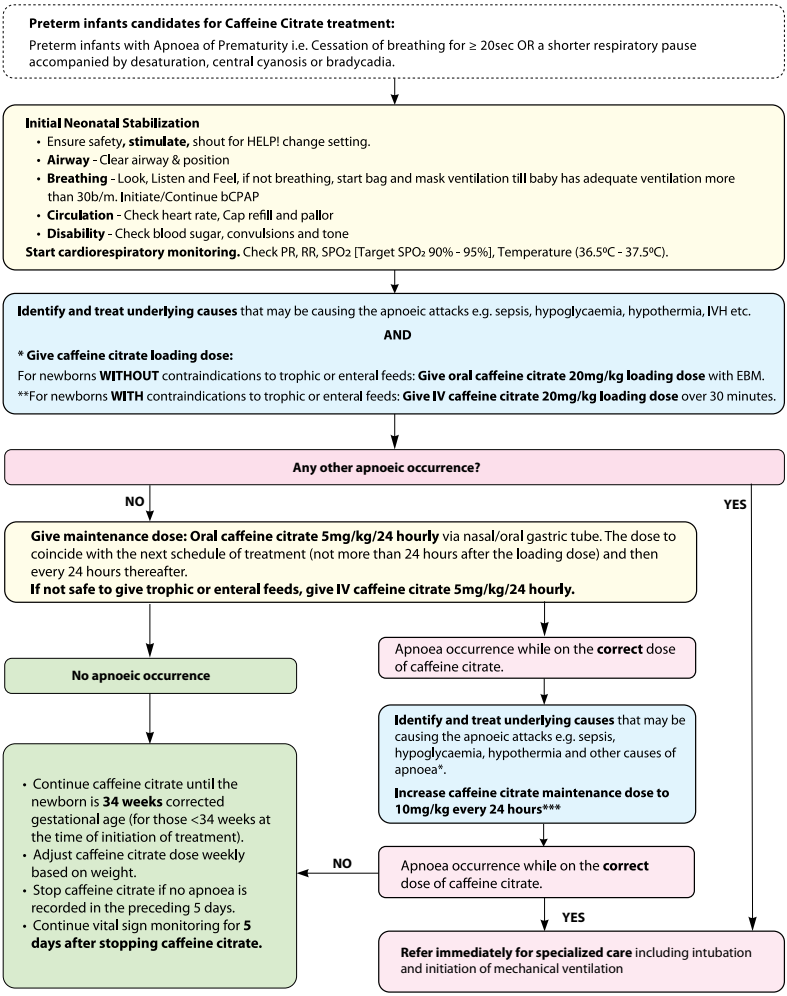
Prevention of Apnoea of Prematurity Using Caffeine Citrate Prophylaxis Algorithm



- **Caffeine citrate should **NOT** be given to newborns with kernicterus or symptomatic heart disease, esp arrhythmia. Caution for newborns with renal or hepatic disease or seizures.*
- *Withhold caffeine citrate if the heart rate is persistently over 180 bpm at rest.*
- *Caffeine citrate is compatible with breast milk.*
- *For Caffeine citrate vials, once opened use immediately and discard the unused portion.*
- ***Adjust the dose of caffeine citrate weekly** (on a fixed day) based on change in body weight.*
- *Use birth weight less than 1500 grams for eligibility for caffeine when baby is over 4 days old if gestational age is not available.*
- *****Contraindications to enteral feeding:** Surgical complications such as; trachea-esophageal fistula, necrotizing enterocolitis and intestinal obstruction*
- ******Clinician may continue with caffeine citrate 5mg/kg if the apnoea episode is associated with hypoglycemia or hypothermia.***

Figure 13: Prevention of Apnoea of Prematurity Using Caffeine Citrate Prophylaxis Algorithm

Treatment of Apnoea of Prematurity Using Caffeine Citrate Algorithm



- *For newborns >34 weeks corrected gestational age at the time of initiation of treatment, stop caffeine citrate if no apnoea is recorded in the preceding 5 days.*
- *Other causes of apnoea include airway obstruction, sepsis, seizures, anaemia, hypoglycemia, intraventricular hemorrhage, hypothermia etc. Escalate care if apnoea persists despite appropriate intervention.*
- **Caffeine citrate should **NOT** be given to newborns with kernicterus or symptomatic heart disease, esp arrhythmia. Caution for newborns with renal or hepatic disease or seizures.*
- *Withhold caffeine citrate if the heart rate is persistently over 180 bpm at rest.*
- *Caffeine citrate is compatible with breast milk.*
- *For Caffeine citrate vials, once opened use immediately and discard the unused portion.*
- ***Adjust the dose of caffeine citrate weekly** (on a fixed day) based on change in body weight.*
- *****Contraindications to enteral feeding:** Surgical complications such as; trachea-esophageal fistula, necrotizing enterocolitis and intestinal obstruction*
- ******Clinician may continue with caffeine citrate 5mg/kg if the apnoea episode is associated with hypoglycemia or hypothermia.***

Figure 14: Treatment of Apnoea of Prematurity Using Caffeine Citrate Algorithm

HOW TO SAFELY GIVE CAFFEINE CITRATE

Requirements

- Alcohol base hand rub (or running water and hand drying facility or towel)
- Valid prescription
- Caffeine citrate
- Naso/orogastric tube
- 2 cc, 5cc and 20cc syringe
- Initiation of Expressed breastmilk (at least trophic feeds) for those with no contraindication to enteral feeds
- Pulse oximeter to monitor heart rate and continuation of vital sign monitoring

a) Practice family centered care

- Inform the mother (caregiver) about apnoea of prematurity in layman terms.
- Describe to the mother (caregiver) in layman terms, the common danger signs associated with AOP that include; pallor, cyanosis, cessation of breathing.
- Explain that caffeine citrate is the treatment of choice for apnoea of prematurity.
- Explain the importance of monitoring using pulse oximetry including early detection of apnoea and side effects of caffeine citrate e.g. tachycardia .
- Answer any questions/concerns they may have.
- Ensure the baby is on continued treatment e.g. oxygen via nasal prongs 1L/min, kept warm etc. as you explain all the above to the mother (caregiver).
- Keep the mother (caregiver) updated on the baby's progress and prognosis.

b) Preparing a neonate for caffeine citrate administration .

- Perform hand hygiene.
- Identify the baby using the wrist or leg band (All names, hospital number, sex, date of birth).
- Check if baby has any contraindication for oral caffeine citrate and enteral feeds.
    - If no contraindication, insert a naso/orogatric tube correctly. Refer to the comprehensive newborn protocol for procedure of correct placement of naso/orogatric tube.
        - If a neonate already has an NGT/OGT in-situ, confirm that it is still in the right position by checking the marking put during insertion.
    - If there is a contraindication, aseptically fix an intravenous access correctly and /or ensure it is patent by flushing with water for injection.
- Get the patients treatment sheet and confirm:
    - That the name, the hospital number corresponds with that on the patient's wrist/leg band.
    - The prescription for caffeine citrate is written correctly based on the patients current weight (use caffeine citrate the dosing chart for the specific formulation)
- Confirm the expiry date for the caffeine citrate.
- Draw the correct volume of caffeine citrate as prescribed into the 2cc or 5 cc syringe.

c) Administration of caffeine citrate

- Recheck and confirm that the drug drawn corresponds to the what is written in the treatment sheet and you are administering to the correct patient via the correct route.
- Oral route is preferred for both loading and maintenance dose unless there is a contraindication .
  - Administer caffeine citrate dose with breastmilk via naso/orogastric tube (trophic feed or 3 hourly feed)
- Intravenous (IV) administration of caffeine citrate for patients with contraindications oral route and enteral feeds. e.g., a distended abdomen, abdominal surgery, tracheoesophageal fistula)
  - Slowly administer the iv-caffeine citrate dose over 30min for the loading dose. For maintenance push over 5-10 min.

d) Documentation

- Tick and sign on treatment sheet, indicating the time and date the caffeine citrate was administered .
- Ensure you document any modification in the dose and route of administration and the reason for the changes on the patient notes and cardex.
- Document the vital sign before and after administration of caffeine.
- Reporting adverse events (see reporting adverse events guide for more details)
  - Report any adverse events to the clinician on duty immediately.
  - Record any adverse event as per hospital policy (e.g., fill the suspected adverse drug reaction notification forms *(Appendix IX)* , incidence report and medical error register)

DOSING CHARTS FOR DIFFERENT FORMULATIONS OF CAFFEINE CITRATE

Table 8: Dosing Chart for caffeine citrate 10mg/1ml formulation.

Weight in gm	Loading dose 20mg/kg	Loading dose in mls 20mg/kg	Standard dose maintenance 5mg/kg	Standard dose maintenance In mls 5mg/kg	High dose maintenance 10mg/kg	High dose maintenance In mls (10mg/kg)
500 -599gm	12mg	1.2 ml	3mg	0.3ml	6mg	0.6mls
600-699gm	14 mg	1.4 ml	3.5mg	0.4ml	7mg	0.7mls
700- 799gm	16mg	1.6 ml	4mg	0.4ml	8mg	0.8mls
800-899gm	18mg	1.8 ml	4.5mg	0.5ml	9mg	0.9ml
900- 999gm	20mg	2.0 ml	5mg	0.5ml	10mg	1ml
1000-1099gm	22mg	2.2 ml	5.5mg	0.6ml	11mg	1.1ml
1100 -1199gm	24mg	2.4 ml	6mg	0.6ml	12mg	1.2ml
1200 -1299gm	26mg	2.6 ml	6.5mg	0.7ml	13mg	1.3 ml
1300 -1399gm	28mg	2.6 ml	7mg	0.7ml	14mg	1.4ml
1400-1499gm	30mg	3.0 ml	7.5mg	0.8ml	15mg	1.5ml
1500- 1599gm	32mg	3.2 ml	8mg	0.8ml	16mg	1.6ml
1600-1699gm	34mg	3.4 m	8.5mg	0.9ml	17mg	1.7 ml
1700-1799gm	36mg	3.6 ml	9mg	0.9ml	18mg	1.8 ml

Table 9: Dosing Chart for caffeine citrate 20mg/1ml formulation.

Weight in gm	Loading dose 20mg/kg	Loading dose in mls 20mg/kg	Standard dose maintenance 5mg/kg	Standard dose maintenance In mls 5mg/kg	High dose maintenance 10mg/kg	High dose maintenance In mls (10mg/kg)
500 -599gm	12mg	0.6mls	3mg	0.2mls	6mg	0.3mls
600-699gm	14 mg	0.7mls	3.5mg	0.2mls	7mg	0.4mls
700- 799gm	16mg	0.8mls	4mg	0.2mls	8mg	0.4mls
800-899gm	18mg	0.9ml	4.5mg	0.3ml	9mg	0.5ml
900- 999gm	20mg	1.0ml	5mg	0.3ml	10mg	0.5ml
1000-1099gm	22mg	1.1ml	5.5mg	0.3ml	11mg	0.6ml
1100 -1199gm	24mg	1.2ml	6mg	0.3ml	12mg	0.6ml
1200 -1299gm	26mg	1.3ml	6.5mg	0.4ml	13mg	0.7ml
1300 -1399gm	28mg	1.4ml	7mg	0.4ml	14mg	0.7ml
1400-1499gm	30mg	1.5ml	7.5mg	0.4ml	15mg	0.8ml
1500- 1599gm	32mg	1.6ml	8mg	0.4ml	16mg	0.8ml
1600-1699gm	34mg	1.7m	8.5mg	0.5ml	17mg	0.9ml
1700-1799gm	36mg	1.8ml	9mg	0.5ml	18mg	0.9ml

(Adapted from the Clinical care bundle for the prevention and treatment of apnoea of prematurity with caffeine citrate in a resource-limited setting study)

DISCONTINUATION OF CAFFEINE CITRATE AND FOLLOW-UP

- Timely discontinuation is advised to avoid delays in discharge.
- Withdraw caffeine citrate when the preterm neonate has reached 34 weeks' corrected gestational age and has had no apnoea, bradycardia or desaturation episode requiring intervention for approximately 5 days.
- Continuation beyond 34 weeks' PMA can be considered on a case-by-case basis.
- After stopping caffeine, monitor patients for apnoea – there is risk of apnoea of prematurity up to 44 weeks' corrected gestation.
- If the patient develops apnoea within 5 days of stopping caffeine citrate, re-initiate caffeine citrate at the previous maintenance dose.
- At discharge, parents should be counselled on danger signs.

DISCHARGE PLAN

- Discharge the baby at an appropriate weight/age as per unit /MOH protocol.
- Ensure there has been no apnoea for the past 5 - 7 days.
- Ensure the mother is comfortable and willing to care for the baby

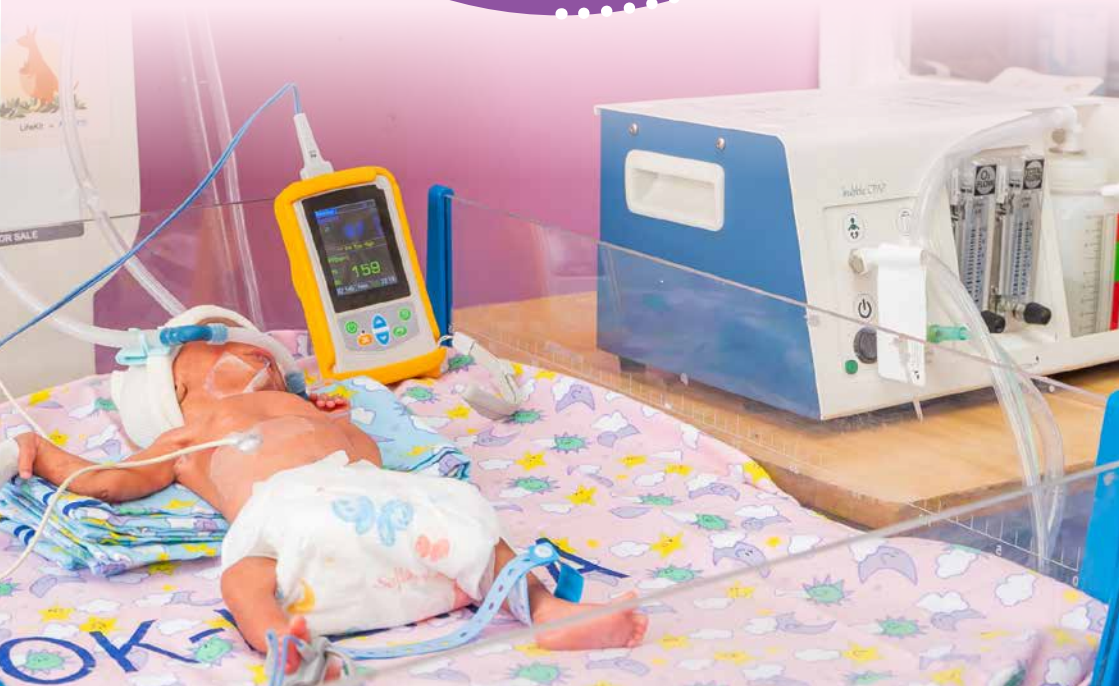
- The baby should have a stable temperature
- There should be adequate support system at home
- The baby should be feeding adequately corresponding to the adequate gaining of weight (15g/kg/day) for 3 consecutive days
- Teach the mother on danger signs and recognition of apnoea and provide contacts for reaching the hospital in case of an emergency.
- Trained healthcare workers should visit the mother/baby at home 1 week after discharge and assess for:
    - Any episodes of apnoea and get spot vital signs - SPO_2 and HR
    - Weight gain – ensure at least 15g/kg/day – MUST BE REWEIGHED WITHOUT CLOTHES
    - Feeding (breastfeeding +/- top up with EBM)
    - Hydration status, urine output.
    - Passing of stools
    - Giving supplements
    - Continuing with KMC
    - Consider weekly follow-up as per NBU protocol.

KEY TAKEAWAY POINTS

1. Caffeine citrate, a methylxanthine, is the drug of choice in the treatment of apnoea of prematurity.
2. Stabilize any neonate with apnoea by initiating the ABC approach.
3. Prophylactic caffeine citrate is prescribed to all preterm neonates <34 weeks' gestation regardless of respiratory support provided.
4. Treatment caffeine citrate is prescribed to preterm neonates <37 weeks' gestation who were not on prophylactic caffeine citrate and developed apnoea, experience an event requiring bag and mask ventilation, prior to elective extubation, unscheduled extubation and following a post anaesthetic event. For neonates who develop an apnoea attack, work up for other causes of apnoea, e.g, hypoglycaemia, sepsis, IVH, etc. should be done.
5. PO caffeine citrate is the preferred method of administration with a loading dose of 20mg/kg followed by a maintenance dose (given within 24 hours at the next scheduled treatment) of 5mg/kg once a day.
6. The loading dose of IV caffeine citrate is administered at 20mg/kg as an infusion over 30 minutes. The maintenance dose of 5mg/kg should be administered as a slow IV infusion over 5 minutes.

4 CHAPTER

USE OF BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE IN THE MANAGEMENT OF APNOEA OF PREMATURITY



USE OF BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE IN THE MANAGEMENT OF APNOEA OF PREMATURITY

INTRODUCTION

DEFINITION

Bubble Continuous Positive Airway Pressure (bCPAP) is a non-invasive method of providing respiratory support to neonates with either upper airway obstruction or respiratory failure. Bubble CPAP provides constant positive pressure to the airway, including a positive end expiratory pressure that maintains an adequate functional residual capacity within the alveoli, therefore preventing atelectasis. Keeping the alveoli open recruits more surface for ventilation and improves oxygen and carbon dioxide exchange within the pulmonary circulation.

BACKGROUND

Bubble CPAP has an established role in the management of respiratory distress in preterm infants (19). Early and effective use of bCPAP (both prophylactic and rescue) has been reported to be associated with reduction in the need for mechanical ventilation and reduction in the risk of developing chronic lung disease/bronchopulmonary dysplasia (BPD).

Bubble CPAP has also been used as one of the non-pharmacological interventions used to prevent apnoea in preterm neonates. It is indicated when the infant continues to have apneic episodes despite achieving a therapeutic serum level of methylxanthine (caffeine citrate) and is initiated after an apneic episode has resolved and the baby is breathing spontaneously to prevent future episodes.

Other indications for the use of bCPAP include management of:

- Pulmonary oedema,
- Transient tachypnoea of the newborn,
- Persistent pulmonary hypertension of the newborn
- Meconium aspiration

MODE OF ACTION

In general, bCPAP provides continuous positive pressure that:

- Splints the upper airway
- Maintains a positive end expiratory pressure (PEEP) that keeps the alveoli open hence recruiting more surface for ventilation, which in turn improves gas exchange within the lung and decreases the work of breathing.
- Stimulates lung growth and surfactant production.

ROLE OF bCPAP IN THE PREVENTION OF APNOEA OF PREMATURITY

bCPAP has been shown to prevent apnoea of prematurity through the following mechanisms (23);

- Providing a respiratory drive *(See figure14 below).*

Figure 15: How bCPAP stimulates the respiratory drive

- Splinting the upper airway thereby reducing the obstructive component.
- Stabilizing the chest wall, thus reducing inhibitory feedback from the chest wall reflexes during rapid eye movement (REM) sleep.
- Regularizing respiration during periodic breathing.

MODES OF bCPAP DELIVERY

i. Bubble CPAP
ii. Variable flow bCPAP
iii. Ventilator derived bCPAP

Note: This guideline shall focus on bubble CPAP

BUBBLE CONTINUOUS POSITIVE AIRWAY PRESSURE (bCPAP)

Bubble CPAP is a device that provides positive pressure and oxygen to improve work of breathing in newborns with respiratory distress. It also has a role in the prevention of apnoea of prematurity as described above..

Bubble CPAP should be used when essential newborn care is in place, thermoregulation is adequate, equipment is functioning, oxygen is available, staff are adequately trained in bCPAP and close monitoring is assured.

MECHANISM OF ACTION/FUNCTION OF BUBBLE CPAP

Bubble CPAP provides continuous distending pressure through a constant flow of air that splints the upper airway and establishes a functional residual capacity (FRC) that keeps alveoli open during expiration. A flow of blended air (ambient air mixed with oxygen) is delivered from the bCPAP machine through an antibacterial filter that removes any microbes that may be in ambient air. The oxygen rich blended, filtered air is humidified and delivered to the baby's respiratory tract through an interface device such as nasal prongs or nasal mask. When the patient exhales, the gas flows through an expiratory tube connected to a pressure-generating bottle. This pressure generator is filled with distilled water and pressurizes the whole circuit. This pressure keeps the lung open during exhalation, preventing atelectasis. The exhaled gas then exits the circuit as bubbles.

COMPONENTS AND DEVICE ASSEMBLY

Bubble CPAP is a closed system. A closed system has a complete path for flow with no interruptions. The system is closed by connecting the inspiratory tube to the machine, while the expiratory tube is submerged in at least 5cm of water. Without a closed system, flow and pressure may escape and will not be fully delivered to the patient. This will decrease the effectiveness of bCPAP.

To provide bCPAP to a patient, five key components are needed:

i) A source of continuous air flow
ii) Inspiratory tube
iii) Expiratory tube
iv) Interface
v) Water bottle generating pressure

The source of continuous air flow can be from a variety of devices which include; air compressor, oxygen concentrator, medical air or oxygen blender.

The interface connects the airway with the system and can range from nasal prongs to full face masks. The most important component is the seal created with the interface. Pressure or flow will always follow the path of least resistance. **A good seal** is needed to ensure flow from the source is delivered to the patient and does not escape from a poorly fitting interface.

A. Nasal mask

B. Nasal prongs

C. Well-fitting nasal mask

Figure 16: Face mask

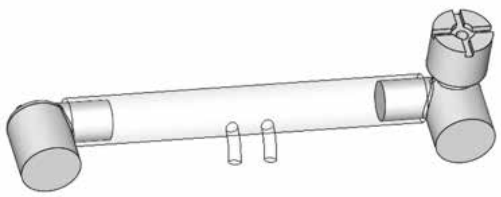


Figure 17: Nasal Prongs

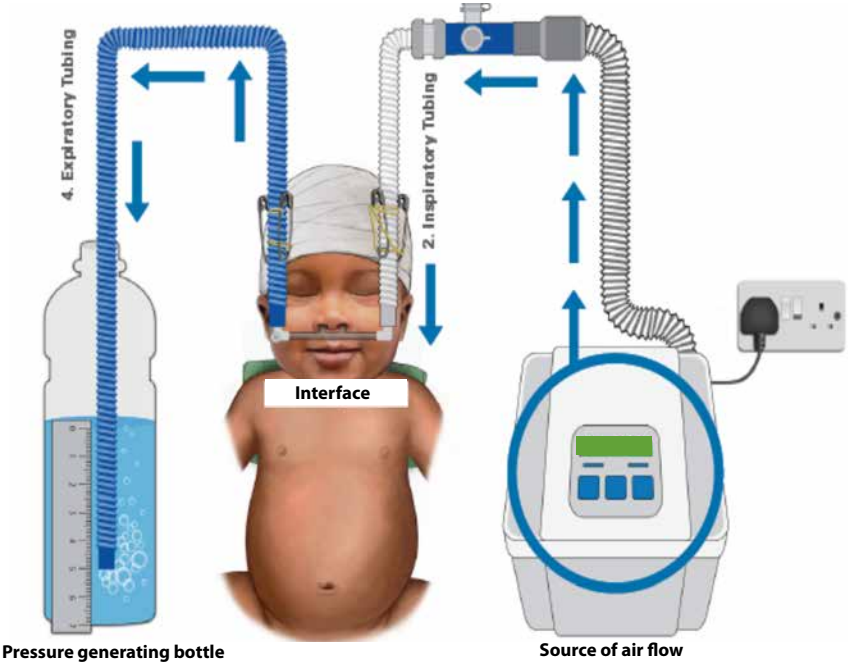


Figure 18 Diagram of a bubble CPAP Machine

bCPAP CAN BE PROVIDED AS:

Prophylactic bCPAP – Preterm <32 weeks' gestation with or without respiratory distress
Rescue bCPAP – Above 32 weeks' gestation with the signs of respiratory distress.
Criteria for rescue bCPAP includes one or more of;

- Tachypnoea (RR>60bpm)
- Nasal flaring
- Grunting
- Sternal retraction
- Lower chest indrawing.
- Increased oxygen requirements - Oxygen sat <90% after ensuring a clear airway and proper position on oxygen at 1L/min.

Management of Apnoea of Prematurity - bCPAP can be initiated after an apneic episode has resolved and the baby is stable to prevent future episodes.

CONTRAINDICATIONS OF bCPAP

bCPAP cannot be used in neonates who are not spontaneously breathing. Other contraindications include:

i) Signs of severe birth asphyxia
ii) Respiratory complications -Gasping respiration, air leaks e.g., pneumothorax
iii) Craniofacial anomalies – cleft palate, choanal atresia
iv) Gastrointestinal anomalies- intestinal perforation, diaphragmatic hernia, gastroschisis etc
v) Severe shock

INITIATION OF bCPAP

A) Practice family centered care

i) Inform the mother (parents) that their baby needs bCPAP to be able to breathe better.
ii) Explain what the procedure involves in layman terms – the connections to the machine, other tubing such as the oral gastric tube (OGT), nasal prongs etc.
iii) Explain that the procedure is safe, and bCPAP has been shown to improve newborn outcomes.
iv) Answer any questions/concerns they may have.
v) Ensure the baby is on oxygen via nasal prongs 1L/min as you explain all this to the parents.
vi) Once the baby has been initiated on bCPAP, explain to the mother that the circuit must be complete and the bubbling present at all times.

B) Ensure availability of bCPAP

Table 10: Checklist for machine and for baby preperation

Checklist for machine preparation	Checklist for baby preparation
bCPAP Machine	Hat or gauze roll
Power cable	Hat clips
Patient (Inspiratory) tubing	Orogastric tube
Bottle (Expiratory) tubing	Normal saline in a 2ml syringe
bCPAP bottle with a lid	Clear adhesive tape
bCPAP assorted sizes nasal prongs	Suction catheter size 6 and 8
Elbow connectors	Assorted nasal prongs (000 - 5)
Oxygen tubing	Blue litmus paper
Oxygen source	5cc syringe
Distilled water (At least 500mls)	Stethoscope
Trolley	Alcohol based hand rub
50cc syringe	Suction machine
Nasal prongs measuring tape.	Pulse oximeter

C) Preparing The bCPAP Machine For Use.

i) Observe hand hygiene
ii) Fill pressure generating and humidifier bottle with distilled water to the indicated level
iii) Connect both the inspiratory and expiratory tubing appropriately
iv) Connect the correct size of interface to the inspiratory and expiratory tubing
v) Insert the bacterial filter disc into the housing and close until a click sound is heard
vi) Connect the blue humidifier tube from the humidifier to the bacterial filter housing
vii) Connect the air/oxygen blender to the other end of the bacterial filter housing
viii) Connect an oxygen source to the air/oxygen blender
ix) Set the oxygen flow at 3L/min
x) Set PEEP at 5cm of H_2O and FiO_2 of 50 % then adjust appropriately
xi) Test for functioning (bubbling) Occlude the interface inlet with your finger and observe for bubbling in the pressure generating bottle.
xii) Machine is ready for use

PREPARING THE BABY FOR bCPAP

i) Determining the correct size of the hat to use and its placement:

- Choose a hat depending on the baby's head and weight.
- Ensure the hat is snuggly fitting on the baby's head
- A stockinette may be used to make a hat if a hat is not available.

Hat Size Selections Chart	
Patient Weight Range	Hat Size
Less than 1,500 grams	Small
1,500 grams to 3,000 grams	Medium
Over 3,000 grams	Large

Figure 19: Choose the most snuggly fit hat

Figure 20: Making a hat from a stockinette

ii) Insert the Oral gastric tube

1. Measure the length from the middle of the lower lip to the tragus of the ear and to midpoint between the xiphisternum and umbillicus.
2. Lubricate the tip of the OGT with breast milk/ water.
3. Slightly flex the baby's head
4. Insert the tube through the mouth (OGT) until the measured distance is reached
6. Secure the gastric tube on the chin using a transparent medical adhesive

Figure 21: Safely secured orogastric tube

iii) Confirm the position of the oral gastric tube:

- Aspirate 2mls of the presumed gastric aspirate using a 2mls syringe
- Check that aspirate turns blue litmus paper pink.
- If no aspirate is obtained, inject 2mls of air down the tube using a 2mls syringe and listen over the abdomen with a stethoscope for a whoosh sound.
- Before feeding always confirm the tube is in the correct position by making sure the mark of the measured distance is visible

iv) Clear the patient's nose and mouth:

- Use a penguin sucker or an appropriately sized suction catheter attached to a suction machine if clinically indicated.

v) Confirm the bCPAP machine is turned on and the flow rates and pressure are set correctly
vi) Size the appropriate bCPAP interphase to use based on the baby's weight
vii) Connect the correctly sized interphase to the inspiratory and expiratory tubing.
viii) Position the baby in sniffing position
ix) Check for effective functioning (water bubbling)
x) Attach pulse oximeter.
xi) Check baby's response to bCPAP (assess Work of Breathing, HR, and SPO_2)
xii) Increase flow rate of oxygen and pressure to achieve SPO_2 of 90-95% as per manufacturers guide.
xiii) Institute supportive care (thermoregulation, nutrition, skin care, pain control and Family Centred Care (FCC)

a) MONITORING OF THE NEONATE

Step 1: Monitor the bCPAP Treatment.

- Vital signs (respiratory rate, heart rate, SpO_2 and temperature)
- Work of breathing (respiratory distress – lower chest wall indrawing, grunting, central cyanosis,

RR>60bpm)

- Nasal blockages - Provide one drop of normal saline to each nostril every 3 hours
- Abdominal distension – ensure oral gastric tube is in situ and open.

Step 2: Check patient attachment (prongs, tubes & hat)

- Check position of the interface – Prongs should not be against the columella & mask should not put pressure on the nasal septum.
- Check nasal columella for skin compromise.
- Check tubing - Tubing should not be kinked or misplaced.
- Check that the hat is not loose; if it is loose, replace with new hat.

Step 3: Monitor function of the equipment

- Check water level: If water level is below or above the target treatment level, add or remove the water from the bottle.
- Check that the bCPAP is bubbling. If not, may be due to the patient's mouth being open or interface not fully fitting, disconnection or a problem with the flow source.
- Check that all tubing is well secured.
- Check that oxygen and total flow settings are correct.

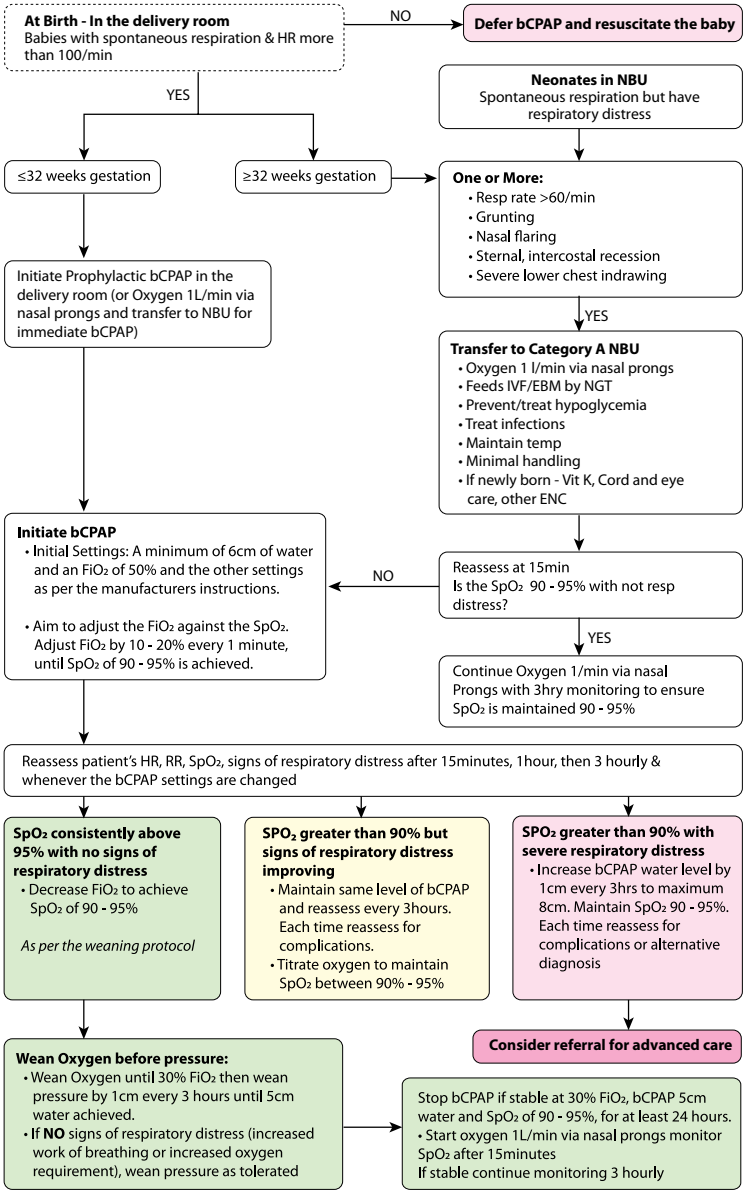
Step 4: Documentation

- Document all assessments and interventions in the baby's file, nurses' cardex and comprehensive newborn monitoring chart as appropriate.

b) FEEDING OF BABIES ON bCPAP

- Feeding is not contraindicated in babies on bCPAP. You can still feed the baby via orogastric (OGT) tube as per unit protocols.
- If OGT is for feeding, close for 30 minutes after feeding then open the OGT.

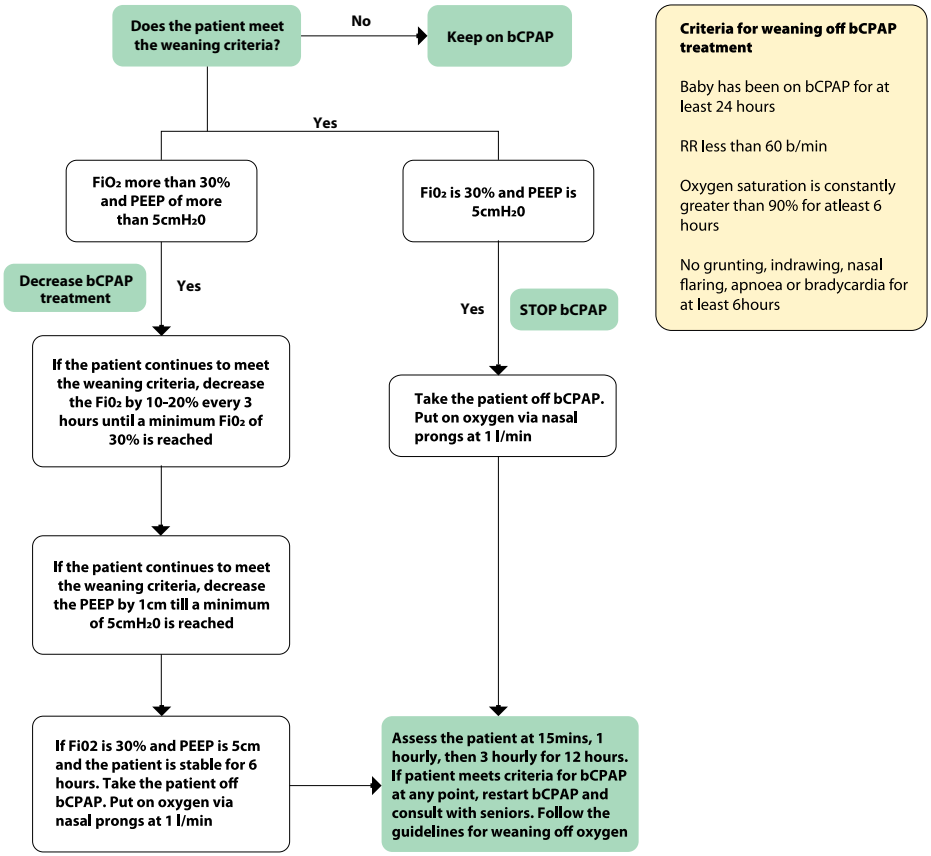
Supporting respiratory efforts - Use of Oxygen and Bubble Continuous Positive Airway Pressure (bCPAP)



bCPAP not to be done for neonates with: APGAR score of less 4 at 5min
Defer bCPAP for neonates with:
1. Uncontrollable seizure
2. Apnoea or gasping respiration

Figure 22: Supporting respiratory efforts - Use of Oxygen and Bubble Continuous Positive Airway Pressure (bCPAP)

FLOW CHART FOR WEANING bCPAP:
(Health, Comprehensive Newborn Care Protocols, 2022)



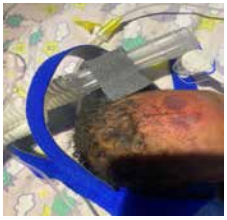
Throughout weaning, keep assessing the baby and ensure:
- SPO_2 of 90 -95%
- The baby has no significant sign of respiratory distress.

Figure 23: Flow chart for weaning bCPAP

Table 11: Complications and Preventions

Complications	Prevention
1. Nasal blockage and dryness	Instil one drop of normal saline to each nostril every 3 hours and humidification of patient on bCPAP
2. Nasal septum erosion & necrosis	Use correct size of interface for each patient. Be gentle when applying the interface. The interface should not be resting on the septum directly. Remove the nasal prongs to review the septum 4 hourly Secure the inspiratory and expiratory tubing to the hat or head band to avoid prong movement. Keep the septum dry.
3. Gastric distention	Insert an OGT and keep it open. If OGT is for feeding, close for 30 minutes after feeding then open the OGT Suction should always be available near the neonate when on bCPAP in case of vomiting.
4. Pneumothorax (tachypnoea, grunting, cyanosis, increased oxygen requirement, chest asymmetry, reduced breath sounds on affected side, positive transillumination in prems <32 weeks' gestation chest Xray.)	Maintain water level between 5 – 8 cm/H_2O In case of pneumothorax urgent senior review
5. Decreased cardiac output	Maintain water level between 5 – 8 cm/H_2O

COMPLICATIONS OF bCPAP

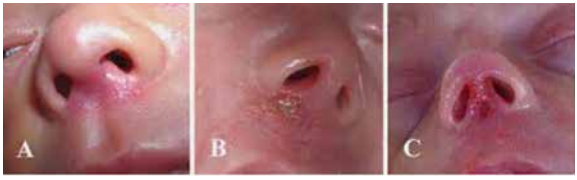


Skin erythema non blanching in an intact skin

Superficial erosion with partial skin loss

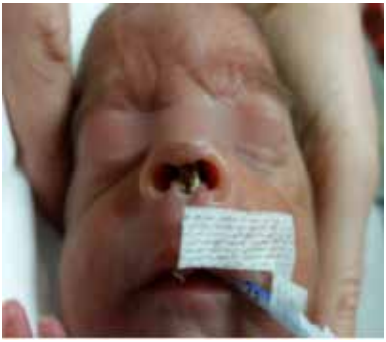
Skin erythema non blanching with an intact skin

Necrosis of full thickness of skin



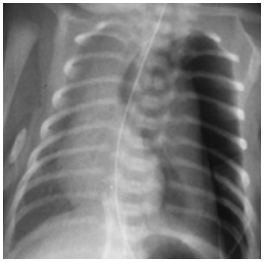
Classifi cation of nasal trauma. (A) stage I (non-blanching erythema), (B) stage II (superfi cial erosion), (C) stage III (necrosis of full thickness of skin).

Columellar defect developed in the newborn receiving NCPAP Treatment



Appearence of columellar defect developed in the newborn receiving NCPAP treatment after secondary healing

Abdominal distension



Pneumothorax

Figure 24: Complications of bCPAP

INFECTION, PREVENTION & CONTROL

After weaning off bCPAP;

i) Change the distilled water in the humidifier daily (Every 24 hours)
ii) Turn off the bCPAP and dispose the water in the pressure regulating bottle.
iii) Disconnect all the tubings and segregate them for decontamination and disinfection.
iv) Clean the hat, hat clips, pressure generating bottle and the tube hanger with soap and water, rinsed in clean water then air dry.
v) Perform high level disinfection for the elbow connectors and, patient and bottle tubing using 0.5% sodium hypochlorite.
vi) Wipe all the metallic parts of the bCPAP machine with a cloth soaked in 70% alcohol.
vii) Autoclave the Silicon Nasal Prongs

Change the bacterial filters every 24hours or as per manufacturer's guidelines.

Preventive maintenace and trouble shooting

Conduct regular and scheduled planned preventive maintenance for all equipment.

Sources: *Comprehensive Newborn Care Protocols, Nov. 2022 and the VAYU bCPAP Training Resources.*

CHAPTER 5

PULSE OXIMETRY IN THE MANAGEMENT OF APNOEA OF PREMATURITY

PULSE OXIMETRY IN THE MANAGEMENT OF APNOEA OF PREMATURITY

INTRODUCTION PULSE OXIMETRY

This is a non-invasive, painless method to indirectly measure the oxygen saturation of haemoglobin in arterial blood (SpO_2) (24). Apnoea of Prematurity (AOP) has been defined as cessation of breathing for ≥ 20 seconds or shorter respiratory pauses <20 seconds that are associated with bradycardia (<100 beats/minute), central cyanosis, and/or desaturation (Saturations <90%) and pallor in neonates born at <37 weeks' gestation and with no underlying disorders causing apnoea (4). Management of AOP includes among others; bCPAP and oxygen supplementation. In management of AOP therefore, continuous SPO_2 monitoring will aid in diagnosis of AOP, early detection of hypoxia and helps avoid hyperoxaemia, which is a risk factor for retinopathy of prematurity. Pulse oximetry is also essential during attempts to wean or titrate oxygen therapy to determine whether a patient can maintain oxygen saturation within the target range. Pulse oximeters also detect pulsatile blood flow therefore most devices will display pulse rate (25).

In addition to the use of pulse oximetry in the management of AOP, it is also used in;

i) Monitoring the newborn post-delivery, during and after resuscitation
ii) Vital signs assessment during triage
iii) To determine need for oxygen therapy
iv) Regular monitoring when on oxygen therapy including when providing continuous positive airway pressure (bCPAP)
v) Regular monitoring of heart rate and oxygen saturation of sick babies when off oxygen
vi) Screening for critical congenital heart diseases

CONDITIONS THAT MAY CAUSE HYPOXEMIA IN NEONATES

i) Respiratory Distress Syndrome
ii) Neonatal pneumonia
iii) Transient tachypnea of newborn
iv) Birth asphyxia
v) Neonatal Sepsis
vi) Apnoea of prematurity
vii) Congenital heart defects
viii) Aspiration – Meconium, amniotic fluid, feeds

DEVICES USED FOR PULSE OXIMETRY (25)

A) BENCHTOP PULSE OXIMETER

It is a stationary device for continuous operation/monitoring. Some can be wall or pole-mounted. It is suitable for longer term monitoring. It can also be used in the operating theatre where more comprehensive parameters can be monitored.

Areas of use – Secondary and tertiary centres, e.g., general medical and outpatient areas, operating room, ICU, NICU, recovery rooms e.t.c.

Merits

It has multiple use-case options.

- It may be pole mounted.
- It has a large internal memory to store patient IDs and records.
- It ideally has a port (or Wi-Fi) for downloading and/or printing data.
- It is the most accurate, in general.

Figure 25: Benchtop Pulse oximeter

b) HANDHELD PULSE OXIMETER

It is a handheld portable device with display screen and attached sensor probe and cable. It is useful for diagnosis, intermittent and continuous monitoring.

Areas of use – Primary, secondary and tertiary centres, e.g., health centres, general medical and outpatient areas, operating room, ICU, neonatal intensive care unit (NICU), Multiple use-case options.

Merits

- It is portable.
- It has alarms and internal memory.
- Typically, have ≥ 12 hours' operational capacity on rechargeable built-in battery and take ≤ 4 hours to charge.
- Ideally have a port (or Wi-Fi) for downloading and/or printing data

Figure 26: Handheld pulse oximeter

c) FINGERTIP PULSE OXIMETER (not recommended in newborns)

It is a portable device that has the sensor, analyzer and display contained in a single unit. The device is put directly on the finger or toe. Almost always designed for adults. Some paediatric models can be used on children (check weight range for device), **but are not appropriate for use in neonates.**

Areas of use Primary, secondary and tertiary level, but application dependent, i.e., where spot checking on adults (or children, if a paediatric model for an appropriate weight range is used) is the desired function.

Merits

- Low upfront cost,
- Portable,
- Self-contained unit;
- No external probes/cables.

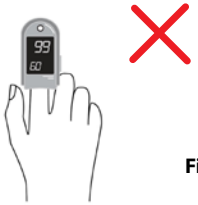


Figure 27: Fingertip pulse oximeter

D) CARDIAC MONITOR

It is stationary, enables continuous operation monitoring a range of vitals and is useful in NICU and operating theatres.

Figure 28: Vital Signs Monitor

PARTS OF A PULSE OXIMETER

Figure 29: Parts of a pulse oximeter

a) Monitor

Displays SPO_2, pulse rate and sometimes, a pulse waveform illustrating the strength of the pulse being detected.

b) Probes

It is made up of LEDs (Light emitting detector) and a photodetector. They come in different types/shapes, often designed for use on fingers, toes, earlobe and foot (neonates). It is the most delicate part of the pulse oximeter and most common point of failure is the probe wiring.

Figure 30: Neonatal probe

Probe fit and sensitivity in paediatric – Ensure the probe fits well and it's not too tight (would constrict circulation) or too loose (may fall off or let other light in). The use of the right probe is recommended – forcing the probe may damage it, the circulation may be reduced and the light may be inadequately detected

c) Connector

This is made up of a series of very fine pins, connecting probe to pulse oximeter. Pins can be easily damaged if not correctly inserted into device

Figure 31: Pulse Oximeter Connector

HOW A PULSE OXIMETER WORKS

Pulse oximeter measures oxygen concentration in arterial blood

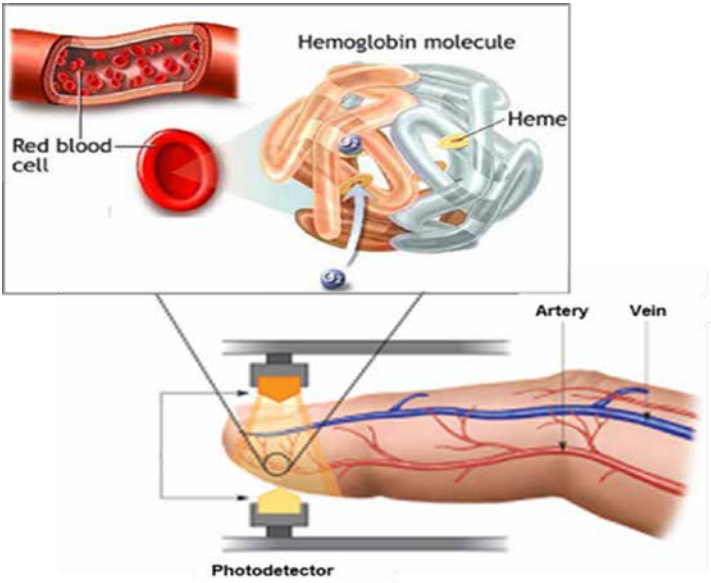


Figure 32: How a Pulse oximeter works1(26)

Pulse Oximeter sensor is made up of small light emitting diodes (LEDs) – red (660 nm) and infrared light (940 nm) – opposite a photodetector.
LEDs absorb differently, depending on oxygen availability in blood
Light from LEDs pass through tissues and are converted to an electronic signal by the photodetector.
This electronic signal (ratio in absorption/oxygenation) is amplified and processed and depicted on the oximeter as SpO_2 and pulse rates on the monitor.

PREPARING AND MONITORING BABIES ON PULSE OXIMETER

i) Follow hand hygiene protocol (Appendix I)
ii) Check that you have the machine and an external newborn attachment probe sensor.
iii) Check that the battery/dry cells are well placed, or the machine is charged
iv) Attach the probe to the machine by ensuring that the shape of the pulse oximeter port corresponds to that of the attachment probe.
v) If the shapes are not the same size, connect with an adapter. This should be provided with the pulse oximeter.
vi) Turn on the pulse oximeter by long pressing the power button.
vii) Check for a red light on the probe.


Connect the probe


Turn the Oximeter on


Check for the red light on the sensor

Figure 33: Preparing the pulse oximeter

vii) Check that the pulse oximeter settings are in neonatal mode.
viii) Set Alarm limits;
- Oxygen saturation - Lower limit 89% – Upper limit 96%
- Heart rate – Lower limit 99 beats/min – Upper limit 180 beats/min.

ix) Set display variables – what will be viewed on the pulse oximeter screen as recommended by the manufacturer. Ensure date and time are set correctly.

x) Clean the pulse oximeter probe thoroughly using 70% alcohol-soaked cotton swab (except the sensor) and let it dry.

PREPARE THE BABY FOR PULSE OXIMETRY

i) Position the baby comfortably in an area away from excessive lighting on the pulse oximeter.

ii) Choose an assessment site/extremity which is warm, well perfused and with minimal movements -usually, the foot or the wrist.

iii) Ensure the probe to be used is the appropriate size for the selected assessment site/extremity.

iv) Clean the site with a cotton wool soaked in 70% alcohol and **let it dry.**

v) Wrap and snuggly secure the probe on the assessment site. Ensure the light source and the sensor line up as shown below.

vi) Turn on the Pulse oximeter and check for the red light on the sensor.

Figure 34: Correctly attach and secure the probe on the selected side

All babies should have continuous SPO_2 monitoring while on oxygen or bCPAP therapy.

vii) Allow the baby's trace to establish.

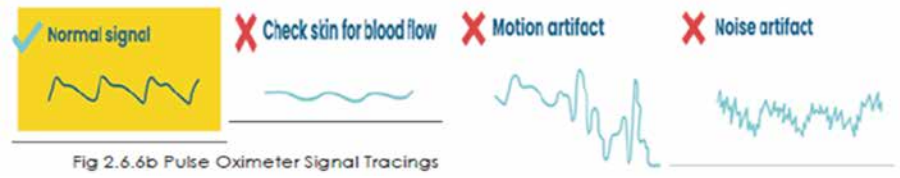


Figure 35: Pulse Oximeter Signal Tracing

viii) Read the oxygen saturation, wave form and heart rate.

ix) Confirm that the device is reading accurately by manually assessing the pulse rate and comparing with what is displayed on the pulse oximeter.

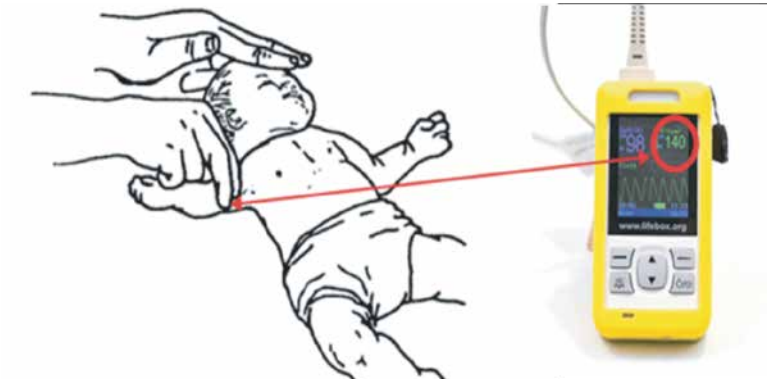


Figure 36: Confirming the device reading with manual assement of the pulse rate

SPECIAL CONSIDERATIONS IN NEWBORNS

Newborns may take the first 10min after birth, for their SpO_2 to reach 85 – 95%. Normal SpO_2 levels are lower than children/adults.

Extra care should be taken on neonatal skin, which is quite thin and sensitive.
The probe should be fastened snuggly on the neonates foot, wrist or hand.
Probes should be repositioned every 3 hours if affixed for continuous monitoring to reduce pressure on the skin.

CAUSES OF INACCURATE READINGS

i) Severe hypotension or anaemia
ii) Venous congestion of the limbs
iii) Exposure to intense external light energy (as in phototherapy)
iv) Hypothermia

v) Shivering and patient movement.
vi) Skin pigmentation - may produce lower or less reliable SpO_2 readings.
vii) Carbon monoxide poisoning may give a falsely high saturation reading.
viii) Tissue injury may occur at the measuring site because of probe misuse (e.g., pressure sores from prolonged application)

TITRATION AND WEANING OFF OF OXYGEN

TITRATION

After initiation of Oxygen,

i) Increase flow rates by 0.5L/min every 15-30 mins until SpO_2 is 90 – 95%. Post resuscitation target in neonates is 90-95%.
ii) Change the oxygen delivery methods (nasal prongs, catheter or NRM) & flow rates based on need.
iii) Stop titrating and begin close monitoring if clinically stable (no emergency signs, SpO_2 > 90% and no increase WoB)

WEANING

i) Oxygen should be gradually discontinued by decreasing the flow by 0.5L/min every 30 minutes and carefully assess for changes in breathing and SpO_2.
ii) Wean off oxygen every 15 –30 min and carefully examine for changes in work of breathing and SpO_2 to assess whether supplemental oxygen is still required.
iii) Once oxygen is stopped, monitor and recheck the SpO_2, after 1 hour as late desaturation can occur.
iv) Discharge only if the child has SpO_2 > 90% and no laboured breathing on room air for at least 24 hours to ensure no late decompensation.

HANDLING AND MAINTENANCE OF THE PULSE OXIMETER

a. INFECTION PREVENTION

Frequency – Whenever you see any type of dirt on the Pulse oximeter and before using on any patient.

Necessary tools – Alcohol swabs, clean damp cloth & soapy water

Aim: To ensure cleanliness of the pulse oximeter and to prevent spread of infections between patients.

Procedure

1. Always wash hands or sanitize before and after monitoring each patient.
2. Turn off the oximeter before cleaning.
3. Use alcohol swabs **(containing medical alcohol (70% isopropyl alcohol solution)** to clean the oximeter. This includes; casing, probe, cable, chassis protection sleeve (all which apply) **EXCEPT** probe sensors (use a clean damp cloth for the sensor)

NOTE: Chlorine will corrode and destroy the device.

b. HANDLING OF THE PULSE OXIMETER

i) Check that the probes open and close smoothly and replace probes if there is any unevenness or variations.

ii) The finger probes are fragile, look after them carefully.

iii) Store probes well to avoid damage.

iv) Ensure that connectors are correctly aligned before attempting to insert it into the oximeter.

v) Never pull the probe from the machine by pulling on the cable; always grasp the connector firmly between finger and thumb.

vi) Loosely coil oximeter probe cable for storage or transport, when not in use (tight coils can damage the wires in the cable).

Do not pull the cord directly as shown above as it may cause the wire cable to get cut and may not function well.

Pull the cord as shown above to connect or disconnect the probe from the Pulse oximeter.

Loosely wind the probes as shown in the diagram for storage

Avoid tight winding of the probes as shown above as this may damage the probes.

Figure 37: Handling of the Pulse Oximeter

If the pulse oximeter is **not turning on**	If the pulse oximeter is turning on but **is not displaying a trace**	If the pulse oximeter is turning on but **taking time to stabilise the trace**
• Press and hold the power button for at least 5 seconds	• Check the probe for a flashing red light • If there is no light, check that the probe is properly connected to the pulse oximeter	• Check that no powerful light sources are shining on the pulse oximeter probe • Confirm that the patient is not moving and the probe is still securely attached • Confirm the probe is dry and clean • Choose an extremity that is warm, dry, and well perfused • Wait at least 1 minute for the signal to stabilise before trying an alternate extremity
		
• Check the battery level • If low, plug in the device to charge or get new batteries	• If the probe is connected and no light is showing try replacing the probe • If the probe is connected and the red light is showing, but no probe is detected or no trace is displayed, replace with a different probe	
		

!! **CONTACT A TECHNICIAN OR MAINTENANCE DEPARTMENT IF DEVICE IS NOT WORKING PROPERLY AFTER ADDRESSING THE COMMON ISSUES** **!!**

Figure 38: Troubleshooting some common problems in Pulse oximetry

APPENDIX I:

Hand washing Job Aid (Source: CDC)

Follow Five Steps to Wash Your Hands the Right Way

Washing your hands is easy, and it's one of the most effective ways to prevent the spread of germs. Clean hands can help stop germs from spreading from one person to another and in our communities—including your home, workplace, schools, and childcare facilities.

Follow these five steps every time.

1. **Wet** your hands with clean, running water (warm or cold), turn off the tap, and apply soap.
2. **Lather** your hands by rubbing them together with the soap. Lather the backs of your hands, between your fingers, and under your nails.
3. **Scrub** your hands **for at least 20 seconds.** Need a timer? Hum the "Happy Birthday" song from beginning to end twice.
4. **Rinse** your hands well under clean, running water.
5. **Dry** your hands using a clean towel or an air dryer.

Hand hygiene technique

APPENDIX II:

New Ballard Score

NEUROMUSCULAR MATURITY SIGN	SCORE -1	0	1	2	3	4	5	RECORD SCORE HERE
POSTURE								
SQUARE WINDOW (Wrist)	 >90°	 90°	 60°	 45°	 30°	 0°		
ARM RECOIL		 180°	 140 –180°	 110 –140°	 90 –110°	 <90°		
POPLITEAL ANGLE	 180°	 160°	 140°	 120°	 100°	 90°	 <90°	
SCARF SIGN								
HEEL TO EAR								
						TOTAL NEUROMUSCULAR MATURITY SCORE		

SCORE
Neuromuscular _____
Physical _____
Total _____

MATURITY RATING

SCORE	WEEKS
-10	20
-5	22
0	24
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44

GESTATIONAL AGE (weeks)
By dates _____
By ultrasound _____
By exam _____

PHYSICAL MATURITY

PHYSICAL MATURITY SIGN	SCORE -1	0	1	2	3	4	5	RECORD SCORE HERE
SKIN	sticky friable transparent	gelatinous red translucent	smooth pink visible veins	superficial peeling & / or rash, few veins	cracking pale areas rare veins	parchment deep cracking no vessels	leathery cracked wrinkled	
LANUGO	none	sparse	abundant	thinning	bald areas	mostly bald		
PLANTAR SURFACE	heel-toe 40–50 mm: -1 < 40 mm: -2	>50 mm no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases over entire sole		
BREAST	imperceptible	barely perceptible	flat areola no bud	stippled areola 1–2 mm bud	raised areola 3–4 mm bud	full areola 5–10 mm bud		
EYE / EAR	lids fused loosely: -1 tightly: -2	lids open pinna flat stays folded	sl. curved pinna; soft; slow recoil	well-curved pinna; soft but ready recoil	formed & firm instant recoil	thick cartilage ear stiff		
GENITALS (Male)	scrotum flat, smooth	scrotum empty faint rugae	testes in upper canal rare rugae	testes descending few rugae	testes down good rugae	testes pendulous deep rugae		
GENITALS (Female)	clitoris prominent & labia flat	prominent clitoris & small labia minora	prominent clitoris & enlarging minora	majora & minora equally prominent	majora large minora small	majora cover clitoris & minora		
						TOTAL PHYSICAL MATURITY SCORE		

Reference
Ballard JL, Khoury JC, Wedig K, et al: New Ballard Score, expanded to include extremely premature infants. J Pediatr 1991; 119:417–423. Reprinted by permission of Dr Ballard and Mosby—Year Book, Inc.

New Ballard Score

Physical maturity							
	−1	0	1	2	3	4	5
Skin	Sticky; friable; transparent	Gelatinous; red; translucent	Smooth; pink; visible veins	Superficial peeling and/or rash; few veins	Cracking pale areas; rare veins	Parchment deep cracking; no vessels	Leathery; cracked; wrinkled
Lanugo	None	Sparse	Abundant	Thinning	Bald areas	Mostly bald	
Plantar creases	Heel-toe 40 to 50 mm: −1 <40 mm: −2	>50 mm; no crease	Faint red marks	Anterior transverse crease only	Crease anterior 2/3	Creases over entire sole	
Breast	Imperceptible	Barely perceptible	Flat areola; no bud	Strippled areola; 1 to 2 mm bud	Raised areola; 3 to 4 mm bud	Full areola; 5 to 10 mm bud	
Eye/ear	Lids fused Loosely: −1 Lightly: −2	Lids open; pinna flat, stays folded	Slightly curved pinna; soft with slow recoil	Well-curved pinna; soft but ready recoil	Formed and firm with instant recoil	Thick cartilage; ear stiff	
Genitals (male)	Scrotum flat, smooth	Scrotum empty; faint rugae	Testes in upper canal; rare rugae	Testes descending; few rugae	Testes down; good rugae	Testes pendulous; deep rugae	
Genitals (female)	Clitoris prominent; labia flat	Prominent clitoris; small labia minora	Prominent clitoris; enlarging minora	Majora and minora equally prominent	Majora large; minora small	Majora cover clitoris and minora	

Maturity rating													
Score	−10	−5	0	5	10	15	20	25	30	35	40	45	50
Gestational age (weeks)	20	22	24	26	28	30	32	34	36	38	40	42	44

The new Ballard score is used to estimate gestational age from neuromuscular and physical features. The scores of each feature are added to calculate a maturity rating that correlates with gestational age.

APPENDIX III:

CATEGORIZATION OF NEONATAL PATIENTS.

Category A babies

Babies who are on oxygen/continuous positive airway pressure (bCPAP or intravenous fluids who are acutely ill and unstable and require the closest monitoring and a higher-level care. For such babies. Delegation of tasks to students and others would only need to be done under very close supervision.

Category B babies

Babies who have stabilized but may still be ill and receiving, for example, assisted feeding (e.g., nasogastric feeds) and intravenous drugs, or require close monitoring for example a baby who is on double phototherapy with intermittent convulsions or at risk of apnoea.

Category C babies

Babies who are stable requiring only monitoring or oral medications often after stepping down from Category A or B care. Many of these should be receiving kangaroo mother care (KMC) or for example may be stable abandoned babies or term babies requiring phototherapy only or accommodation because of severe maternal illness. These babies may require regular feeding and changing – done by parents wherever possible – but limited care in terms of nursing observations.

APPENDIX IV:

Blender Charts

Blender Charts

4 cmH2O

Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 4 LPM	11 mm 2.75 LPM	15 mm 2.75 LPM	27 mm 3 LPM	32 mm 4.25 LPM	37 mm 4.75 LPM	41 mm 6.25 LPM	50 mm 6 LPM
	6 LPM	0 mm 4.25 LPM	11 mm 3 LPM	15 mm 2.75 LPM	29 mm 4.25 LPM	33 mm 5 LPM	37 mm 5.75 LPM	41 mm 7.25 LPM	50 mm 7.5 LPM
	7 LPM	0 mm 4.5 LPM	11 mm 3.25 LPM	17 mm 3 LPM	30 mm 5 LPM	32 mm 5.25 LPM	38 mm 6.5 LPM	41 mm 8.25 LPM	50 mm 9 LPM
	8 LPM	0 mm 4.5 LPM	11 mm 3.25 LPM	26 mm 3.75 LPM	30 mm 4.75 LPM	33 mm 6.5 LPM	38 mm 6.75 LPM	41 mm 9 LPM	50 mm 9 LPM
	9 LPM	0 mm 5 LPM	11 mm 3.5 LPM	26 mm 4 LPM	30 mm 6 LPM	33 mm 7 LPM	38 mm 9.25 LPM	41 mm 10.5 LPM	50 mm 11 LPM
	10 LPM	0 mm 5 LPM	11 mm 3.5 LPM	27 mm 4.5 LPM	30 mm 5.75 LPM	33 mm 7.75 LPM	39 mm 8.75 LPM	41 mm 10.75 LPM	50 mm 10.5 LPM

5 cmH2O

Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 4.25 LPM	11 mm 2.75 LPM	15 mm 3 LPM	28 mm 3.5 LPM	31 mm 4.25 LPM	38 mm 5.75 LPM	41 mm 6.25 LPM	50 mm 6.75 LPM
	6 LPM	0 mm 4.25 LPM	11 mm 3 LPM	15 mm 3 LPM	29 mm 3.75 LPM	32 mm 5 LPM	38 mm 6.75 LPM	40 mm 7 LPM	50 mm 8 LPM
	7 LPM	0 mm 4.5 LPM	11 mm 3.25 LPM	17 mm 3.25 LPM	29 mm 4 LPM	32 mm 5.5 LPM	38 mm 7.5 LPM	41 mm 8.5 LPM	50 mm 9.25 LPM
	8 LPM	0 mm 4.75 LPM	10 mm 3.5 LPM	25 mm 3.5 LPM	30 mm 5.5 LPM	33 mm 6.5 LPM	37 mm 7.75 LPM	41 mm 9 LPM	50 mm 10.5 LPM
	9 LPM	0 mm 5 LPM	11 mm 3.5 LPM	26 mm 4 LPM	30 mm 5.75 LPM	33 mm 7 LPM	37 mm 8.5 LPM	41 mm 10 LPM	50 mm 11.5 LPM
	10 LPM	0 mm 5.25 LPM	11 mm 3.75 LPM	27 mm 4.75 LPM	30 mm 6.5 LPM	33 mm 7.75 LPM	37 mm 9.25 LPM	41 mm 11 LPM	50 mm 12.25 LPM

6 cmH2O

Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 4.25 LPM	10 mm 3 LPM	15 mm 3 LPM	28 mm 3.75 LPM	30 mm 4 LPM	37 mm 5.75 LPM	40 mm 6.25 LPM	50 mm 7.5 LPM
	6 LPM	0 mm 4.5 LPM	10 mm 3.25 LPM	15 mm 3.25 LPM	29 mm 4 LPM	32 mm 5 LPM	37 mm 6.5 LPM	40 mm 7 LPM	50 mm 8.75 LPM
	7 LPM	0 mm 4.75 LPM	10 mm 3.5 LPM	17 mm 3.5 LPM	29 mm 4.25 LPM	32 mm 5.5 LPM	37 mm 7.25 LPM	41 mm 8.75 LPM	50 mm 9.75 LPM
	8 LPM	0 mm 5 LPM	10 mm 3.5 LPM	26 mm 4 LPM	30 mm 5.5 LPM	33 mm 6.75 LPM	37 mm 8 LPM	41 mm 9.5 LPM	50 mm 10.5 LPM
	9 LPM	0 mm 5.75 LPM	10 mm 3.75 LPM	26 mm 4.25 LPM	30 mm 6 LPM	33 mm 7 LPM	37 mm 8.75 LPM	41 mm 10.75 LPM	50 mm 11.5 LPM
	10 LPM	0 mm 6.25 LPM	10 mm 4 LPM	26 mm 4.75 LPM	30 mm 6.5 LPM	33 mm 7.75 LPM	37 mm 9.5 LPM	41 mm 11.25 LPM	50 mm 12.5 LPM

7 cmH2O

Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 4.5 LPM	10 mm 3.25 LPM	15 mm 3.25 LPM	26 mm 3.5 LPM	30 mm 4.25 LPM	36 mm 4.75 LPM	40 mm 6.25 LPM	50 mm 6.25 LPM
	6 LPM	0 mm 4.75 LPM	10 mm 3.5 LPM	15 mm 3.25 LPM	29 mm 4.25 LPM	32 mm 5.25 LPM	36 mm 6 LPM	40 mm 7 LPM	50 mm 8 LPM
	7 LPM	0 mm 5 LPM	10 mm 3.5 LPM	17 mm 3.5 LPM	30 mm 5.5 LPM	32 mm 5.75 LPM	37 mm 7 LPM	41 mm 8.75 LPM	50 mm 9 LPM
	8 LPM	0 mm 5 LPM	11 mm 3.5 LPM	25 mm 4 LPM	29 mm 4.5 LPM	33 mm 6.75 LPM	37 mm 7 LPM	41 mm 9.75 LPM	50 mm 9 LPM
	9 LPM	0 mm 6.25 LPM	10 mm 4 LPM	26 mm 4.5 LPM	30 mm 6.25 LPM	33 mm 7.5 LPM	37 mm 8.75 LPM	41 mm 11 LPM	50 mm 11.5 LPM
	10 LPM	0 mm 6.5 LPM	10 mm 4 LPM	26 mm 4.75 LPM	30 mm 6.25 LPM	33 mm 7.75 LPM	38 mm 9 LPM	41 mm 11.25 LPM	50 mm 10.5 LPM

8 cmH2O

Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 4.75 LPM	10 mm 3.25 LPM	14 mm 3.25 LPM	27 mm 3.75 LPM	30 mm 4.25 LPM	35 mm 5.25 LPM	40 mm 6.25 LPM	50 mm 7.75 LPM
	6 LPM	0 mm 5 LPM	10 mm 3.5 LPM	14 mm 3.5 LPM	29 mm 4.25 LPM	32 mm 5.25 LPM	36 mm 6.25 LPM	40 mm 7 LPM	50 mm 8.75 LPM
	7 LPM	0 mm 5.5 LPM	10 mm 3.75 LPM	17 mm 3.75 LPM	29 mm 4.75 LPM	32 mm 5.75 LPM	37 mm 6.75 LPM	41 mm 9 LPM	50 mm 10 LPM
	8 LPM	0 mm 6 LPM	10 mm 4 LPM	24 mm 4 LPM	30 mm 6 LPM	33 mm 7 LPM	37 mm 7.75 LPM	41 mm 9 LPM	50 mm 10.5 LPM
	9 LPM	0 mm 6.5 LPM	10 mm 4 LPM	25 mm 4.25 LPM	29 mm 5.25 LPM	33 mm 7.5 LPM	37 mm 8.5 LPM	41 mm 10.25 LPM	50 mm 11.5 LPM
	10 LPM	1 mm 6.5 LPM	10 mm 4.25 LPM	26 mm 4.75 LPM	30 mm 7 LPM	33 mm 7.75 LPM	37 mm 9.5 LPM	41 mm 11.25 LPM	50 mm 12.5 LPM

9 cmH2O

Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 5 LPM	9 mm 3.5 LPM	14 mm 3.5 LPM	28 mm 4.25 LPM	30 mm 4.5 LPM	36 mm 5.75 LPM	39 mm 6.25 LPM	50 mm 8.25 LPM
	6 LPM	0 mm 5.5 LPM	9mm 3.75 LPM	14 mm 3.5 LPM	28 mm 4.5 LPM	32 mm 5.5 LPM	36 mm 6.75 LM	40 mm 7 LPM	50 mm 9.25 LPM
	7 LPM	0 mm 6 LPM	10 mm 3.75 LPM	14 mm 3.75 LPM	29 mm 4.75 LPM	32 mm 6 LPM	37 mm 7.25 LPM	40 mm 8 LPM	50 mm 10 LPM
	8 LPM	0 mm 6.5 LPM	10 mm 4 LPM	25 mm 4.25 LPM	29 mm 5 LPM	33 mm 7 LPM	37 mm 8 LPM	41 mm 10.25 LPM	50 mm 10.5 LPM
	9 LPM	0 mm 6.75 LPM	9 mm 4.25 LPM	24 mm 4.25 LPM	29 mm 6.25 LPM	33 mm 7.5 LPM	37 mm 8.75 LPM	40 mm 11.25 LPM	50 mm 12 LPM
	10 LPM	0 mm 7.5 LPM	10 mm 4.25 LPM	25 mm 4.5 LPM	30 mm 7.25 LPM	33 mm 8.25 LPM	37 mm 9.5 LPM	41 mm 11.5 LPM	50 mm 12.75 LPM

10 cmH2O

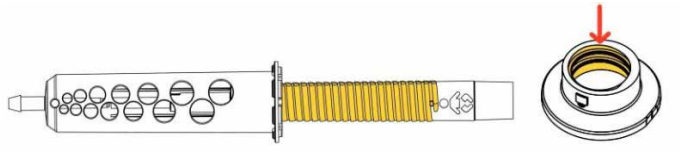
Blender setting / Oxygen flow rate		%O_2 30%	40%	50%	60%	70%	80%	90%	100%
Flow	5 LPM	0 mm 5 LPM	10 mm 3.5 LPM	14 mm 3.5 LPM	21 mm 3.75 LPM	30 mm 4.5 LPM	34 mm 5 LPM	39 mm 6.25 LPM	50 mm 7 LPM
	6 LPM	0 mm 5.75 LPM	10 mm 3.75 LPM	14 mm 3.75 LPM	27 mm 4.5 LPM	32 mm 5.75 LPM	36 mm 6.25 LPM	40 mm 7 LPM	50 mm 8.75 LPM
	7 LPM	0 mm 6.5 LPM	9 mm 4 LPM	14 mm 3.75 LPM	28 mm 4.75 LPM	32 mm 6 LPM	36 mm 7.25 LPM	40 mm 8 LPM	50 mm 9.75 LPM
	8 LPM	0 mm 6.5 LPM	10 mm 4 LPM	19 mm 4.25 LPM	29 mm 5.25 LPM	33 mm 7 LPM	37 mm 7.25 LPM	40 mm 9 LPM	50 mm 9.5 LPM
	9 LPM	0 mm 7 LPM	10 mm 4.25 LPM	24 mm 4.5 LPM	29 mm 5.25 LPM	33 mm 7.75 LPM	37 mm 8.75 LPM	40 mm 9.5 LPM	50 mm 11.25 LPM
	10 LPM	0 mm 7 LPM	10 mm 4.25 LPM	25 mm 4.75 LPM	29 mm 5.75 LPM	33 mm 8.5 LPM	37 mm 8.5 LPM	41 mm 11.75 LPM	50 mm 10.5 LPM

APPENDIX V:

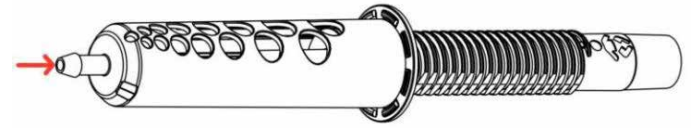
Manual Cleaning and High Level Disinfection (Source: VAYU)

Immediately After Use	Pour out any water or acetic acid solution from the humidifier and pressure generator jars. Remove gross soiling from all the components by wiping with gauze or rinsing in potable water.
Disassembly	**Disassemble the blender into its subcomponents: blender, locknut.** 1. Completely unscrew the lock nut to separate from blender. 2. Adjust the blender to 40% O_2 on the % O_2 scale Do not put the lock nut back on. **Disassemble the bacterial viral filter into its subcomponents: filter housing, O-ring, filter disk.** 1. Separate the two halves of the filter housing. 2. Dispose of the filter disk. 3. Remove the O-ring from the filter housing. **Disassemble the humidifier into its subcomponents: jar, lid.** 1. Unscrew the lid from the jar. **Disassemble the pressure generator into its subcomponents: jar, lid, wand.** 1. Separate the wand completely from the lid by pinching the collar on the lid and pulling the wand up and out. 2. Unscrew the lid from the jar. **Disassemble the warmer bracket into its subcomponents: warmer bracket, blender clip.** 1. Remove the blender clip from the warmer bracket.
Manual Cleaning	**Required equipment:** Enzymatic detergent 3/8", 1/2", and 1" diameter soft bristled brushes 1. If more than 30 minutes have elapsed since patient use, presoak all components in potable water for at least 6 hours at 25-27°C. 2. Soak all subcomponents in a solution of enzymatic detergent for at least 30 minutes in accordance with the manufacturer's instructions, ensuring that components are fully submerged. 3. Scrub all components vigorously with a soft bristled brush for at least 20 seconds each. 4. Pay extra attention to lumens and ridges like the blender nozzle, blender orifice, blender threads, filter housing grooves, humidifier lid, pressure generator wand, and tubing. Make sure to brush each lumen for an additional 20 seconds each. To properly brush lumens, be sure to select a soft bristled brush that is slightly larger in diameter than the lumen being brushed so that all inner surfaces of the lumen are reached. 5. Flush all lumens twice with enzymatic detergent for at least 20 seconds each time.

6. Fully submerge and articulate any moving parts (like the blender and rotator) in enzymatic detergent for 20 seconds each.
7. Rinse twice in sterile water, agitating for at least 10 seconds each time. Pay extra attention to any lumens or ridges.

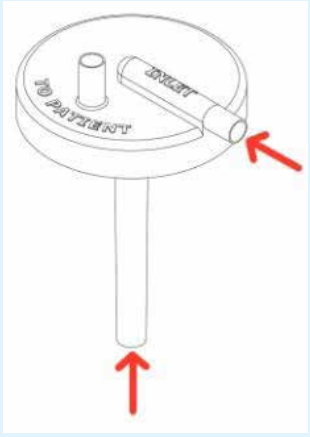


Pay extra attention to the threads on the orifice of the blender and the internal threads on the locknut as highlighted

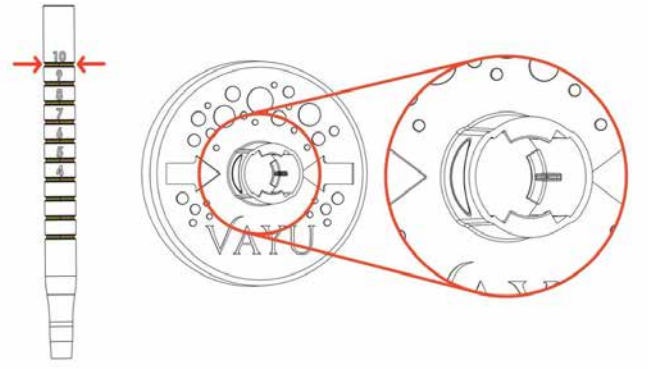


Pay extra attention to the blender nozzle and orifice.

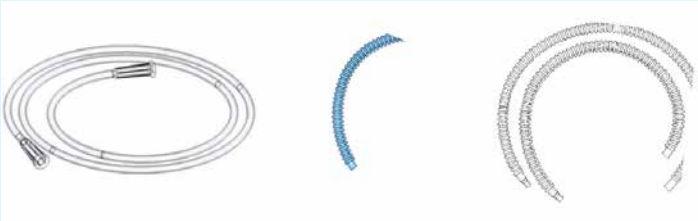
Pay extra attention to the O-ring groove



Pay extra attention to the lumens on the humidifier lid



Pay extra attention to the ridges on the wand and also the collar on the lid



Pay extra attention to the inner surfaces of all tubing

Drying After Cleaning	All components must be thoroughly dried before disinfection to ensure effective disinfection. Components may be dried using gauze or left to air dry out of direct sunlight. Flush lumens with air to ensure proper drying.
High Level Chemical Disinfection	Required Equipment: 400 – 675 ppm active chlorine solution 1. Submerge all components completely in 400 – 675 ppm active chlorine solution for 10 minutes at 25°C. 2. Rinse thoroughly according to manufacturer's rinsing instructions, paying extra attention to lumens and ridges such as the blender nozzle, blender orifice, blender threads, filter housing grooves, humidifier lid, pressure generator wand, and tubing.

Drying after High Level Disinfection	Required Equipment: Sterile gauze 70–90% medical-grade ethyl or isopropyl alcohol Medical grade air 1. Fully submerge and articulate any moving parts (like the blender and rotator) in 70-90% medical grade isopropyl alcohol for 20 seconds each. 2. Flush all lumens with 100mL of 70-90% medical grade isopropyl alcohol each. 3. Flush all lumens with medical grade air for 20 seconds to ensure proper drying. 4. Wipe down all surfaces with sterile gauze. **WARNING:** Failure to fully dry components before storage could result in microbial growth on the components.
Component Reassembly	**Blender:** Set the $\%O_2$ to 100% and tighten the locknut in place. **Filter housing:** Place the O-ring back in the O-ring groove and snap the two halves together. **Humidifier:** Screw the humidifier lid back onto the humidifier jar. **Pressure generator:** Screw the pressure generator lid back onto the pressure generator jar and insert the wand into the lid. **Warmer bracket and blender clip:** Reattach the blender clip to the warmer bracket.

APPENDIX VI:

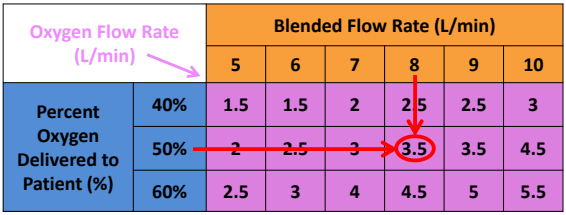
SETTING THE FLOWS FOR A SPECIFIC PERCENT OXYGEN DELIVERED TO PATIENT

1. Find the column with the chosen blended flow rate to deliver to the patient, known as the **Blended flow rate (L/min).**
2. Find the row with the chosen **percent Oxygen Delivered to patient (%).**
3. The table value where the chosen column and row meet is your **Oxygen Flow Rate (L/min).**

An **Example setting** is shown in the table to the right:

- A patient requires a **Blended Flow Rate of 8 L/min** and an **Oxygen Concentration of 50%.** Therefore, an **Oxygen Flow Rate of 3.5 L/min** should be delivered to the patient

Oxygen Flow Rate (L/min) →		Blended Flow Rate (L/min)					
		5	6	7	8	9	10
Percent Oxygen Delivered to Patient (%)	40%	1.5	1.5	2	2.5	2.5	3
	50%	2	2.5	3	3.5	3.5	4.5
	60%	2.5	3	4	4.5	5	5.5



[HOSPITAL NAME]

COMPREHENSIVE NEWBORN MONITORING CHART

Version 2.8

Name	IP NO	Sex M □ F □ Indeterminate □	D.O.A	D.O.B
Date today	Diagnosis			
Birth Wt gm	*Interventions: CPAP □ Oxygen □ Phototherapy □ Blood tranfusion □ Exchange transfusion □ KMC □*			

Daily Clinician Feed and Fluid prescription

Day of Life	Current Wt = gm
Total feed + fluid =_____ mls/kg/day = _____mls	
Feed: BF ☐ EBM ☐ Term Formula ☐ Pre-Term Formula ☐	
Route: Cup☐ NGT☐ OGT☐	
Volume & Frequency = _____mls 3hrly ☐ 2hrly ☐	
24hr Feed Volume = _____mls	

IV Fluid & Additives	Vol (ml)	Duration

Other prescribing instructions

Clinician's name Time:

Daily IV Fluid Nursing plan

Start time:

Hourly rate= _____ mls (____ drops/min)

Planned vol = _____ mls in_____ hrs

	Monitoring Freq___hrs | Time													
Vitals	Temp (^{0}C)													
	Pulse (b/min)													
	Resp Rate (b/min)													
	Oxy Sat (%) or Cy^0 Cy$^+$													
Assessment	Resp Distress 0,+,+++													
	CPAP Pressure (cm H_2O)													
	FiO_2 (%)													
	Jaundice 0,+,+++													
	Apnoea Y/N													
	Blood Sugar (mmol/l)													
	Completed by (name)													
Feed	Breastfeeding sufficient Y/N													
	EBM vol given (ml)													
	Formula vol given (ml)													
Fluid	IV volume given (ml)													
	IV Line working Y/N													
Output	Vomit Y/N													
	Urine Y/N													
	Stool Y/N													
	Completed by (name)													

All these are mandatory observations for category A babies i.e those on bCPAP

Morning shift notes — Completed by (name)
Category: A□ B□ C□
For this shift: Total feed_____ mls
Total fluid _____ mls
Total feed/fluid deficit_____ mls

Afternoon shift notes — Completed by (name)
Category: A□ B□ C□
For this shift: Total feed_____ mls
Total fluid _____ mls
Total feed/fluid deficit_____ mls

Night shift notes — Completed by(name)
Category: A□ B□ C□
For this shift: Total feed_____ mls | Total fluid _____ mls
Shift deficit_____ mls
Total feed+fluid input in 24hrs_____ mls
24hr deficit_____ mls

Jaundice 0 none, +mild(face),+++severe(feet)

Tick the category of baby after assessment

Alerts : circle readings outside normal range with red pen and action

APPENDIX VIII:

LIST OF SUPPLIES AND EQUIPMENTS REQUIRED FOR MANAGEMENT OF APNOEA OF PREMATURITY

- Complete bCPAP machine
- Pulse oximeters with neonatal probes
- Caffeine citrate .
- A bag-valve-mask device(200ml-300ml size)
- Paediatric flowmeters,
- Nasal prongs, and Masks
- Oxygen source
- Power source
- sunction machine
- Suction catheter size 5, 6, 8
- Bacterial or viral filter and Filter disk
- Various sizes of syringes (2cc, 5cc, 10cc, 20cc and 50cc) and needles.
- Syringes compatible with the syringe pumps and perfuser tubing
- IV fluid solusets
- IV fluids (5%Dextrose, 10%Dextrose, Ringer's lactate and Normal saline)
- Perfuser lines
- IV Catheters
- Nasogastric tubes
- Measuring cups
- Feeding cups
- Expressing bowl
- Neonatal scales with 10g intervals
- Oxygen delivery sets
- Penguin suckers
- Comprehensive Newborn monitoring chart
- New Ballard score chart
- Weighing scale
- Baby towel
- Hat/ elastic headband
- Suction machine
- Clear adhesive tape
- Blue litmus paper
- Stethoscope
- Gloves
- Hand sanitizer
- Sink/bucket
- Soap and water
- Functional laboratory able to do FHG, Electrolyte, acute phase reactants and blood culture
- heater
- A low reading thermometer
- A wall thermometer
- A low reading glucometer
- Appropriate size name tags

APPENDIX IX:

THE SUSPECTED ADVERSE DRUG REACTION NOTIFICATION FORMS

(FORM001/MEP/PMS/SOP/001)

MINISTRY OF HEALTH
PHARMACY AND POISONS BOARD
P.O. Box 27663-00506 NAIROBI
Tel: (020)-3562107 Ext 114, 0720 608811, 0733 884411 Fax: (020) 2713401/2713409
Email: pv@pharmacyboardkenya.org

IN CONFIDENCE

SUSPECTED ADVERSE DRUG REACTION REPORTING FORM

REPORT TITLE: .....

The report is on:
☐Suspected adverse drug reaction ☐Therapeutic ineffectiveness

Report Type:
☐Initial Report ☐Follow Up Report

Product category (Tick appropriate box)
☐Medicinal product ☐Blood and blood products. ☐Herbal product. ☐Cosmeceuticals. ☐Others.....

Institution details

Name of Institution	Contact/Tel No.	Facility Code:	County:

1. Patient Information
Patient name/initials: ..... IP/OP. No: .....
D.O.B/Age: ..... Patient address: ..... WARD/CLINIC:.....
(NAME/NUMBER)
Gender: ☐ Male ☐ Female

Any known allergy ☐No ☐Yes (specify).....
Pregnancy status
☐ Not Applicable ☐ Not pregnant
☐ 1st Trimester ☐ 2nd Trimester ☐ 3rd Trimester
Weight: ..... kg Height: .....cm

2. Suspected Adverse Reaction
Date of onset of reaction: .....
Brief description of reaction:.....

3. Medical History. (Other relevant history including pre-existing medical conditions e.g. allergies, smoking, alcohol use, hepatic/ renal dysfunction etc)
.....
.....

4. List all medicines being currently used by the patient including OTC, and herbal products (*** Tick the suspected medicine)

Tick (√) Suspected drug	INN/Generic Name	Brand Name	Batch/ Lot No.	Manufacturer	Dose	Route	Frequency	Treatment Period		Indication
								Start date	Stop Date	

5. Past medication history (List all medicines used in the last 3 months including OTC, herbals, if pregnant indicate medicines used in the 2nd trimester)

INN/Generic Name	Brand Name	Batch/Lot No.	Manufacturer	Dose	Route	Frequency	Treatment Period		Indication
							Start date	Stop date	

6. Dechallenge/Rechallenge
Did the reaction resolve after the drug was stopped or when the dose was reduced?
☐ Yes. ☐No ☐Unknown. ☐N/A
Did the reaction reappear after the drug was reintroduced?
☐ Yes. ☐ No. ☐Unknown ☐ N/A

7. Any lab investigations and results.....
.....

8. Grading of the reaction /event
I. Severity of reaction : ☐ Mild ☐ Moderate ☐ Severe ☐ Fatal ☐ Unknown
II. Is the reaction serious? ☐Yes ☐No
III. Criteria/reason for seriousness : ☐ Hospitalization/Prolonged Hospitalization ☐ Disability. ☐ Congenital anomality ☐ Life threatening ☐ Death
IV. Action taken : ☐ Drug withdrawn. ☐ Dose reduced. ☐ Dose increased. ☐ Dose not changed ☐ Not applicable. ☐ Unknown
V. Outcome : ☐ Recovered. ☐ Recovered with sequelae. ☐ Recovering ☐ Not recovered ☐ Death. ☐ Unknown

9. Any other comment .....
.....

10. Reporter Details

Name of Initial reporter:	Cadre/designation:	Mobile no: Email:	Date of report:
Name of Person Submitting to PPB if different from reporter:	Cadre/designation:	Mobile no: Email:	Date of Submission:

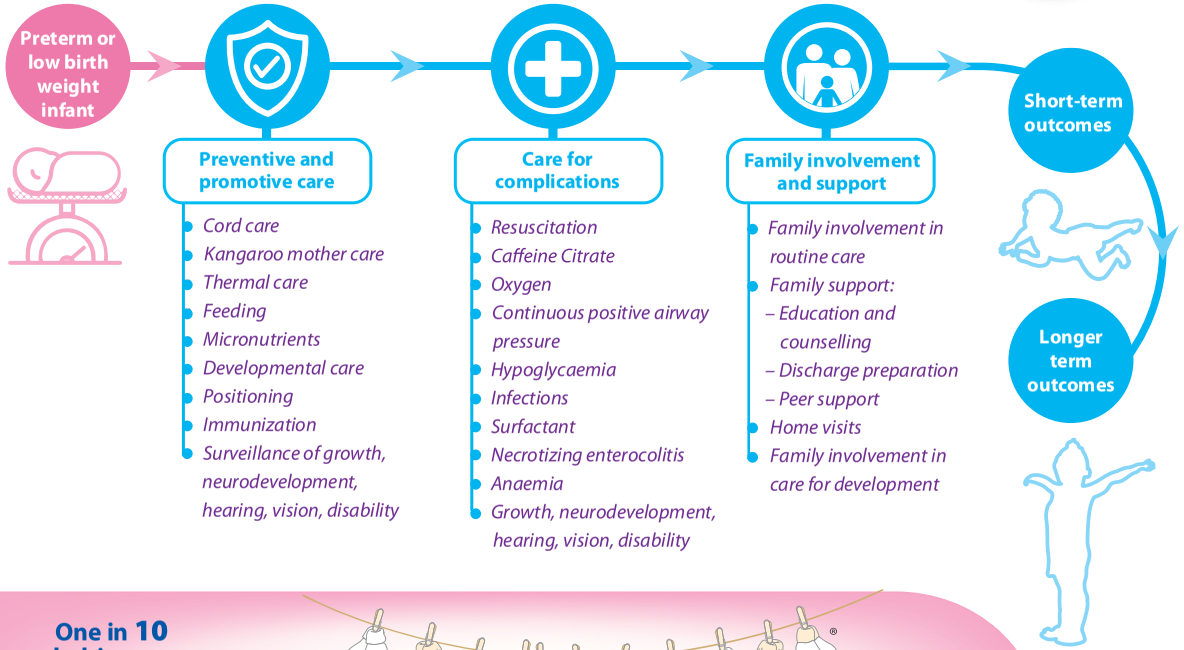
You need not be certain..... Just be suspicious!

Your support towards the National Pharmacovigilance system is appreciated

Submission of a report does not constitute an admission that medical personnel or manufacturer or the product caused or contributed to the event.
Patient's identity is held in strict confidence and program staff is not is not expected to and will not disclose reporter's identity in response to any public request.
Information supplied by you will contribute to the improvement of drug safety and therapy in Kenya. Once completed please send to:
The Pharmacy and Poisons Board on the above address

FOR OFFICIAL (PPB) USE ONLY
ADR Report No: ...../...../..... Date Received ...../...../.....
Vigiflow Entry Number..... Date Committed ...../...../.....

Scope of WHO recommendations for care of the preterm or low-birth weight infant



One in **10** babies are born **Preterm**

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REPUBLIC OF KENYA

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