TRAINING MODULE ON NEWBORN AND PAEDIATRIC QUALITY OF CARE STANDARDS & USE OF OXYGEN THERAPY FOR MANAGEMENT OF HYPOXEMIA

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Nurse wearing a PPE cleaning a baby's nose inside the NICU at BSMMU, 09 May 2020

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National Newborn Health Programme and IMCI Section
Directorate General of Health Services

Ministry of Health and Family welfare

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Acronyms

AHA	American Heart Association
ARI	Acute Respiratory Tract Infections
BP	Blood Pressure
CFT	Capillary Filling Time
COVID 19	Corona virus Disease 2019
CPAP	Continuous positive airway pressure
HBB	Helping Babies Breathe
ICU	Intensive Care Unit
IMCI	Integrated Management of Childhood Illness
IPC	Infection Prevention Committee
LED	Light Emitting Diodes
MDG 4	Millennium Development Goal 4
PEEP	Positive End Expiratory Pressure
PPHN	Persistent Pulmonary Hypertension of Newborn
PPE	Personal Protective Equipment
RDS	Respiratory Distress Syndrome
ROP	Retinopathy of Prematurity
SCANU	Special Care Newborn Unit
SDG	Sustainable Development Goal
TTNB	Transient Tachypnea of newborn
VLBW	Very Low Birth Weight
WHO	World Health Organization

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SESSION-**1**

Introduction

Learning objectives:

At the end of the session participants will be able to enumerate:

- Global and national burden of under-five deaths
- Importance of quality care for children
- Importance of oxygen therapy in children

Background:

Infant and child mortality rates are basic indicators of a country's socio-economic situation and quality of life. The World has made remarkable progress in child survival in the past three decades towards achieving Millennium Development Goals mainly by increasing interventions for maternal and child health. But many under five children are still dying every day which is a major public health concern and needs urgent attention.

Global burden:

An estimated 6.6 million children and young adolescents died in 2016 (5.6 million children under 5 years and 1 million children aged 5-14 years, mostly from preventable causes. (UNICEF, WHO, World Bank: Child mortality report 2017). Neonatal death constitutes 47% of all under five deaths worldwide with about one third dying on the day of birth and close to three quarters dying within the first week of life (WHO 2020) which is worrisome.

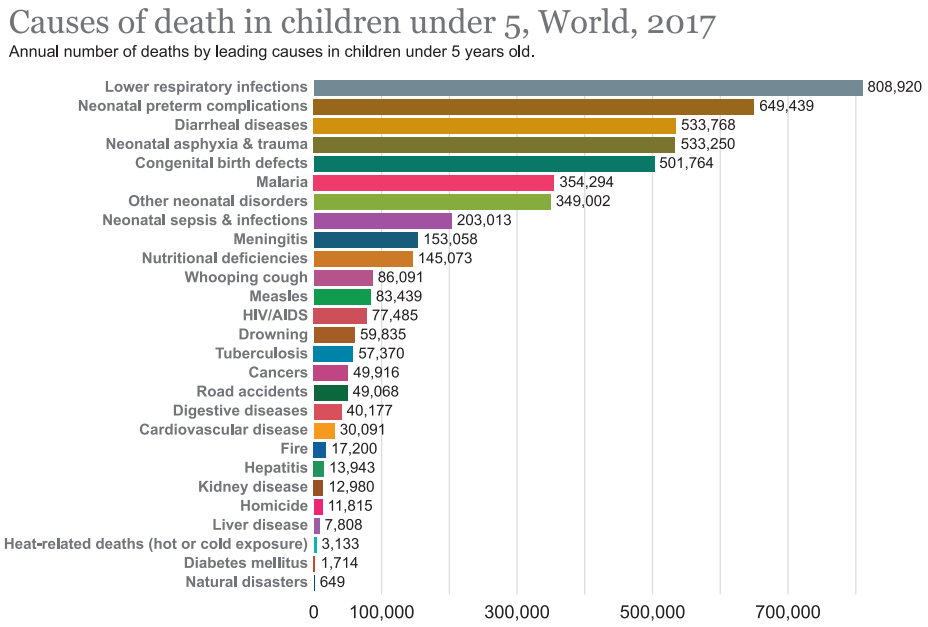
But it is noteworthy that, the under-five mortality rate has declined by 59 per cent, from 93 deaths per 1,000 live births in 1990 to 38 in 2019 (UNICEF 2020).

National Burden:

Bangladesh has experienced a significant reduction of child mortality over the past decades which helped achieve the Millennium Development Goal 4 (MDG 4) target. But the mortality among under-5 aged children is still relatively high that is 45 deaths per 1000 live births and neonatal mortality accounts for 67% of all under-5 deaths (BDHS 2017-18).

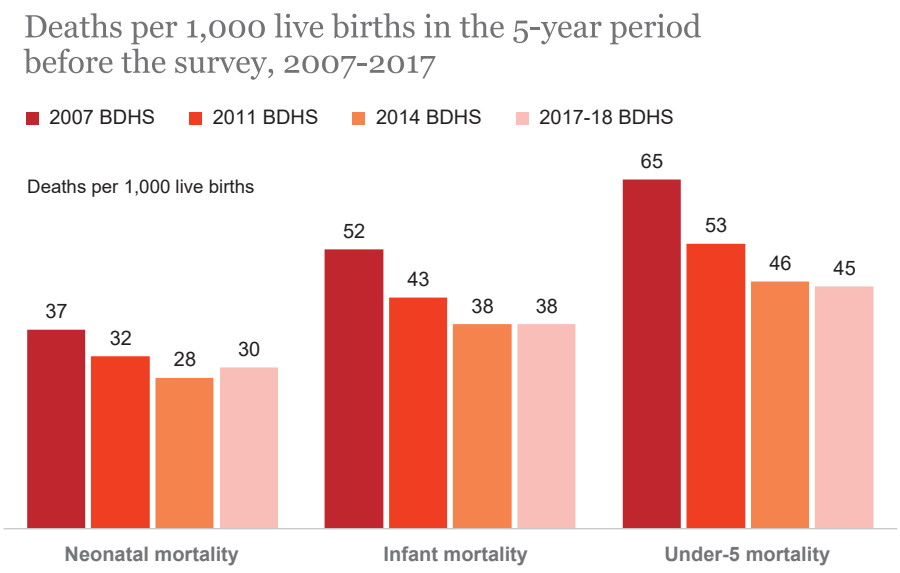
Causes of under- five death:

Among several causes of under-five mortality, lower respiratory tract infections (pneumonia) and neonatal complications are predominant.



Source: IHME, Global Burden of Diseases (GBD) 2017

Trends in childhood mortality rate in Bangladesh:



Source: Bangladesh Demographic & Health Survey 2017-18

Data confirms that over the last 2 decades, there was a steady downward trend in childhood mortality. However between 2014 BDHS and the 2017-18 BDHS, the decline appeared to flatten.

Importance of quality care for children:

- Quality of care is ''the extent to which health care services provided to individuals and patient populations improve desired health outcomes.
- Poor quality service and care reduce the effectiveness of interventions and increase the risk for nosocomial infections, life-long disability and death from avoidable complications and preventable causes.
- Therefore, achieving the ambitious Sustainable Developmental Goal 3 will require universal health coverage with high quality affordable services for women and children, as stated in the Global Strategy for women's, and children's health (2016-2030).

Importance of oxygen therapy for children:

Hypoxemia or insufficient oxygen in blood is a common and potentially lethal complication of pneumonia and other ARI (Acute Respiratory Tract Infections) like bronchial asthma, bronchiolitis; in under five children. Globally, there are over 1,400 cases of pneumonia per 100,000 children, or 1 case per 71 children every year, with the greatest incidence occurring in South Asia (2,500 cases per 100,000 children) and West and Central Africa (1,620 cases per 100,000 children).

(Pneumonia in children. UNICEF 2020)

Neonatal conditions such as perinatal asphyxia, neonatal sepsis and prematurity related complications can also lead to hypoxemia and subsequently deaths especially in developing countries (WHO 2020).

This hypoxemia can be simply managed by initiation of oxygen therapy which is an easy measure and can be applied in all health facilities. Thus it can reduce hypoxemia related complications as well as mortality.

Key Message

- Under – five mortality is a major public health problem
- Most of the causes of under -5 mortality are preventable and treatable
- Children require evidence based standard care to ensure their right of getting quality service
- Oxygen therapy is essential to reduce hypoxemia related complications and death among children.

SECTION-**ONE**

SESSION-**2**

Newborn and Paediatric Standards

Learning objectives:

At the end of the session participants will be able to define

- Different newborn and Paediatric standards for quality of care

Newborn & Paediatric standards:

Health of children is of utmost importance for any nation. Their physical, psychosocial, developmental, communication and cultural needs are different from those of adults. For ensuring their particular needs and for minimizing risk during health service delivery, World Health Organization (WHO) has developed some standards.

Aims:

These standards are focused on evidence based clinical care, availability of child and adolescent and family friendly health facilities and services, availability of trained competent staff and availability of appropriate equipment. Thus it will improve the quality of care in the health system for managing children. It will also facilitate to achieve optimal outcomes for children.

Standards:

There are total eight standards highlighting the points for quality care

Standard-1:	Every child receives evidence based care and management of illness according to WHO guideline
Standard-2:	The Health Information system ensures the collection, analysis and use of data to ensure early, appropriate action to improve the care of every child
Standard-3:	Every child with condition (s) that cannot be managed effectively with the available resources, receives appropriate, timely referral with seamless continuity of care
Standard-4:	Communication with children and their families is effective, with meaningful participation, and responds to their needs and preferences
Standard-5:	Every child's rights are respected, protected and fulfilled at all times during care, without discrimination
Standard-6:	All children and their families are provided with educational, emotional and psychosocial support that is sensitive to their needs and strengthens their capability
Standard-7:	For every child, competent, motivated, empathic staff are consistently available to provide routine care and management of common childhood illnesses
Standard-8:	The health facility has an appropriate, child friendly physical environment, with adequate water, sanitation, waste management, energy supplies, medicines, medical supplies and equipment for routine care and management of common childhood illnesses

Standard-1:

Every child receives evidence based care and management of illness according to WHO guideline:

Scope and identified priorities for evidence based practice for following conditions:

- Emergency care
- Management of common childhood conditions
- Serious bacterial infection in young infants
- Pneumonia and wheeze
- Diarrhoea
- Common causes of febrile illness in children
- Acute malnutrition
- Common chronic conditions in children (e.g. chronic respiratory diseases, tuberculosis, HIV infection, heart disases and diabetes)
- Maltreatment, including neglect and violence
- Surgical emergencies and injuries
- Infant and young child feeding
- Routine immunization

Standard-2:

The Health Information system ensures the collection, analysis and use of data to ensure early, appropriate action to improve the care of every child.

2.1. Every child will have a complete, accurate, standardized, up-to-date medical record, which is accessible throughout their care, on discharge and on follow-up.

2.2. Every health facility will have a functional mechanism for data collection, analysis and use as part of its activities for monitoring performance and quality improvement.

2.3. Every health facility will have a mechanism for collecting, analyzing and providing feedback on the services provided and the perception of children and their families of the care received.

Standard-3:

Every child with condition (s) that cannot be managed effectively with the available resources, receives appropriate, timely referral with seamless continuity of care.

3.1. Every child who requires referral receives appropriate decision to refer is made without delay.

3.2. Every child who requires referral receives seamless, coordinated care and referral according to a plan that ensures timeliness.

3.3. For every child referred or counter-referred within or among health facilities, there is appropriate information exchange and feedback to relevant health care staff.

Standard-4:

Communication with children and their families is effective, with meaningful participation, and responds to their needs and preferences

4.1. All children and their carers are given information about the child's illness and care effectively, so that they understand and cope with the condition and the necessary treatment.

4.2. All children and their carers experience coordinated care, with clear, accurate information exchange among relevant health and social care professionals and other staff.

4.3. All children and their carers are enabled to participate actively in the child's care, in decision- making, in exercising the right to informed consent and in making choices, in accordance with their evolving capacity.

4.4. All children and their carers receive appropriate counselling and health education, according to their capacity, about the current illness and promotion of the child's health and well-being.

Standard-5:

Every child's rights are respected, protected and fulfilled at all times during care, without discrimination

5.1 All children have the right to access health care and services, with no discrimination of any kind.

5.2. All children and their carers are made aware of and given information about children's rights

to health and health care.

5.3. All children and their carers are treated with respect and dignity, and their right to privacy and confidentiality is respected.

5.4. All children are protected from any violation of their human rights, physical or mental violence, injury, abuse, neglect or any other form of maltreatment.

5.5. All children have access to safe, adequate nutrition that is appropriate for both their age and their health condition during their care in a facility.

Standard-6:

All children and their families are provided with educational, emotional and psychosocial support that is sensitive to their needs and strengthens their capability

6.1. All children are allowed to be with their carers, and the role of carers is recognized and supported at all times during care, including rooming-in during the child's hospitalization.

6.2. All children and their families are given emotional support that is sensitive to their needs, with opportunities for play and learning that stimulate and strengthen their capability.

6.3. Every child is assessed routinely for pain or symptoms of distress and receives appropriate management according to WHO guidelines.

Standard-7:

For every child, competent, motivated, empathic staff are consistently available to provide routine care and management of common childhood illnesses

7.1. All children and their families have access at all times to sufficient health professionals and support staff for routine care and management of childhood illnesses.

7.2. Health professionals and support staff have the appropriate skills to fulfil the health, psychological, developmental, communication and cultural needs of children.

7.3. Every health facility has managerial leadership that collectively develops, implements and monitors appropriate policies and legal entitlements that foster an environment for continuous quality improvement.

Standard-8:

The health facility has an appropriate, child friendly physical environment, with adequate water, sanitation, waste management, energy supplies, medicines, medical supplies and equipment for routine care and management of common childhood illnesses

8.1. Children are cared for in a well-maintained, safe, secure physical environment with an adequate energy supply and which is appropriately designed, furnished and decorated to meet their needs, preferences and developmental age.

8.2. Child-friendly water, sanitation, hand hygiene and waste disposal facilities are easily accessible, functional, reliable, safe and sufficient to meet the needs of children, their carers and staff.

8.3. Child-friendly, age-appropriate equipment designed to meet children's needs in medical care, learning, recreation and play are available at all times.

8.4. Adequate stocks of child-friendly medicines and medical supplies are available for the routine care and management of acute and chronic childhood illnesses and conditions.

Knowledge test:

1. Physical and psychosocial needs of children are-

(a) More than adult

(b) Different than adult

(c) Same than adult

2. There are total ___ standards for ensuring quality care for newborns and children

3. Standard 5 include following criteria-

(a) Every child receive evidence based care and management

(b) Communication with children and their parents will be effective

(c) Every child's rights are respected, protected and fulfilled at all time during care.

SESSION-**3**

Indicators for Standard-1 quality care: Every child receives evidence based care and management of illness according to WHO guideline

Learning objectives:

At the end of the session participants will be able to

- Enlist the indicator for ensuring evidence based quality care for children

Scope and identified priorities for evidence based practice for following conditions:

- Emergency care
- Management of common childhood conditions
- Serious bacterial infection in young infants
- Pneumonia and wheeze
- Diarrhoea
- Common causes of febrile illness in children
- Acute malnutrition
- Common chronic conditions in children (e.g. chronic respiratory diseases, tuberculosis, hiv infection, heart disases and diabetes)
- Maltreatment, including neglect and violence
- Surgical emergencies and injuries
- Infant and young child feeding
- Routine immunization

Indicators for quality of care:

Quality statement 1.1

All children are triaged and promptly assessed for emergency and priority signs to determine whether they require resuscitation and receive appropriate care according to WHO guidelines

Indicators:

1. Health facilities will have up to date protocols and procedures for emergency triage, common emergencies (IMCI) and pre-referral treatment protocol
2. Resuscitation guideline by WHO for managing babies who are in shock
3. Availability of essential equipment and supplies for assessing and monitoring paediatric emergencies (weighing scale, pulse oximeter, blood pressure and glucose monitoring) and oxygen supply
4. Availability of 24 hours triage system for every sick baby
5. Has system of emergency assessment of sick baby within 15 minutes of arrival by trained staff when referred for emergency care
6. Designated emergency care area for children with appropriate paediatric equipment
7. Standardized algorithm, protocols, medicines, fluids in the designated emergency care area for children
8. Emergency care drills arranged for health facility professional staff at least one per 12 month
9. Up to date 24 hour staff duty roster with a functioning contact mechanism
10. Training and refresher courses of staff who work in emergency care/ triage area

Quality statement 1.2

All sick infants, especially small newborns, are thoroughly assessed for possible serious bacterial infection and receive appropriate care according to WHO guidelines.

Indicators:

1. Health facility has up to date clinical protocols for identifying and managing PSBI, jaundice in newborns and young infants consistent with WHO guideline
2. Health facility has supply of antibiotics for pre-referral treatment / treatment of sepsis/ meningitis those are adequate for case load
3. Training or refresher course facility for health staff who care for newborn and young infant
5. Referral facilities have available procedures/ machines for jaundice management
6. Referral facility will have separate corner/ room for newborn and young infant management
7. Optimal thermal care and KMC service in referral facility for preterm babies
8. Bilirubin estimation, phototherapy availability
9. Pulse oximeter for sepsis babies presenting with fast breathing
10. Glucose monitoring for babies with convulsion

Quality statement 1.3

All children with cough or difficult breathing are correctly assessed, classified and investigated and receive appropriate care and/or antibiotics for pneumonia, according to WHO guidelines.	
Input	**Process**
1. Health facility has up to date guideline for managing cases with cough or difficult breathing 2. Referral facility will have lab and diagnostic facility for children with pneumonia 3. Adequate supply of antibiotics for managing pneumonia cases 4. Health facility will have adequate number of inhaled bronchodilators 5. Health facility clinical staff are trained	1. Up to do date IMCI and paediatric care guideline 2. Availability of Pulse oximeter 3. CBC and Chest x-ray facility 4. Adequate antibiotic supply with proper dosage, formulation will be available 5. Ensure supply of inhaled broncodilator 6. Ensure oxygen supply for hypoxemic babies 7. Referral system for TB patients 8. Refresher training

Quality statement 1.4

All children with diarrhea are correctly assessed and classified and receive appropriate rehydration and care, including continued feeding, according to WHO guidelines.	
Indicators	
1. Health facility will have written up to date guideline for diarrhea, dysentery, dehydration management based on WHO guideline 2. Rehydration algorithm will be present at outpatient areas for health staff 3. Adequate supply of medications for diarrhea management (i) Antibiotic supply for dysentery (ii) ORS, Zinc, IV fluid supplementation	4. Monitoring chart for diarrhoea baby's intake, feeding 5. Health facility will have adequate space for ORS preparation, safe and clean water 6. Pre-referral treatment as per standards

Quality statement 1.5

All children with fever are correctly assessed, classified and investigated and receive appropriate care according to WHO guidelines	
Input	**Process**
1. Health facility has evidence based written protocol for identifying and managing children with fever according to WHO 2. Basic lab and diagnostic facility for evaluation of patient with fever 3. Available antibiotics and antimalarial agents 4. Training and refresher courses for health care staff 5. Proper monitoring	1. WHO guidelines for managing fever and malaria 2. Available blood glucose test, malaria smear/ rapid test, full blood count, blood and urine culture, urine analysis and otoscopes 3. There will be available first and 2nd line antibiotics for bacterial infection and for malaria 4. Training arrangements 5. Temperature chart

Quality statement 1.6

All infants and young children are assessed for growth, breastfeeding and nutrition, and their carers receive appropriate support and counselling, according to WHO guidelines	
Indicators	
1. All health facility will have policy for exclusive breast feeding according to WHO 2. Health facilities will maintain a baby friendly status for supporting breast feeding 3. Health facility will fully comply with International code of marketing of breast milk substitute and has system to monitor compliance	4. Adequate supplies and materials to support breast feeding and alternate feeding (Feeding cups, spoons, nasogastric tube, IV fluids, Feeding chart) 5. Growth chart for assessing growth and delayed development 6.Training and refresher courses for health staff

Quality Statement 1.7

All children at risk for acute malnutrition and anaemia are correctly assessed and classified and receive appropriate care according to WHO guidelines.

Indicators

1. Health facility has written up to date guidelines for assessing and managing children with malnutrition and anaemia according to WHO guideline

2. Adequate functioning equipment will be available for assessing nutritional status

(weighing scale, length and height board, MUAC tape)

3. Nutritional support and feeding assistance

4. Managing capability of child with acute severe malnutrition (Resomal, F -75, F-100, ready to use therapeutic food, antibiotics)

5 Lab and diagnostic facilities (blood glucose, FBC, blood and urine culture, urine analysis, chest X-ray, s. electrolytes)

6. Seperate room for malnourished babies for keeping warm and giving developmental stimulation

7. Vital chart, anthropometry chart, feeding chart

8. Counseling to parents

9. Training of staff

Other quality statements:

	Quality Statement	Indicators
1.8	All children at risk for TB and/or HIV infection are correctly assessed and investigated and receive appropriate management according to WHO guidelines.	Guideline for TB infection, facility for screening of children with TB symptoms, availability of investigations like Xpert/ RIF, anti TB drug available in adequate amount, antiretroviral therapy for mothers and children when required
1.9	All children are assessed and checked for immunization status and receive appropriate vaccinations according to the guidelines of the WHO expanded programe on immunization.	Guideline on immunization, functioning refrigerator with temperature regulation, supply of vaccines, immunization cards, tally sheets, ice packs, puncture resistant containers for sharp
1.10	All children with chronic conditions receive appropriate care, and they and their families are sufficiently informed about their condition(s) and are supported to optimize their health, development and quality of life.	Protocols for managing chronic conditions, adequate supply of medicines, indoor staff training, follow up plans, counseling of parents
1.11	All children are screened for evidence of maltreatment, including neglect and violence, and receive appropriate care.	Comprehensive written protocol for identifying, assessing and managing children with suspected maltreatment, staff have training to prevent maltreatment, to provide optimal care for children

	Quality Statement	Indicators
1.12	All children with surgical conditions are screened for surgical emergencies and injuries and receive appropriate surgical care.	Written protocol for emergency triage for assessment and management of trauma, injury, antibiotic availability for surgical cases, pain management within 30 minutes of arrival in emergency corner
1.13	All sick children, especially those who are most seriously ill, are adequately monitored, reassessed periodically and receive supportive care according to WHO guidelines.	Written protocol for monitoring and supportive care for various conditions, availability of patient monitoring chart, designated area for managing seriously sick children, in-house staff training
1.14	All children receive care with standard precautions to prevent health care-associated infections.	Written protocol for infection prevention, guidelines for clinical procedures, hand washing, sterilizing facilities and disinfectants for medical materials, proper waste disposal, staff training
1.15	All children are protected from unnecessary or harmful practices during their care.	Written guideline for unnecessary procedures/ intervention, not to use infant formula, staff training

Knowledge test:

1. For managing small sick newborns facility should have-

(a) Glucose monitoring facility

(b) KMC facility

(c) Both

2. Oxygen supply is essential for managing babies who present with

(a) Jaundice

(b) Cough or difficult breathing

(c) Feeding problems

3. For assessing growth of all infant and young children, health center should have-

(a) Blood pressure machine

(b) Weighing scale

(c) Weighing scale, MUAC tape, length and height board

SESSION-4

Indicators for Other Quality Standards

Learning objectives:

At the end of the session participants will be able to understand

- The different indicators for improving quality care for children

There are seven more standards which are set to ensure rights of children and providing high quality of care. These standards are as below:

Standard-2

The Health Information system ensures the collection, analysis and use of data to ensure early, appropriate action to improve the care of every child.

Quality statement	Indicators
2.1. Every child has a complete, accurate, standardized, up-to-date medical record, which is accessible throughout their care, on discharge and on follow-up.	Age appropriate child care registers, clinical records, observation charts, cards for recording and monitoring, storage system for medical records with safety, registration system, disease classification system (ICD)
2.2. Every health facility has a functional mechanism for data collection, analysis and use as part of its activities for monitoring performance and quality improvement	Standard operating procedures (SOP), data collection form, monthly meeting of staff with manager, paediatric death review
2.3. Every health facility has a mechanism for collecting, analysing and providing feedback on the services provided and the perception of children and their families of the care received.	Appropriate system for collecting information and responding to the perception of children and care givers

Standard 3

Every child with condition (s) that cannot be managed effectively with the available resources, receives appropriate, timely referral with seamless continuity of care.

Quality statement	Indicators
3.1. Every child who requires referral receives appropriate prereferral care, and the decision to refer is made without delay	Written protocol for pre-referral treatment of critically ill children, emergency triage, availability of medicines
3.2. Every child who requires referral receives seamless, coordinated care and referral according to a plan that ensures timeliness.	Referral network of facilities within same geographical area with agreed arrangement, functioning vehicle with fuel, receives immediate attention on arrival
3.3. For every child referred or counter-referred within or among health facilities, there is appropriate information exchange and feedback to relevant health care staff.	Standard referral form, methods of communication

Standard-4

Communication with children and their families is effective, with meaningful participation, and responds to their needs and preferences

Quality statement	Indicators
All children and their carers are given information about the child's illness and care effectively, so that they understand and cope with the condition and the necessary treatment.	Provision to ensure that all staff are identifiable with their name badges, introduce themselves to children and their parents, give relevant information
All children and their carers experience coordinated care, with clear, accurate information exchange among relevant health and social care professionals and other staff.	Standard form of handover of patient to caring team at shift change, functioning communication system
All children and their carers are enabled to participate actively in the child's care, in decision-making, in exercising the right to informed consent and in making choices, in accordance with their evolving capacity.	Guidelines and job aids for providing information to parents and children about purpose, importance, benefits, risk of treatment and investigation
All children and their carers receive appropriate counselling and health education, according to their capacity, about the current illness and promotion of the child's health and well-being.	Health record of each child, counseling services, immunization clinic, growth and development monitoring clinic

Standard-5

Every child's rights are respected, protected and fulfilled at all times during care, without discrimination

Quality statement	Indicators
5.1. All children have the right to access health care and services, with no discrimination of any kind. 5.2. All children and their carers are made aware of and given information about children's rights to health and health care. 5.3. All children and their carers are treated with respect and dignity, and their right to privacy and confidentiality is respected. 5.4.All children are protected from any violation of their human rights, physical or mental violence, injury, abuse, neglect or any other form of maltreatment. 5.5.All children have access to safe, adequate nutrition that is appropriate for both their age and their health condition during their care in a facility.	Policy that guarantee free or affordable health care for all children, up to date charter on children's rights, children's rights awareness raising program, child friendly ward: playrooms, waiting rooms.

Standard-6

All children and their families are provided with educational, emotional and psychosocial support that is sensitive to their needs and strengthens their capability

Quality statement	Indicators
6.1. All children are allowed to be with their carers, and the role of carers is recognized and supported at all times during care, including rooming-in during the child's hospitalization. 6.2. All children and their families are given emotional support that is sensitive to their needs, with opportunities for play and learning that stimulate and strengthen their capability. 6.3. Every child is assessed routinely for pain or symptoms of distress and receives appropriate management according to WHO guidelines.	Family centered policy on parents'and carers'rights to stay with their children at all times including time during medical procedures, rooming in policy, staffs are trained to play with children for sensory stimulation in young infants

Standard-7

For every child, competent, motivated, empathic staff are consistently available to provide routine care and management of common childhood illnesses

Quality statement	Indicators
7.1. All children and their families have access at all times to sufficient health professionals and support staff for routine care and management of childhood illnesses. 7.2. Health professionals and support staff have the appropriate skills to fulfil the health, psychological, developmental, communication and cultural needs of children. 7.3. Every health facility has managerial leadership that collectively develops, implements and monitors appropriate policies and legal entitlements that foster an environment for continuous quality improvement	Policy that defines staffing criteria and standards, standard procedures for recruitment, competent child health care provider available all the time, programme for continuous professional education, attitude and skill development of heath care professionals, ensuring patient safety and improving quality of care

Standard-8

The health facility has an appropriate, child friendly physical environment, with adequate water, sanitation, waste management, energy supplies, medicines, medical supplies and equipment for routine care and management of common childhood illnesses

Quality statement	Indicators
8.1. Children are cared for in a well-maintained, safe, secure physical environment with an adequate energy supply and which is appropriately designed, furnished and decorated to meet their needs, preferences and developmental age. 8.2. Child-friendly water, sanitation, hand hygiene and waste disposal facilities are easily accessible, functional, reliable, safe and sufficient to meet the needs of children, their carers and staff. 8.3. Child-friendly, age-appropriate equipment designed to meet children's needs in medical care, learning, recreation and play are available at all times. 8.4. Adequate stocks of child-friendly medicines and medical supplies are available for the routine care and management of acute and chronic childhood illnesses and conditions.	Child friendly hospital, seamless access to dedicated areas, will have dedicated areas for children in outpatient, inpatient areas, 24 hours rooming in with mothers, safe water and sanitation.

Knowledge test:

1. For timely referral of a child to a health center with desired facility there should be-

(a) Functioning vehicle

(b) Partially filled referral form

(c) None of these

2. Family centered patient care has been described in which standard?

(a) 2

(b) 6

(c) 7

3. Child friendly environment means-

(a) Safe, secure, physical environment for children

(b) Poor hand hygiene and sanitation

(c) Children are kept isolated from parents

SECTION-**TWO**

SESSION-**5**

Oxygen Therapy for Management of Hypoxemia in children

Learning Objectives:

At the end of the session, participants will be able to discuss:

- Hypoxemia and its impact on under -5 mortality
- Importance of knowing about oxygen therapy for hypoxemia management

Pneumonia is a major killer:

Pneumonia is one of the most common global childhood illnesses and one of the leading causes of mortality in under five children. It contributes to 21% of all deaths in this age category and it is estimated that of every 1000 children born alive, 12–20 will die from pneumonia before their fifth birthday.

Globally, there are over 1,400 cases of pneumonia per 100,000 children every year, with the greatest incidence occurring in South Asia (2,500 cases per 100,000 children) and West and Central Africa (UNICEF 2020).

1 case per 71 children every year due to pneumonia

Hypoxemia in children:

- Hypoxemia or insufficient oxygen in blood is a common and potentially lethal complication of pneumonia and other ARI (Acute Respiratory Tract Infections) in under five children (Duke T et al 2002).
- According to World Health Organization, 13.3% of the under- five pneumonic children are hypoxemic (Lancet infectious diseases 2009).
- Early detection of hypoxemia, and timely management can improve the outcome of children with these conditions.

Practical consideration for oxygen therapy:

Despite its significant importance in virtually all types of acute severe illness, hypoxemia is often not well recognized or managed in many resource limited countries including Bangladesh due to:

- Lack of adequate knowledge among health staff
- Lack of oxygen supply
- If oxygen delivery is available, supplies are often unreliable and interrupted
- Poor oxygen delivery system

- Poor maintenances
- Untrained staff
- Inadequate guideline

Oxygen is an important lifesaving drug that is required during hypoxemia management and it should be given in adequate flow for adequate duration.

Purpose of training on oxygen therapy:

- To increase awareness for improving the availability of oxygen therapy for children
- To increase identification and management of hypoxemia in severely ill children
- To increase the availability of oxygen therapy in all health facilities
- To improve monitoring of patients while on oxygen therapy
- To increase practical skills of health care providers for oxygen therapy
- To ensure use of infection prevention measures during oxygen therapy

This training will also guide the health care providers in rational use of oxygen for newborns and children.

Key Message

- Childhood pneumonia, perinatal asphyxia, sepsis are contributors of under 5 mortality
- These conditions cause hypoxemia which eventually can lead to death
- Early detection of hypoxemia and oxygen therapy is essential to improve the outcome

SESSION-**6**

Hypoxemia in children

Learning Objectives:

At the end of the session participants will be able to answer

- What is hypoxemia?
- Causes of hypoxemia in newborns and children
- Methods of detecting hypoxemia in newborns and children

Hypoxemia and Hypoxia:

- Hypoxemia means low level of oxygen in blood (low blood oxygen saturation or content).
- Hypoxia is inadequate oxygen in tissues for normal cell and organ function and hypoxia results from hypoxemia.

If hypoxemia is not recognized, eventually it will lead to organ dysfunction and death. So hypoxemia is a life threatening condition that requires early detection and management.

Common causes of Hypoxemia:

Neonates	Children
• Respiratory distress syndrome • Perinatal asphyxia • Transient Tachypnea of newborn • Pneumonia • Meconium aspiration syndrome and other aspirations • Congenital heart diseases • Anaemia • Any sick neonate having prematurity or sepsis or seizure are prone to have apnea. Apnea further leads to hypoxemia and slow the heart rate and reduces oxygen delivery to tissue. • Congenital malformations (e.g. congenital diaphragmatic hernia)	• Pneumonia • Bronchiolitis • Asthma • Heart failure or cardiac arrest • Meningitis • Sepsis • Anaemia

- Hypoxemia is more common in lower than upper respiratory tract infections.
- Pneumonia in children is most commonly due to bacteria (Streptococcus pneumoniae and Haemophilus influenzae) and viruses (respiratory syncytial virus, influenza virus). Other pathogens are common in certain high risk groups.

Methods of detecting hypoxemia in children:

It is essential for the health workers to know about these signs for early recognition and management of sick, hypoxemic patients.

(A) Clinical:

Neonates:

- Fast breathing
- Cyanosis
- Grunting
- Apnea in very low birth weight infants and premature babies

(As features are non-specific in neonates, screening by pulse oximetry is the best tool).

Children:

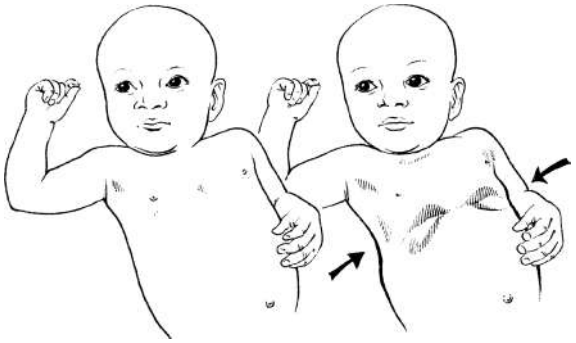
- Central cyanosis (Bluish discoloration of the tongue or gums)
- Fast breathing: It is best measured by observing movement of chest wall for 60 seconds.

  Age specific definition for fast breathing is listed below:

If the child is:	Child has fast breathing if breath count for 1 minute[12]
Less than 2 months	60 breaths per minute or more
2 months up to 11 months	50 breaths per minute or more
12 months up to 5 years	40 breaths per minute or more

(Ref: Integrated Management of Childhood Illness, 2016)

- Head nodding, grunting or nasal flaring
- Severe lower chest in-drawing[13]
- Inability to drink or feed (when due to respiratory distress)
- Coma, severe lethargy, prostration or prolonged convulsions (lasting for more than a few minutes) put a child to a significant risk for hypoxemia.



(B) By pulse oximetry:

- Pulse oximetry is the most accurate, non-invasive method used to measure the percentage of oxygenated haemoglobin in arterial blood (SpO2).
- It is useful in detection as well as monitoring of hypoxemia

(C) By Blood gas analysis:

- It is another very accurate method for detecting hypoxemia
- It is used to measure partial pressure of oxygen (PaO2) and carbon dioxide in blood, blood pH and the concentrations of the main electrolytes.

Pulse Oximeter

Blood Gas Analyser

Key Message

- Hypoxemia can be detected from clinical signs, with a pulse oximeter or by blood gas analysis
- Pulse oximetry should be used in hospitals for accurate detection of hypoxemia
- Where pulse oximetry is not available, clinical signs may provide useful criteria for deciding whether to provide oxygen.

Demonstration:

Video: Pulse oximeter

Group practice: Steps of using pulse oximeter **(please see Annexure I)**

Knowledge test:

Choose the correct answer:

1. **Hypoxemia is defined as :**
   (a) Insufficient oxygen in blood
   (b) Lack of oxygen in tissue
   (c) Excessive oxygen in blood
2. **A 3 months female baby have fast breathing if respiratory rate is**
   (a) 60 breaths per minute or more
   (b) 50 breaths per minute or more
   (c) 40 breaths per minute or more
3. **Pulse oximetry is better than blood gas analysis:**
   (a) Invasive
   (b) Non-invasive
   (c) Expensive

SESSION-**7**

Indication of oxygen therapy

Learning Objectives:

At the end of the session participants will be able to determine

- Target saturations in newborns and children
- When to start oxygen?

Neonates:

Oxygen therapy in newborn infants, particularly when they are born preterm, should reflect the fact that in the first hours of life they have lower normal oxygen saturation than older newborn.

Targeted Saturation (pre-ductal SpO2) after birth:

Age after birth	Targeted Pre-ductal saturation (SpO2)
1 minutes	60 - 65%
2 minutes	65 – 70%
3 minutes	70 – 75%
4 minutes	75 – 80%
5 minutes	80 – 85%
10 minutes	85 – 95%

(Ref: Singapore National Resuscitation Guideline 2016)

*Pre-ductal saturation refers to arterial oxygen saturation in vessels originating from the aorta before the ductus arteriosus. Pre ductal values are recorded at right hand.

Pulse oximetry should be used to monitor SpO2, which should be maintained between 90-95% to prevent eye damage (SUPPORT study 2010 and WHO 2016 Guideline for oxygen in children).

Oxygen therapy needs to be initiated in following condition.

Preterm Newborns	Term/Near Term Newborns	Irrespective of gestational age
• Respiratory Distress Syndrome (RDS) • Delayed adaptation	• Transient Tachypnea of newborn (TTNB) • Perinatal asphyxia • Meconium aspiration syndromes • Congenital malformations: Congenital diaphragmatic hernia • Persistent pulmonary hypertension of newborn (PPHN)	• Pneumonia • Sepsis • Apnea • Congenital heart disease (except duct dependent lesions) • Meningitis • Apnea

Children:

Any child with a SpO2 <90% should receive oxygen. *(WHO Oxygen therapy in children 2016)*

When a child presents with cough or difficult breathing, will be classified according to IMCI (Integrated Management of Childhood Illness 2016) and if oxygen saturation by using pulse oximeter is found < 90%, oxygen therapy is required especially in children aged 2 month up to 5 years.

Key Message

- Newborn infants in the first few hours of life may have lower normal oxygen saturation than older newborns. The normal level for neonates in the first hours of life is 88% or more.

Knowledge Test:

Choose the correct answer:

1. The normal level of oxygen saturation in neonates in first hours of life should be-

(a) 60%

(b) More than 88%

(c) 100%

2. Common cause of hypoxemia in preterm newborn

(a) Respiratory distress syndrome

(b) Pneumonia

(c) Both

3. A 5 year old child having oxygen saturation 87%

(a) Will need oxygen

(b) Will need to give bronchodilator

(c) Will not need hospitalization

SESSION-**8**

Use of oxygen in Neonatal Resuscitation

Learning Objectives:

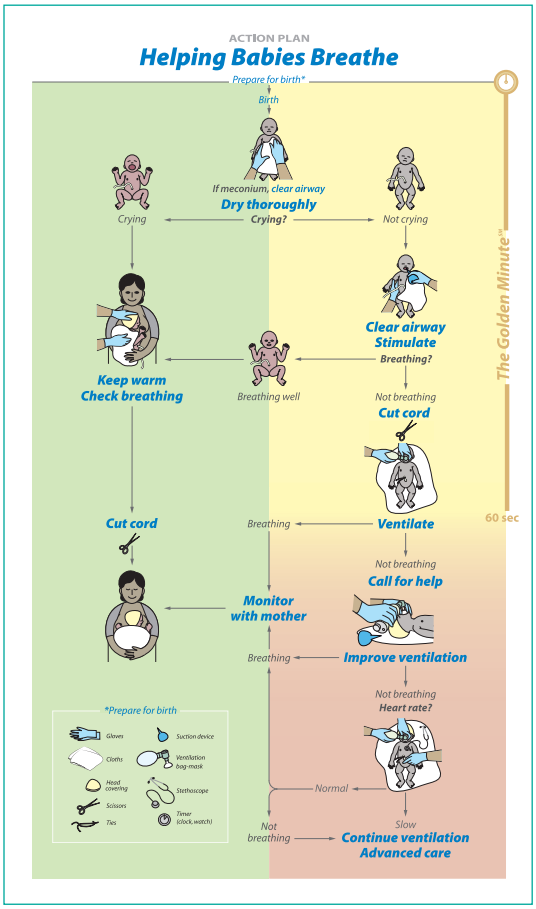
At the end of the session participants will be able to enumerate

- Basic steps of neonatal resuscitation
- Oxygen targets during resuscitation

Newborn Resuscitation:

Perinatal asphyxia is a common neonatal problem which can lead to hypoxemia. Approximately 85% of newborn infants born at term have been shown to initiate spontaneous respiration within 10-30 seconds of birth with additional 10% respond to drying and stimulation and other 3 % initiate breathing after positive pressure ventilation; 2% need intubation to support respiratory function and 0.1% require chest compression and /or adrenaline (Singapore National Resuscitation Guideline 2016).

The primary respiratory problem in most cases of perinatal asphyxia is lack of initiation of ventilation or lack of effective ventilation, so the most important intervention is to assist the neonate to take breaths more effectively other than to increase oxygen non-judiciously which may be harmful for the newborn.



Targeted oxygen saturation during resuscitation:

During resuscitation, whatever the gestational age or birth weight usually oxygen is not required. If with bag mask ventilation with room air (21% oxygen) and with proper maintaining of the HBB steps, oxygen saturation of infant does not improve to target level, then oxygen can be started with lower FiO2.

For Different gestation: oxygen targets during resuscitation:

AHA (American Heart Association) 2019
When newborn term or preterm (> 35 weeks' gestation) infants require positive pressure ventilation, bag-mask resuscitation with air containing 21% oxygen is effective **For preterm infants (< 35 weeks' gestation), bag-mask resuscitation with 30% oxygen should be used.** **In some trials, for resuscitation of preterm infants < 32 weeks' gestation, use of FiO2 30% has been suggested*

Recommended oxygen saturation target for preterm is between 90-95%.

Key Message

- In preterm infants born at < 32 weeks of gestation, SpO2 should be maintained between 88% and 95%, and not above 95% to avoid eye damage

Demonstration: (please see annexure-II)

1. Preparation of equipments for newborn resuscitation before delivery
2. Steps of checking Ambu bag
3. Review of HBB flow chart

Knowledge test:

Choose the correct answer:

1. If a baby has delayed cry after birth-

(a) Start oxygen

(b) Follow basic resuscitation steps

(c) Give inj. Adrenalin

2. During bag and mask ventilation, ideal FiO2 should be

(a) 85-90%

(b) 90-95%

(c) 95-100%

3. For resuscitation of a baby born at 32 weeks of gestation, initial FiO2 will be provided

(a) 50%

(b) 30%

(c) 100%

SESSION-**9**

Cough or difficult breathing in Children

Learning objectives:

At the end of the session participants will be able to -

- Classify cough or difficult breathing
- Identify indication for oxygen therapy in children

Sick Child (Age 2 months up to 5 years):

A child with *cough or difficult breathing* may have **PNEUMONIA** or any other severe infection of the respiratory system. **PNEUMONIA** is infection of lungs. Bacteria and virus both can cause **PNEUMONIA.** Children suffering from bacterial **PNEUMONIA** may die from hypoxia or sepsis.

When children develop **PNEUMONIA**, their lungs become stiff. One of the body's responses to stiff lungs and hypoxia or oxygen saturation (SpO2) <90%. Fast breathing and chest indrawing are another signs of hypoxemia.

How to assess a child with cough or difficult breathing?

A child with *cough or difficult breathing* is assessed for:

- How long the child has had *cough or difficult breathing*
- Count breathe in one minute
- Chest indrawing
- Stridor in a calm child
- Wheeze
- Measure arterial oxygen saturation with a pulse oximeter

If a child is classified with **SEVERE PNEUMONIA OR VERY SEVERE DISEASE** (pink row in table, he is very sick. He needs to be sent to hospital **URGENTLY** so that he receives oxygen, bronchodilator or antibiotic. Give him the first dose of intramuscular Gentamicin and oral Amoxicillin (Training module on Integrated Management of Childhood Illness 2016)

A classification in a *yellow* row means that the child needs an appropriate antibiotic, Salbutamol (if wheezing) or other treatment. The treatment includes teaching the mother how to give oral drugs or to treat local infections at home. The health care provider also advises her about caring for the child at home and when she should return.

A classification in a *green* row means the child does not need specific medical treatment such as antibiotics. The health provider teaches the mother how to care for her child at home. This is **COUGH OR COLD**. However, if wheezing (or disappeared after inhaler Salbutamol) is present, give an inhaled Salbutamol for 5 days (Module on Integrated Management of Childhood Illness, 2016).

IMCI Classification of a child with cough or difficult breathing:

SIGNS	CLASSIFY	IDENTIFY TREATMENT (Urgent pre-referral treatments are in bold print)
• Any general danger sign or • Stridor in calm child or • Oxygen saturation (SpO_2) <90%	*Pink:* SEVERE PNEUMONIA OR VERY SEVERE DISEASE	➢ **Give first dose of intramuscular Gentamicin and first dose of oral Amoxicillin** ➢ **Refer URGENTLY to hospital** ➢ **Give Diazepam if convulsing now** ➢ **Give inhaled Salbutamol if wheezing**
• Chest indrawing or • Fast breathing	*Yellow:* PNEUMONIA	➢ **Give oral Amoxicillin for 5 days** ➢ If wheezing (or disappeared after inhaler Salbutamol) give an inhaler Salbutamol for 5 days ➢ Soothe the throat and relieve the cough with a safe remedy ➢ If coughing for more than 14 days or recurrent wheeze, **refer** for possible TB or asthma assessment ➢ Advise mother when to return immediately ➢ Follow-up in 3 days
• No signs of pneumonia or very severe disease	*Green:* COUGH OR COLD	➢ If wheezing (or disappeared after inhaler Salbutamol) give an inhaled Salbutamol for 5 days ➢ Soothe the throat and relieve the cough with a safe remedy ➢ If coughing for more than 14 days or recurrent wheezing, **refer** for possible TB or asthma assessment ➢ Advise mother when to return immediately ➢ Follow-up in 5 days if not improving

Assessment and Classification of sick young infants (Age 0-2 months)

Check for signs and symptoms of Possible Serious Bacterial Infection or Very Severe Disease-Critical Illness (Vsd-Ci), Possible Serious Bacterial Infection or Very Severe Disease- Clinical Severe Infection (Vsd-Csi), Possible Serious Bacterial Infection or Very Severe Disease-Fast Breathing Pneumonia (0-6 Days), Fast Breathing Pneumonia (7-59 Days), Local Bacterial Infection And Infection Unlikely. Then classify the young infant based on the signs found:

- Check for JAUNDICE and classify the young infant based on the signs found
- Ask about diarrhoea. If the infant has diarrhoea, assess the related signs.
- Classify the young infant for dehydration
- Check for feeding problem or low weight. This may include assessing breastfeeding. Then classify feeding
- Check the young infant's immunization status
- Assess any other problems

Possible Serious Bacterial Infection or Very Severe Disease- Fast Breathing Pneumonia (0-6 days):

Young infants with this classification having fast breathing 60 breath/ minute or more for age 0-6 days. Treat the infants presenting with isolated fast breathing with Oral Amoxicillin for 7 days.

In case of **referral** compliance: The infant will be administered 1st dose of oral Amoxicillin and **referred URGENTLY** to hospital with **referral** slip containing referral note. Mother and family members must be taught and advised on frequent breast feeding on way to prevent low blood sugar. They must also be advised on keeping the baby warm.

Fast Breathing Pneumonia (7-59 days):

Young infants with this classification have fast breathing (60 breaths/ minute or more for age 7-59 days). Give the first dose of oral Amoxicillin dispersible tablet twice daily for 7 days and ask the family to continue this oral antibiotic treatment for 7 days twice daily. The mother and the family member must be taught and advised on frequent breastfeeding to prevent low blood sugar.

(Module on Integrated Management of Childhood Illness, 2016).

SIGNS	CLASSIFY AS	IDENTIFY TREATMENT (Urgent pre-referral treatments are in bold print)
Any one or more of the following signs: • Unconsciousness/drowsy • Convulsion or H/O Convulsion • Unable to feed • Persistent Vomiting • Bulging fontanels • Apnoea • Central Cyanosis • Major Bleeding • Weight < 1500 gm • Major congenital malformation • Surgical condition requiring hospitalization	*Pink:* **POSSIBLE SERIOUS BACTERIAL INFECTION or VERY SEVERE DISEASE- CRITICAL ILLNESS (VSD-CI)**	➢ **Give first dose of intramuscular Gentamicin and first dose of oral Amoxicillin** ➢ **Treat to prevent low blood sugar** ➢ **Advise mother how to keep the infant warm on the way to the hospital** ➢ **Refer URGENTLY to hospital**
Any one or more of the following signs • Severe chest indrawing • Fever (37.5°C* or above) or low body temperature (less than 35.5°C*) • Not feeding well • Movement only when stimulated/ no movement at all	*Pink:* **POSSIBLE SERIOUS BACTERIAL INFECTION or VERY SEVERE DISEASE- CLINICAL SEVERE INFECTION (VSD-CSI)**	➢ **Give first dose of intramuscular Gentamicin and first dose of oral Amoxicillin** ➢ **Treat to prevent low blood sugar** ➢ **Advise mother how to keep the infant warm on the way to the hospital** ➢ **Refer URGENTLY to hospital** ➢ **If referral is REFUSED or NOT FEASIBLE, continue intramuscular Gentamicin for 2 days and oral Amoxicillin for 7 days** ➢ **Follow up in 4 days**
• Fast breathing (60 breaths per minute or more) for age 0-6 days	*Pink:* **POSSIBLE SERIOUS BACTERIAL INFECTION or VERY SEVERE DISEASE- FAST BREATHING PNEUMONIA (0-6 DAYS)**	➢ **Give first dose of oral Amoxicillin** ➢ **Treat to prevent low blood sugar** ➢ **Advise mother how to keep the infant warm on the way to the hospital** ➢ **Refer URGENTLY to hospital** ➢ **If referral is REFUSED or NOT FEASIBLE, continue oral Amoxicillin for 7 days** ➢ **Follow up in 4 days**
• Fast breathing (60 breaths per minute or more) for age 7-59 days	*Yellow:* **FAST BREATHING PNEUMONIA (7-59 DAYS)**	➢ Give oral Amoxicillin for 7 days ➢ Treat to prevent low blood sugar ➢ Follow up in 3 days
• Umbilicus red or draining pus • Skin pustules	*Yellow:* **LOCAL BACTERIAL INFECTION**	➢ Give oral Amoxicillin for 5 days ➢ Teach mother to treat local skin infections at home ➢ Advise mother to give home care ➢ Follow up in 2 days
• None of the signs of very severe	*Green:* **INFECTION UNLIKELY**	➢ Advise mother to give home care for the young infant

Key Message

- It is strongly recommended that infant and older children with oxygen saturation <90% should receive oxygen therapy

Case study:

Eti is 6 months old baby weighing 5 kg. Her temperature is 39°C.

Her parents told the health provider, "Eti has had cough for 2 days and difficulty in breathing. She did not breast fed and did not take any drink when she was offered

The health provider checked for general danger signs. Eti is lethargic. She has chest in-drawing and respiratory rate is 56/min. Oxygen saturation is 86%.

(a)Now look at the classification table for cough or difficult breathing on the chart. Classify this child's illness.

(b) What will be the steps of management?

Knowledge test:

Choose the correct answer:

1. If a child presents with cough or difficult breathing, health care provider will look for:

(a) Fast breathing

(b) Severe chest in-drawing

(c) Both

2. A 1 year old child has been brought to emergency department. On examination, baby is having stridor and saturation is 85%. What is the classification according to IMCI?

(a) Cough or cold

(b) Severe pneumonia or very severe disease

(c) Pneumonia

3.When you will refer a child urgently for oxygen therapy if presents with cough or difficult breathing?

(a) Chest indrawing

(b) Stridor

(c) Oxygen saturation on pulse oximetry <90%

SESSION-**10**

Oxygen Delivery System

Learning Objectives:

At the end of the session participants will be able to describe

- Different components of oxygen delivery system

Oxygen delivery system:

A complete oxygen delivery system comprises of its source, distribution, regulation and conditioning, delivery and maintenance of the system. However, not all of these components are always necessary or appropriate in different context.

(WHO-UNICEF technical specifications and guidance for oxygen therapy devices 2019)

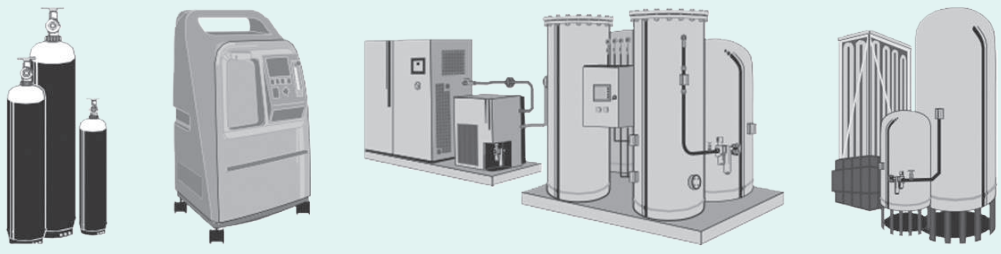
Sources of oxygen:

The sources of oxygen and its delivery method usually depend on the facility and the availability of resources. The different sources of oxygen are:

- Oxygen cylinder
- Oxygen concentrator
- Oxygen plant
- Bulk liquid oxygen

Different types of oxygen sources:

Oxygen Cylinders	Oxygen concentrators	Oxygen plant	Bulk liquid oxygen
-Oxygen produced in manufacturing plants by cooling air until it liquefies > distilling the liquid to separate pure oxygen> passed through a liquid oxygen pump into cylinders.	-It draws in air from the environment, (21% O2 78% N2 and 1% other gases)> extract the nitrogen to leave almost pure oxygen	-It is a large, onsite, central source of oxygen that is piped directly to terminal units within patient areas.	-Bulk liquid oxygen is generated off site and stored in a large tank and supplied throughout a health facility via a central pipeline system.

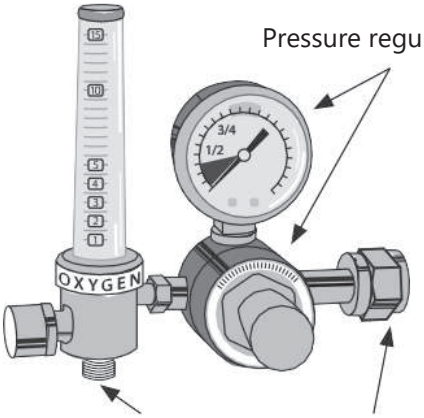


Distribution:

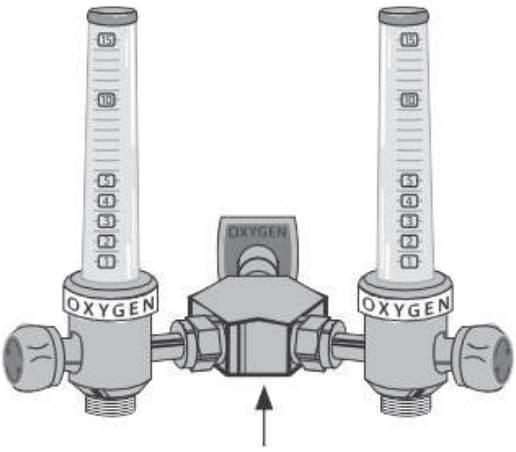
To supply the oxygen as clean, highly pure and under stable pressure it is distributed via central pipe system or within tube.

Regulation and conditioning:

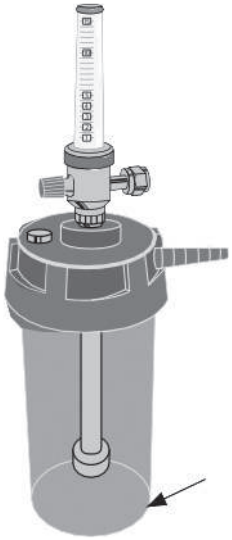
There are several devices which play different roles in regulation and conditioning of oxygen gas for the delivery of O2 therapy to patients such as Regulator, flow meter (Thorpe tube), flow splitter (flow meter stand), humidifier, blender, CPAP, ventilator.



Thorpe Tube flow meter with pressure regulator and outlet connector



Flow splitting device (dual flow meter from a single wall source for use in two patients)



Humidifier bottle

Different types of oxygen delivery devices:

Non-invasive	Head box, face mask
Semi-invasive	Nasal cannula or prongs, nasal catheter

Special consideration:

- Humidification is required if oxygen is delivered from a cylinder as it provides cold oxygen. Concentrator provides oxygen at room temperature, so humidification is not required.
- When oxygen is delivered at a standard flow rate (0.5–1 L/min for a neonate, 1–2 L/min for an infant, 1–4 L/min for an older child) through a nasal catheter or nasal prongs, humidification is not necessary.[8]

Key Message

- The commonest source of oxygen are cylinders and concentrators
- Nasal prongs are the preferred oxygen delivery method in most circumstances for an optimal balance between safety, efficacy and efficiency
- For neonates, infants and children, the use of head boxes, face-masks, incubators and tents to deliver oxygen is generally discouraged, as they are wasteful of oxygen and potentially harmful (hypercapnea)

Video Demonstration:

Video on concentrator and cylinder (also see annexure III-IV)

Video on nasal catheter and nasal prongs

Practical Demonstration:

In ward - at the end of the session

Knowledge test:

Choose the correct answer:

1. Which source can draw the oxygen directly from air and then concentrate it?

(a) Cylinder

(b) Concentrator

(c) Liquid oxygen

2. Which of the following is used for conditioning of oxygen

(a) Oxygen plant

(b) Nasal prongs

(c) Flow meter

3. Semi-invasive method of oxygen delivery is-

(a) Head box

(b) Nasal prongs

(c) Face mask

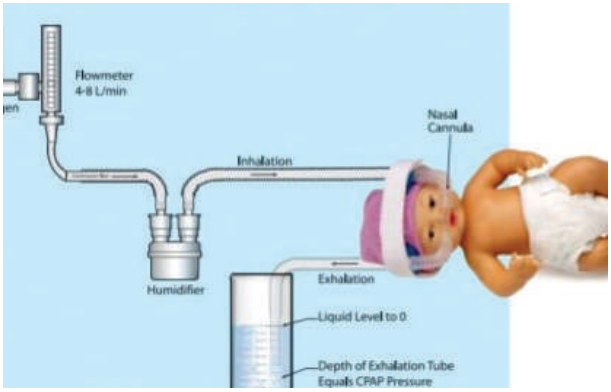
SESSION-**11**

CPAP in Children

Learning objectives:

At the end of the session participants will be able to tell:

- Definition of CPAP
- Beneficial role of CPAP
- Indication of CPAP
- Contraindication of CPAP
- Complications of CPAP



Continuous Positive Airway Pressure (CPAP):

Continuous positive airway pressure (CPAP) is a simple, inexpensive and gentle mode of respiratory support for infants and children.

CPAP is a form of non- invasive ventilation where a positive pressure is applied in the airway of a spontaneously breathing infant throughout the respiratory cycle and thus prevents collapse of alveoli and terminal airway during expiration.

Background:

In the early 1970s, Gregory et al. first described the clinical use of CPAP in preterm infants with respiratory distress syndrome (RDS). After that CPAP was widely used in many centers and till now it has proven its beneficial role regarding respiratory management of infants and children worldwide.

Beneficial role of CPAP:

- **Prevents alveolar atelectasis by improving and maintaining functional residual capacity (FRC)**
- **Corrects ventilation-perfusion abnormalities secondary to an improvement in FRC**
- **Reduces intrapulmonary shunting**
- **Decreases total airway resistance**
- **Regularizes breathing pattern**
- **Reduces work of breathing**
- **Improves oxygenation**
- **Reduces apnea**

CPAP requires a source of continuous airflow (often an air compressor) and usually requires an oxygen blender connected to an oxygen source.

Indication of CPAP:

Neonates:

Common indications:

1. Respiratory Distress Syndrome (RDS)
2. Apnea of prematurity (especially obstructive apnea)
3. Post extubation in preterm VLBW infant
4. Transient tachypnea of Newborn (TTNB)/ delayed adaptation

Other indications:

1. Pneumonia
2. Meconium aspiration/ other aspiration syndromes
3. Pulmonary hemorrhage
4. Laryngomalacia/ tracheomalacia/bronchomalacia

In neonates CPAP can be provided in following way:

Early CPAP:

- All preterm infants (<35 weeks') with any sign of respiratory distress (tachypnea/chest in-drawing/grunting) should be started immediately on CPAP.

  (Prophylactic CPAP is not recommended now-a-days)

Infant and Children:

It is indicated for infants and children with severe respiratory distress, hypoxaemia or apnoea despite receiving oxygen in conditions such as:

- Respiratory insufficiency associated with acute and chronic lung injury
- Pneumonia
- Acute severe asthma
- Bronchiolitis
- Congenital heart disease associated with increased work of breathing
- Post-extubation
- Obstructive airway disease
- Neuromuscular diseases

Contra-indication of CPAP:

- Conditions with imminent ventilatory support (severe cardio-respiratory compromise and poor respiratory drive)
- Certain congenital malformations of the airway (Choanal atresia / Cleft palate / Tracheo-esophageal fistula/Congenital diaphragmatic hernia
- Progressive respiratory failure with PCO2>60 mmHg and/or inability to maintain oxygenation (PO2<50 mmHg).

CPAP delivery system:

There are 3 components of a CPAP system: (a) gas source (b) pressure generator and (c) patient interface.

Gas source	To provide continuous supply of warm humidified and blended gases i.e. air and oxygen
Pressure generator	To create the positive pressure in the circuit. There are different types of CPAP pressure generators like bubble CPAP, ventilator CPAP and flow driver CPAP etc.
Patient interface/ delivery system	To connect the CPAP circuit to the infant's airway. There are various interface used like nasal prongs (single/double or binasal), nasopharyngeal prongs, nasal cannula, nasal masks etc.

Initiation and maintenance of CPAP:

Initiation of CPAP	Maintenance of CPAP (How to proceed?)
• Pressure(PEEP): Start at 5 cm H2O • FiO2: 0.3-0.4 • Flow: 5 L/min	• Pressure(PEEP):Increase in steps of 1-2 cm H2O to reach a maximum of 8 cm H2O • FIO2:Increase in steps of 0.05 (if oxygenation is still compromised) up to a maximum of 0.8 • Flow: Usually constant

Weaning from CPAP:

Infants clinical condition will guide the speed of weaning

- When baby is haemodynamically stable, with no signs of respiratory distress, adequate lung expansion in chest X-ray, attempts should be taken to wean from CPAP

- Reduce FiO2 in steps of 0.05 to 0.3, and then decrease pressure in steps of 1-2cm H2O until 3-4 cm H2O.

*Respiratory distress can be assessed by using Silverman-Anderson score which can be done clinically.

Feature	Score 0	Score 1	Score 2
Chest movement	Equal	Respiratory lag	Seesaw respiration
Intercostal retraction	None	Minimal	Marked
Xiphoid retraction	None	Minimal	Marked
Nasal flaring	None	Minimal	Marked
Expiratory grunting	None	Audible with stethoscope	Audible without stethoscope

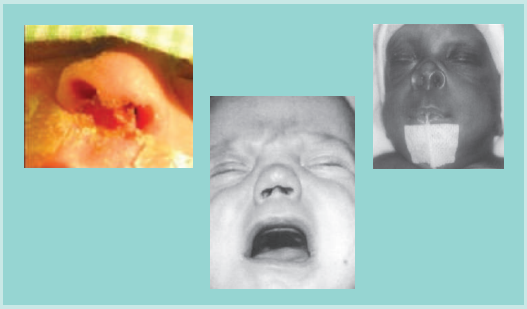
[Avery ME, Fletcher BD. The lung and its disorders in the newborn. Philadelphia, W.B. Saunders Company. 1974 (Courtesy of W.A. Silverman)]

Interpretation:

Score: 4-7 = Respiratory distress

Score: >7 = Impending respiratory failure

Complications of CPAP:

Patient related	Equipment related
(A) Local: **Nasal:** • Nasal septal damage due to in-appropriate size and softness of nasal prongs • Nasal irritation, damage to nasal septum, nasal bleeding, columellar necrosis (rarely)  **(B) Systemic:** • Air leak (pneumothorax) • Impaired cardiac output and decrease urine output • Gastric distension	• Obstruction of nasal prongs from mucus plugging or kinking of nasopharyngeal tube • Inactivation of airway pressure alarms • Insufficient or excessive gas flow may lead to increase work of breathing and over-distension of lungs respectively.

Key Message

- CPAP is simple and gentle respiratory support for infants and children
- Respiratory distress syndrome (RDS), pneumonia, apnea in preterm infants are common indications for use of CPAP

Demonstration:

Video: How to set a bubble CPAP

Group practice: **please see annexure V**

Bed side teaching at the end of the session

Knowledge test:

1. CPAP is beneficial as it-

(a) Reduces apnea

(b) Increase work of breathing

(c) Increases airway resistance

2. CPAP can be given in which condition:

(a) Choanal atresia

(b) Severe cardio-pulmonary compromise with poor respiratory drive

(c) Pneumonia not improving with oxygen through nasal interface

3. CPAP can cause-

(a) Nasal septal injury

(b) Gastric distension

(c) Both

SESSION-**12**

Monitoring & Care of Child while getting Oxygen & When to stop?

Learning Objectives:

At the end of the session participants will be able to enumerate

- Monitoring parameters of a child while on oxygen therapy
- Criteria for stopping oxygen support
- Oxygen toxicity

Clinical monitoring:

- Signs of respiratory distress: respiratory rate, chest indrawing
- Any slow or shallow breathing (signs of inadequate ventilation)
- Consciousness level (irritable or drowsy)
- Perfusion - CFT, BP, peripheral pulses, urine output
- Position of nasal prong or catheter (3 hourly check at least)
- Blockage of prongs/catheters with mucus secretion
- Connections are secure for interface
- Any injury at interface site
- Oxygen flow rate
- Abdominal distension especially who is in CPAP
- Settings: FiO2, PEEP and flow

(Chest X-ray to see adequate lung expansion in CPAP and lung condition for other diseases)

Pulse oximetry monitoring:

Sick patients require continuous monitoring with pulse oximetry and can be tested for weaning off oxygen when clinically stable.

If pulse oximeter is inadequate in number, then at least 4 hourly all patients on oxygen support should be monitored and tried for oxygen off.

Care of a child while getting Oxygen:

1. Handling	• Gentle handling. • Painful procedure and unnecessary stress should be avoided
2. Airway	
(i) Positioning	• Head raised about 30° with neck support can improve breathing. • Some hypoxic neonates and young infants may be more stable in the prone position, as long as their faces are not obstructed.
(ii) Suctioning	• Assessment of secretions in the nose and mouth. • Suctioning is recommended only when required. • When the secretions are thick, moisten the nares with normal saline or sterile water
3. Fluid and nutrition:	• Withhold oral feeds while the child has severe respiratory distress to avoid the risk of aspiration • Ensure good nutrition as soon as respiratory distress resolves
4. Interface	• Ensure prongs/ catheters are fit snuggly into the nares. • Watch for symmetry of nose, blanching of the skin and any skin break down. • Ensure distance between columella and nasal prongs
5. Cap	• In CPAP, the cap should cover the ears and fit snugly. • Watch for twisting of the nasal interface, blanch the tip of nose and assess for perfusion integrity
6. Oxygen delivery system	• To check whether flow rate is perfect or not in any delivery system. In CPAP, the set pressure (PEEP), FiO2, flow rate needs to look for. • Bubble chamber should be monitored for bubbling and the level of water.
7. Humidifier	• Set temperature of 37°C on the humidifier • Adequate water in the chamber • No condensation in the inspiratory limb and some condensation in the expiratory limb are proof of good and adequate humidification. • The humidification chamber should be set at invasive mode in automatic humidification.
8. Orogastric tube	Pass an orogastric tube and keep the proximal end of tube open. If the infant is being fed while on CPAP, close the tube for half an hour after giving feeds and keep it open for the next 90 minutes (if fed 2hourly)
9.Skin	Watch for color, perfusion, areas of pressure points and areas of skin excoriations

Criteria for stoppage of oxygen:

- **No signs of respiratory distress**
- **Baby is haemodynamically stable**
- **Adequate lung expansion in chest X-ray**

*If these conditions are met, then trial of weaning from oxygen should be given daily.

During trial for stopping oxygen:

- Take off the oxygen (unless he or she has severe respiratory distress)
- Monitor the SpO2
- If the SpO2 is > 90% 10–15 min after the child has been taken off oxygen, leave the oxygen off
- Check the SpO2 again in 1 h
- If the SpO2 is < 90%, resume oxygen
- Each day, record the SpO2 and pulse rate on the patient's monitoring chart, and record bedside to determine sufficient supply of oxygen

**Children should not be discharged until their SpO2 has been stable at ≥ 90% while breathing room air for at least 24 h, until all danger signs have resolved and appropriate home treatment can be organized.

Oxygen Toxicity:

Increased exposure to oxygen is detrimental to life. It has several harmful effect on body. Oxidative damage may occur in any cell of the body but mostly affected systems are as follows:

Central Nervous System: convulsion, unconsciousness

Respiratory System: Chronic Lung Disease (CLD)

Eyes: Retinopathy of Prematurity (ROP)

** In preterm infants, the retina is often not fully vascularised. Retinopathy of prematurity occurs when the development of the retinal vasculature is arrested and then proceeds abnormally. Associated with the growth of these new vessels is fibrous tissue (scar tissue) that may contract to cause retinal detachment.

Key Message

- Patient on oxygen support will require both clinical and pulse oximetry monitoring
- Based on patient's clinical condition, daily trial for weaning oxygen can be given

Knowledge test:

1. Site of interface checking is a part of _____ monitoring.

2. Patient who is in CPAP, other than clinical monitoring which following test can give information about lung expansion

(a) Blood gas analysis

(b) Chest X-ray

(c) Both

3. If during trial of oxygen stoppage, saturation maintains to more than 90% what you will do?

(a) Increase oxygen flow

(b) Stop oxygen

(c) Decrease oxygen flow

SESSION-**13**

Infection prevention and Cleaning of Equipment

Learning objectives:

At the end of the session participants will be able to tell

- Requirements for infection prevention in a health facility
- Infection prevention measures
- Cleaning method of respiratory equipments

Requirements for infection prevention in a health facility:

Besides maintaining aseptic precaution for handling of respiratory equipment, following criteria should be met in all health care facilities:

- There will be IPC committee and IPC guideline in the facility
- All staff will be aware of IPC guideline and instructions will be available at each point of care
- All health care providers will have knowledge on rational use of PPE (personal protective equipment)
- Facility will have designated hand washing areas with water and soap
- There will be adequate hand hygiene supplies (70% alcohol based solutions)
- For respiratory hygiene, masks, disposable tissue will be available for the staff and patients
- Facility will have guidelines and instructions for identifying and managing COVID 19 patients
- Facilities will have environmental cleaning and safe waste management protocol and practice

Infection Prevention measures:

The following infection prevention practices should be in place at all facilities where newborn and child care is provided.

Hand washing (HW)

Hand washing is the most practical procedure for preventing the spread of infection.

Fig 12: Steps of Routine Hand washing

Use of personal protective equipment

- Using personal protective equipment provides a physical barrier between micro-organisms and the wearer. It offers protection by helping to prevent microorganisms from:
  - contaminating hands, eyes, clothing, hair and shoes;
  - being transmitted to other baby and staff
- Discard the used personal protective equipment in appropriate disposal bags, and dispose of as per the policy of the hospital.
- Do not share personal protective equipment

Personal protective equipment includes:
☐ **gloves;** ☐ **protective eye wear (goggles);**
☐ **mask;**
☐ **apron;** ☐ **gown;**
☐ **boots/shoe covers; and**
☐ **cap/hair cover**

It is important to use personal protective equipment effectively, correctly, and at all times where contact with patient's blood, body fluids, excretions and secretions may occur. Also in triage, PPE should be used.

** In special situations like patients suspected for COVID infection, service providers should wear personal protective equipment which includes full sleeve gown, goggles, gloves, cap, mask, N95 (during aerosol generating procedures) and face shield.

Waste Disposal:

- Segregate clinical (infectious) waste from nonclinical waste in dedicated containers.
- Transport waste in a dedicated trolley (not used for any other purpose)
- Store waste in specified areas with restricted access.
- Mark the storage areas with a biohazard symbol.
- Dispose per protocol (land fill/ deep burial/ transfer to waste disposal transport etc.)

The following are different color drums with different color polythene for different type of waste, to be disposed off in a different way.

Colour of Waste bin	Type of waste
Black drums/ bags (general waste)	Leftover food, fruits, feeds, vegetables, waste paper, packing material, empty box, bags etc. This waste is disposed off by routine municipal council committee machinery.
Yellow drums / bags (infected non-plastic waste)	Infected non-plastic waste e.g. human anatomical waste, blood, body fluids, placenta, diapers etc. This type of waste requires incineration.
Blue drums / bags (Infected plastic waste)	Infected plastic waste such as used disposable syringes, needles (first destroy the needle in the needle destroyer) and soiled gloves.
Red drums / bags (sharp wastes)	sharps, blade and broken glass

Cleaning of Equipment:

Respiratory equipment	Frequency of cleaning	Disinfectant
Oxygen cylinders	Daily: delivery tubes and masks	Disinfectant (0.5% alcohol)
	Humidifier bottle if used have to disinfect and refill with clean water	
	Weekly: Cylinder, valve, flow meter	Damp cloth
Oxygen concentrator		
Thorpe tube flow meter	Disconnect all connections before cleaning. Clean and disinfect exterior surfaces of the flow meter daily	Never use lubricant as they are flammable
Humidifiers	Water level should be checked twice daily and topped up as necessary Water in the humidifier should be changed daily Humidifier, water jar, catheter must be washed and disinfected to prevent bacterial colonization*	Soap and water, rinse with clean water and dry in air before use
Nasal Cannula/ catheter/ tubing	These are single use products and should be discarded after each use.	
Pulse oximeter	Wipe after each use	Alcohol swab
CPAP	Always use disposable circuits No need to replace circuit routinely Fill the Humidifier chamber with Distilled water Use Auto-fill option for filling the chamber	Clean the equipment with a soft cloth

Key Message

- Infection is a basic requirement for ensuring quality of care
- Respiratory equipment requires regular cleaning and maintenance

Video on hand hygiene

Demonstration:

Practical: Steps of hand washing

Knowledge test:

1. For prevention of infection, a health facility should have:

(a) IPC

(b) Clear instructions and guidelines

(c) Both

2. Sharp wastes should be discarded into-

(a) Yellow drum

(b) Red drum

(c) Black drum

3. Pulse Oximeter should be cleaned with alcohol swab-

(a) Once daily

(b) After each use

(c) Weekly

SESSION-**14**

Areas requiring oxygen therapy in health facility and indicators for quality

Learning objectives:

At the end of the session participants will be able to

- Identify areas where oxygen support is required for children

  In all health facilities, there are designated areas /corners for newborn infants and children, where oxygen can be provided when it is required. These areas are:

- Labor/ Delivery room:
- SCANU: inborn/ outborn/ septic/ step down
- Paediatric ward: conditions causing acute respiratory distress
- Triage: for suspected COVID 19 newborns and children
- ICU (intensive care unit)

These areas should be equipped with following:

For resuscitation:

- Bag and mask (complete set): according to age group appropriate sized mask and bag will be present
- Suction device: it may be manual/ electrical or central vaccum

For delivery of oxygen:

- Oxygen source (cylinders or concentrators or liquid gas)
- Central piping or tubing for oxygen distribution
- Regulator, flow meters or flow splitters for regulation and conditioning
- Delivery interface: prongs/cannula/ catheter/ mask etc.

For monitoring of patient's hypoxaemia:

- Pulse oximeter

SESSION-**15**

Equipment maintenance & Trouble shooting

Learning objectives:

At the end of the session participants will be able to discuss

- How to address and solve the problems related to equipment

Maintenance of Equipments:

Oxygen Cylinder:

Schedule period	Activities	Check
Daily	Cleaning	Ensure delivery tubes and masks are decontaminated. If humidifier bottle is used, disinfect and refill with clean water
	Visual checks	Check cylinder is correct type and correctly labelled Check all parts are fitted tightly and correctly
	Function	Before use, ensure cylinder has sufficient pressure Ensure flow is sufficient for intended use Close cylinder valve after each use
Weekly	Cleaning	Clean cylinder, valve and flow meter with damp cloth
	Visual checks	Check for leakage: hissing sound or reduction in pressure
	Function	Remove valve dust with brief, fast oxygen flow checks

Source: Adapted from *User care of medical equipment: a first line maintenance guide for end users. Strengthening Specialised Clinical Services in the Pacific;* 2015 (https://bmet.ewh.org/handle/20.500.12091/83, accessed 26 April 2019)

Thorpe tube flow meter:

- Disconnect all connections before cleaning
- Clean and disinfect exterior surface of the flow meter according to the manufacturers instruction and infection prevention control (IPC) protocol specific to the setting
- Never use lubricants as they are flammable
- A trained biomedical engineer or technician should perform regular inspections and calibration checks with an oxygen flow analyzer.

Bubble Humidifiers:

- The water level in the humidifier should be checked twice daily and topped up as necessary
- Humidifier equipment must be washed and disinfected regularly to prevent bacterial colonization.

- The water in the humidifier should be changed daily
- Humidifier, water jar and catheter should be washed in mild soapy water, rinsed with clean water and dried in air before reuse.
- All components of humidifier should be soaked in a mild anti-septic solution for 30 minutes, rinsed with clean water and dried in air
- A spare, clean humidifier filled with clean water should always be available, so that oxygen therapy is not interrupted while the humidifier is being cleaned

Nasal cannula, catheter, oxygen tubing:

- These are single used products and should be disposed of after each patient.

Pulse Oximeter:

Schedule period	Activities	Check
Daily	Cleaning	- Clean and disinfect exterior surface of the pulse oximeter according to the manufacturers instruction and infection prevention control (IPC) protocol specific to the setting - Clean and disinfect the probe after each use according to manufacturer's instruction and infection prevention control (IPC) protocol specific to the setting -Discard single-use probes after each use
	Visual checks	- Check all parts are present and connected - Ensure that probes which are not in use, are not left hanging, or lying about where they can be damaged - Check cables are not twisted and remove from service if any damage is visible
	Function	-Check operation on healthy subject if in doubt of function
Weekly	Cleaning	- Unplug, remove equipment cover, clean and disinfect exterior surface manufacturers instruction and infection prevention control (IPC) protocol specific to the setting - Replace cover
	Visual checks	- Tighten any loose screw and check parts are fitted tightly. If plug, cable or sockets are damaged, replace those
	Function	- Check operation of all lights, indicators and visual displays. - Check probe disconnection alarm
Every 6 months		Biomedical engineer unit preventive maintenance check required

CPAP:

Circuit/ Bubbler:
Blended air/ O2 gas supply
Air flow between 5-10 L/min
Correct humidifier temperature (36.8° - 37.3° C)
Water present in humidifier bottle up to the specified mark
Corrugated tubings correctly placed
Gas bubbling continuously
Water level at 5 cm H20
Interface:
Nasal prongs: correct size and position
Chin strap: correct size and position
Nasal septum intact or not
Position:
Head and neck position correct (can be used neck roll if supine or side position of infant)

Trouble shooting:

Oxygen cylinder:

Problem/fault	Possible cause	Solution
No oxygen is flowing	• Empty cylinder.	• Replace cylinder
	• Flow meter knob or cylinder flow valve is closed	• Open valves, and then check meter registers flow
	• Faulty regulator	• Close all valves and replace regulator
Leakage from cylinder or flow meter	• Cylinder is not connected to pressure regulator properly	• Tighten all fittings
	• Faulty or missing washer between regulator and cylinder	• Replace washer
	• Flow meter seal damaged or loose	• Replace sealing washer and re-align flow meter
	• Cylinder faulty	• Label faulty and take appropriate action
Leakage cannot be located	• Leakage too small to be heard.	• Apply detergent solution (not oily soap) to joints. Bubbles will show at leak point • Clean/ replace washer and tighten at that point
Flow meter ball not moving, yet oxygen is flowing	• Faulty flow meter	• Close all valves, disconnect flow meter and clean inside. Reconnect and test • If problem persists, replace flow meter
Pressure gauge does not show pressure, yet oxygen is flowing	• Faulty pressure gauge	• Replace pressure gauge

Thorpe tube flow meter:

Problem/fault	Possible cause	Solution
No oxygen is flowing	Flow meter knob or cylinder flow valve is closed	• Open valves, and then check meter registers flow
Leakage from cylinder or flow meter	Flow meter seal damaged or loose	• Checks for leaks at the connection between the flow meter and the oxygen source, at the connection between the oxygen flow meter and the oxygen delivery device, and along the oxygen delivery device to the patient • If leak occurs at the regulator, try tightening the connection • If leak occurs at the terminal unit, try another flow meter. If a different flow meter still leaks, the leak is probably at the terminal unit
Leakage cannot be located	Leakage too small to be heard	• Apply detergent solution (NOT oily soap) to joints. Bubbles will show at leak point • Clean/replace washer and tighten at that joint
Flow meter ball not moving, yet oxygen is flowing	Faulty flow meter	• Close all valves, disconnect flow meter and clean inside. Reconnect and test. • If problem persists, replace flow meter
Flow meter fails to deliver expected flow or behaves erratically	Faulty flow meter	• Check the output with a calibrated flow analyser • If necessary, send it for repair to a biomedical engineering unit or replace the flow meter
Patient is on oxygen and the patient's oxygen saturation is declining	Patient is not getting oxygen flow	• Check that oxygen is flowing from the delivery device • Check that the oxygen tubing is connected to the flow meter • Check that the correct oxygen flow is set

Bubble Humidifier:

There is no specific corrective maintenance for reusable bubble humidifiers.

The following list indicates when the device should be replaced:

- Replace cracked/leaking reservoir or lid seal
- Replace damaged threaded connecter to the flowmeter or concentrator outlet
- Replace the reservoir or lid if there is any sediment or scaling that is not possible to clean out.

Nasal Cannula, catheter, oxygen tubing:

Replacement is required if broken or malfunctioning

Pulse oximeter:

Problem/fault	Possible cause	Solution
Equipment is not running	• No power from mains socket	• Check power switch is on • Replace fuse with correct voltage and current if blown • Check mains power is present at socket using equipment known to be working • Contact electrician for rewiring if power not present
	• Battery (if present) is discharged	• Recharge or replace battery
	• Power supply cable fault	• Try cable on another piece of equipment to determine the power cable or the device is faulty • Contact biomedical engineering unit for repair if required
SpO2 or pulse rate not displayed or unstable	• Probe is not mounted correctly	• Connect probe and cable properly
	• Probe is dirty	• Remove grease, dirt, nail polish, etc. and clean probe
	• Patient movement	• Request patient to remain still • For paediatric patients, try employing distraction/engagement of the apprehensive child or breast feed (if still breast feeding). • For neonates and infants, try locating the sensor on the foot
	• Patient's SpO2 value is too low to be measured	• Re site probe if necessary. Further clinical examination of patient
	• Internal malfunction	• Device may require replacement. Contact biomedical engineering unit.

CPAP:

Trouble	Possible cause	Solution
Bubbling absent	Loss of air flow or pressure leak in the system	Differentiate whether system problem or baby problem Remove the prongs from nose and occlude with finger - If bubbling absent > problem in circuit > re-check all connections - If bubbling present > problem in patient > pressure leak via nares or open mouth
Prongs doesn't stay in place	Whether prong size appropriate? Is the hat loose? Are the corrugated tubes are in proper position with prongs	- avoid too small prongs - avoid loose hat - Re position the attachments
Nothing happens when applying power to humidifier	Device may be unplugged	Ensure all cords are properly plugged into the machine and the wall
High leakage	Tubing may not be connected properly and isn't sealing properly	Check mask and tubing for kinks or tears. If there are no tears, try reconnecting tube to the machine
	The machine may not be attached properly to the humidifier	Separate the machine from the humidifier completely and try to reconnect
	The water chamber is not seated properly in the humidifie	Remove the water chamber from the humidifier completely and place back in
Excessive condensation in tubing	Humidity level is too high	Reduce the humidity level setting
	The humidifier is positioned incorrectly	Verify that the CPAP machine and humidifier are positioned away from air conditioning equipment

SESSION-**16**

Annexures

Annexure-I

Steps of using pulse oximeter:

Step 1: Ensure the pulse oximeter is well charged. Connect the probe to the pulse oximeter.

Step 2: Select the appropriate probe with particular attention to correct sizing and where it will go (usually finger, toe or ear). Turn the pulse oximeter on. Always make sure the alarms are on.

Step 3: The probe emits a red light when the machine is switched on; check that you can see this light to make sure the probe is working properly.

Step 4: Ask the mother to calm the baby. If used on a finger or toe, make sure the area is clean and well exposed.

Step 5: Put the probe in the toe and position the probe carefully; make sure it fits easily without being too loose or too tight.

Step 6: Allow several seconds for the pulse oximeter to detect the pulse and calculate the oxygen saturation. Once the unit has detected a good pulse, the oxygen saturation and pulse rate will be displayed. Look for the displayed pulse indicator that shows that the machine has detected a pulse. Without a pulse signal, any readings are meaningless.

Step 7: If reading is taken from the thumb, avoid the arm being used for blood pressure monitoring as cuff inflation will interrupt the pulse oximeter signal.

If no signal is obtained on the oximeter after the probe has been placed on a finger, check the following:

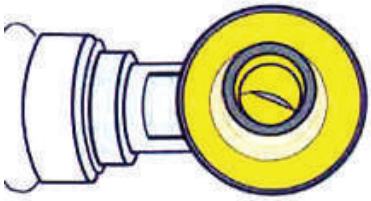
- Is the probe working and correctly positioned? Try another location.
- Does the patient have poor perfusion?
- Check the temperature of the patient. If the patient or the limb is cold, gentle rubbing of the digit or ear lobe may restore a signal.

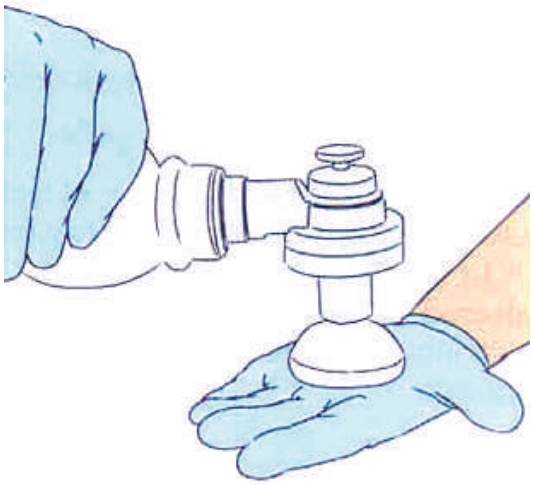
Annexure II (i)

List of equipment before delivery

Annexure II (ii)

Checking Ambu Bag



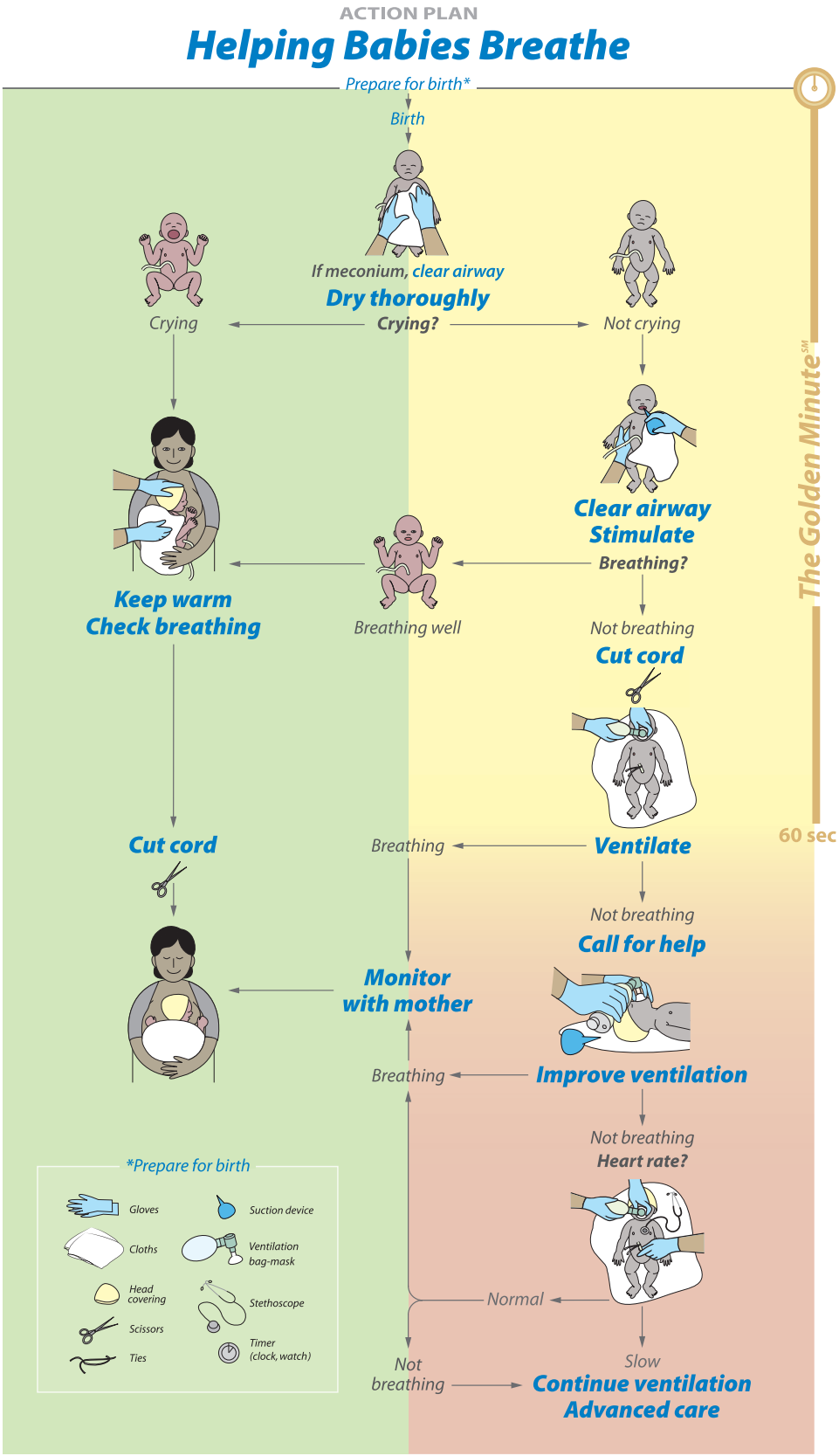


1. Squeeze the bag and check outlet valve whether opens or not

2. Check pop up valve: by sealing outlet and squeezing the bag whether pop up valve opens up

Annexure II (iii)

HBB Flow Chart



Annexure III (i)

Steps of using Concentrator

1. Position the concentrator so that it is at least 30 cm away from walls or curtains, so that the inlet at the back is not obstructed.
2. Connect oxygen tubing to the flow splitter or oxygen outlet
3. Plug the power cord into the mains electricity supply.
4. Turn on the concentrator (switch on the console). A green light should come on when a sufficiently high oxygen concentration is reached, usually within 10 min.
5. Adjust the flow meter to the flow required for the patient or, if using a flow splitter, the number of patients receiving oxygen.

Annexure III (ii)

Steps of using cylinder

- Tighten all the connections (between the cylinder and the regulator and between the regulator and the flow meter), so that oxygen does not leak out.
- Open the regulator, and check the amount of oxygen in the cylinder on the pressure gauge. If the needle of the gauge is in the red zone, the cylinder is nearly empty and should not be used, unless it is the only one you have. *Never* allow such a cylinder to be used for a child overnight, as it will run out and the child will become hypoxaemic.

Annexure-IV (i)

Nasal Prongs

Nasal prongs are a device that ends in two short tapered tubes (about 1 cm in length) designed to lie just within the nostrils. They are also called nasal cannulae.

Practical considerations:

- The distal prong should fit well into the nostril (premature infants: 1 mm, infants weighing up to 10 kg: 2 mm).
- The prongs should be secured with a piece of tape on the cheeks near the nose.

Flow rates: 0.5–1 L/min for neonates, 1–2 L/min for infants, 1–4 L/min for older children.

Advantage:

- There is no risk of gastric distension at standard flow rates, as they cannot be inserted too far into the nasal passage.
- Humidification is not required with standard oxygen flow rates, as the natural nasal mechanisms heat and humidify the inspired oxygen.

Disadvantages:

The airway will become obstructed by mucus, especially if a high flow with no humidification is used.

Annexure IV (ii)

Nasal catheter

A nasal catheter is a thin, flexible tube that is passed into the nose and ends with its tip in the nasal cavity.

Practical consideration:

- In neonates and infants, 8-French (F) size catheters should be used. A catheter passed for a distance equal to the distance from the side of the nostril to the inner margin of the eyebrow usually reaches the posterior part of the nasal cavity. In infants, this is about 2.5 cm.
- The tip of the catheter should **not** be visible below the uvula. A catheter is easily secured with tape above the upper lip.
- The maximum flow rate should be set at 0.5–1 L/min for neonates and 1–2 L/min for infants and older children.

Advantages:

- Nasal catheters are usually well tolerated, and they are unlikely to be dislodged.
- The oxygen does not have to be humidified because the tip of the catheter lies in the nasal cavity.

Disadvantages:

Catheters can become blocked with mucus, which can cause upper airway obstruction. There is little risk of displacement into the oesophagus, with a consequent risk of gastric distension.

Annexure-V

Steps of setting Bubble CPAP

Step 1: Assemble the machine, circuit, distilled water bottles, gloves, cloths and antiseptic solutions

Step 2: Clean the machine, temperature probe and heater wire

Step 3: Connect the blender to compressed air and compressed oxygen sources

Step 4: Fix the water chamber available in the disposable circuit kit to the humidifier. Fill the water chamber with distilled water.

Step 5: Fix the bubble chamber to the slot on the CPAP machine. Fill it with distilled water. Ensure this is below the level of patient.

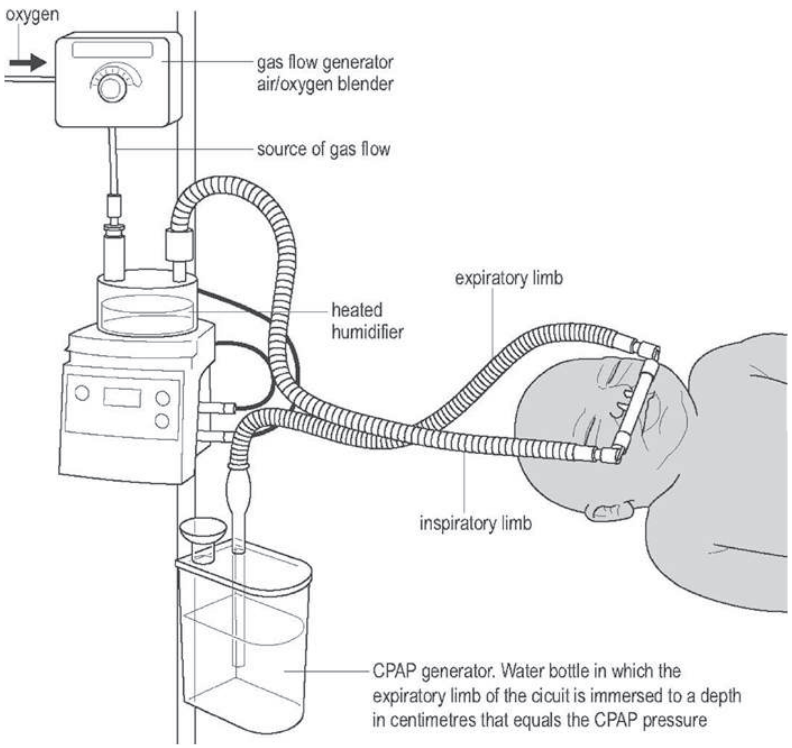
Step 6: Identify the safety device- the blue inspiratory limb and white expiratory limb.

Step 7: Fix the safety device to the water chamber and to the oxygen tube from the blender

Step 8: Fix the inspiratory limb to the water chamber

Step 9: Lock the white expiratory to the blue inspiratory limb

Step 10: Connect the other end of expiratory limb to the bubble chamber



Bubble CPAP circuit connected to an infant by close fitting nasal prongs

Step 11: Fix the heater wire at appropriate slots in the humidifier and in the inspiratory limb

Step 12: Fix the temperature probe to the appropriate slot on the humidifier and the two slots in the blue inspiratory limb

Step 13: Switch on the humidifier and set it in invasive mode only

Step 14: Set the appropriate flow, FiO2 and pressure

Step 15: Wait for the temperature display to reach 37 degree before connecting to the patient.

Then occlude the patient end of the circuit with your palm and observe if:

a. Bubbling occurs in the water chamber - If there are no bubbles, look for any leak in the circuit; if no leak is found, increase the flow by 1 L/min and re-check.

b. The set pressure is delivered (see the manometer reading) - If it is less than the set pressure, look for any leaks in the circuit/around the cannula. If no leak is found, increase the flow and recheck

**Inspiratory limb is

i) From the flow meter to the humidifier and

ii) From the humidifier to the patient end (e.g. nasal cannula)

**Expiratory limb is: from the patient side to water chamber.