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Neonatal Intensive Care Unit (NICU) Training Participants' Manual



Federal Ministry of Health of Ethiopia

January 2021
Addis Ababa



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List of Acronyms

AGA	Appropriate for gestational age
ASD	Atrial septal defect
BP	Blood pressure
BPD	Broncho pulmonary dysplasia
BW	Birth weight
CHD	Congenital heart disease
CMV	Cytomegalovirus
CPAP	Continuous positive airway pressure
CVP	Central venous pressure
DDH	Developmental dysplasia of the hips
DIC	Disseminated intravascular coagulation
EBM	Expressed Breast Milk
ECG	Electrocardiogram
EDD	Estimated date of delivery
ELBW	Extremely low birth-weight
FFP	Fresh frozen plasma
FHB	Fetal heart beat
GPH	Gestational proteinuria & hypertension
HIE	Hypoxic ischemic encephalopathy
HMD	Hyaline membrane disease
HR	Heart rate
ICP	Intracranial pressure
IPPV	Intermittent positive pressure ventilation
IUGR	Intrauterine growth restriction
IVH	Intraventricular hemorrhage
KCL	Potassium chloride
LBW	Low birth weight
LFT	Liver function test
LGA	Large for gestational age
LMP	Last menstrual period
LP	Lumbar puncture
MAS	Meconium aspiration syndrome
NEC	Necrotizing enterocolitis
NGT	Naso-gastric tube
NICU	Newborn intensive care unit
OR	Operating room
PaCO₂	Partial pressure arterial carbon dioxide
PaO₂	Partial pressure arterial oxygen
PDA	Patent ductus arteriosus
PIE	Pulmonary interstitial emphysema
PIP	peak inspiratory pressure
PINSP	Peak inspiratory pressure
PPH	Postpartum hemorrhage
PPHN	Persistent pulmonary hypertension of the newborn
PPROM	Prelabour premature rupture of the membranes

PROM	Prolonged rupture of membranes
PSV	Pressure support ventilation
PVH	Periventricular hemorrhage
RDS	Respiratory distress syndrome
ROP	Retinopathy of prematurity
RV	Residual volume
SpO₂	Oxygen saturation
SGA	Small for gestational age
SVD	Spontaneous vaginal delivery
TGA	Transposition of the great arteries
TOF	Tracheal esophageal fistula
TTN	Transient tachypnoea of the newborn
UVC	Umbilical venous catheter
VLBW	Very low birth weight

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The FMOH highly appreciates the team of experts who sit down and work in group to develop the NICU training packages. We would like to recognize the following health professionals for their technical input and for leading the development of the NICU Training Participants' Manual NICU Management Protocol and NICU Registration Logbook.

Bogale Worku (Prof. of Pediatrics) – Ethiopian Pediatric Society and Addis Ababa University
Mulualem Gessesse (Dr. Neonatologist) – Ethiopian Pediatric Society and Yekatit 12 Hospital
Abiy Seifu (Newborn Health Advisor) – Save the Children/MCHIP
Dr. Goitom Gebreyesus – Department of Pediatrics and Child Health, Addis Ababa University
Dr. Asrat Dimtse – Department of Pediatrics and Child Health, Addis Ababa University
Dr. Nestanet Workineh – Department of Pediatrics and Child Health, Jimma University
Dr. Tadele Hailu – Department of Pediatrics and Child Health, Mekele University
Dr. Hailu Berta – Department of Pediatrics and Child Health, Zewditu Memorial Hospital
Dr. Terefe Assefa – Department of Pediatrics and Child Health, Zewditu Memorial Hospital
Dr. Gezahegn Nekatibeb – Department of Pediatrics and Child Health, Debreberhan Hospital
Mohammed Reshid – Newborn Health Focal Person, Federal Ministry of Health

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Foreword

Chapter 1 Introduction

Course objectives:

By the end of this introductory session participants are expected to

1. Describe the training objectives and expectations
2. Identify key course training manuals and their use in the training
3. Determine pre-course knowledge on selected key areas that the training covers

Globally an estimated 3.7 million neonates die each year, 99% of them in low-income countries. Since neonatal death rates stagnated in many low-income countries, neonatal deaths now represent an increasing proportion of under-five child deaths, an estimated 41% globally in 2008 compared to 38% in 2000. This proportion is even greater in high mortality settings such as Ethiopia.

As shown in the 2011 DHS report Ethiopia recorded a rapid decrease in infant and under-five mortality during the five years prior to the survey compared to those reported in the 2005 EDHS. However, looking further at the breakdown of the data it becomes evident that the neonatal mortality rate did not show significant decrease. Instead the proportion of under-five child deaths attributed to neonatal deaths increased from 32 percent in 2005 EDHS to 42 percent in the 2011 EDHS.

Background

The government of Ethiopia is committed to achieve the Millennium Development Goals (MDGs) related both to maternal and child health. This is clearly reflected in the Health Sector Development Program (HSDP IV). Alongside scaling up successful practices of HESP implementation and rolling out the Health Development Army (HDA) the FMOH has paid due emphasis to expansion of quality high impact neonatal interventions in health centers and hospitals. This includes establishing basic newborn care units (newborn corners) at health centers and NICUs at hospitals.

As initial activity FMOH with partners has started strengthening and/or establishing NICU in selected federal level and university teaching hospitals. The performances of the NICUs in these facilities have been encouraging. Lessons learnt from this exercise was documented that will be fed into the implementation of NICU in the remaining referral and regional hospitals. The FMOH has been working with the Child Survival TWG to define the NICUs and different levels of care expected at the NICUs that the Ethiopian government is planning to strengthen and/or establish.

Neonatal Intensive Care Unit (NICU)

NICU gives care for babies who are born early, who have problems during delivery, or who develop problems while still in the hospital. NICUs are generally classified into three levels.

The functional capabilities of facilities that provide inpatient care for newborn infants should be classified uniformly, as follows:

- **Level I (basic):** a hospital organized with the personnel and equipment to perform neonatal resuscitation, evaluate and provide postnatal care of healthy newborn infants,

stabilize and provide care for infants born at 35 to 37 weeks' gestation who remain physiologically stable, and stabilize newborn infants born at less than 35 weeks' gestational age or ill until transfer to a facility that can provide the appropriate level of neonatal care.

- **Level II (specialty):** a hospital special care nursery organized with the personnel and equipment to provide care to infants born at more than 32 weeks' gestation and weighing more than 1500 g who have physiologic immaturity such as apnea of prematurity, inability to maintain body temperature, or inability to take oral feedings; who are moderately ill with problems that are expected to resolve rapidly and are not anticipated to need subspecialty services on an urgent basis; or who are convalescing from intensive care.
- **Level III (subspecialty):** a hospital NICU organized with personnel and equipment to provide continuous life support and comprehensive care for extremely high-risk newborn infants and those with complex and critical illness. Level III is subdivided into 3 levels differentiated by the capability to provide advanced medical and surgical care.

For Hospitals in Ethiopia the level of care expected to be provided by different types of hospitals varies. District hospitals are expected to have minimum of Level I NICU. Regional referral hospitals should at least have Level II NICU. Specialized teaching hospitals must have Level III NICU.

Establishing NICU is very expensive by its nature. Hence, whilst working towards meeting international standards facilities should start providing the most possible care for newborns with the minimum set of equipments and supplies they may have.

Establishing NICU in hospitals and/or strengthening existing one includes providing training and continuous support for newborn health care providers and managers, ensuring the basic equipments and supplies are in place, and strengthening the facility infrastructure and referral system. These training packages were developed to ensure that hospitals are staffed with well trained NICU service providers, equipped with basic and necessary equipment and supplies for provision of NICUs and a strong linkage and referral system among the NICU care providers and facilities are established.

Process of developing the NICU Training Manual

The FMOH through the national child survival TWG and with financial support from UNICEF has developed NICU training manuals, treatment protocols and recoding and reporting formats. The training materials were developed by a team of highly qualified Ethiopian pediatricians and newborn health experts selected from universities across the country and partners. Three workshops were held in the process of developing the training materials.

First workshop was conducted and participants identified key newborn health problems causing motility and morbidity of newborns in Ethiopia, identified the training areas that should be addressed by the NICU training, listed the topics to be included in the NICU training materials, agreed on the trainees and training modality. Finally, each of the technical

people picked a topic or topics according to their expertise and agreed to share draft module on the topic to FMOH before the second workshop.

In the second workshop the team came together to review each of the sections that were separately developed by them. Small groups were formed and the drafts developed on each topic were distributed to the groups according to their expertise and their involvement in drafting the modules. The groups reviewed the draft sections, and in plenary the whole team discussed thoroughly reviewing each of the sections. At the end of the second workshop a draft training NICU manual was developed.

In the third workshop the group again came together to review the NICU training manual and develop NICU Management Protocol and Power Point Presentations on each of the topics that were covered in the training manual. By the conclusion of the third workshop draft NICU Training Manual, Management Protocol and Power Point Presentation on each topic were developed.

Following the third workshop smaller group from the panel of experts further refined the training manual and management protocol and shared with selected partners and Federal Ministry of Health for feedback. Feedback from the partners (including from Save the Children, World Health Organization) and Federal Ministry of Health was incorporated in the documents. Finally NICU Facilitators' manual detailing the training schedule, method and materials was developed by the three colleagues (Prof. Bogale Worku from EPS, Dr. Mulualem Gessesse from Yekatit 12 Hospital Neonatology Department and Abiy Seifu from School of Public Health of Addis Ababa University).

Participants/Trainees

Participants of the NICU training should be newborn care providers with at least BSc degree in nursing, public health or related training. As the training is intensive and requires a huge investment upon return from the training participants of the training must commit to work at NICUs in their respective hospitals. It is highly recommended that the hospital management provide close support and follow up for the strengthening or establishment of the NICUs in their hospitals and ensure that health care providers trained on NICU are assigned and working at the NICUs.

Chapter 2: Working in the NICU

Learning Objectives:

- Describe what the NICU set-up look like
- Understand the ethical aspect of working in the NICU
- Describe the developmentally supportive NICU environment
- Describe the developmentally supportive NICU practices

Neonatal intensive care is a unit where premature babies and newborns with serious medical & surgical conditions can receive specialized care from a medical team consisting of a neonatologist or pediatrician or medical doctor, neonatal nurse or a nurse, and a social worker amongst others.

MEDICAL ETHICS IN NICU

What does caring a newborn in NICU mean?

In the neonatal intensive care unit most of the admitted babies are critically sick and need the support the supervision of the NICU staff. The mother of this babies are usually sick or have pain themselves and are usually unable to come and visit their babies frequently and spend much time with the baby. The father and other family members are taking care of the mother and are frequently going to home to take care of other children at home. The NICU unit in Ethiopia is limited in size and allowing care takers stay in the NICU is difficult except for short visit of their infant.

There are frequent procedures that will be done to the Newborn, nasogastric tubes, monitors, intranasal oxygen or other respiratory support, intravenous lines and intravenous medications and all are disturbing and painful to the newborn.

The newborn needs frequent feeding at least every 2 hourly the NICU staff is responsible to provide and make sure he baby has the feeding on time. Newborns have diapers that could disturb the baby and makes him cry it is a must that the diaper is changed on time. All the above condition makes the newborn vulnerable and dependent on the staff working in the NICU. As a health worker working in the NICU it is mandatory to keep the newborn comfortable. Summarize in one paragraph

Values and behaviors working in the NICU

Care-

Compassion- is how care is given through relationships based on empathy, respect and dignity. It can also be described as intelligent kindness, and is central to how people perceive their care.

Competence- means all those in caring roles must have the ability to understand an individual's health and social needs and the expertise, clinical and technical knowledge to deliver effective care and treatments based on research and evidence.

Communication- is central to successful caring relationships and to effective team working. Listening is as important as what we say and do and essential for "no decision about me without me". Communication is the key to a good workplace with benefits for those in our care and staff alike.

Courage -enables us to do the right thing for the people we care for, to speak up when we have concerns and to have the personal strength and vision to innovate and to embrace new ways of working.

Commitment -to our patients and populations is a cornerstone of what we do. We need to build on our commitment to improve the care and experience of our patients, to take action to make this vision and strategy a reality for all and meet the health, care and support challenges ahead.

KEY CONCEPTS UNDERLYING ETHICAL CARE IN THE NEONATAL INTENSIVE CARE UNIT

Respecting parental authority/autonomy-is the right of parents to decide the care of their newborns. Support and educating the parents is the responsibility of the NICU nurses and physician to help the parents to decide to the best interest of the baby.

Beneficence-is the obligation of health care providers to "do good," that is, to promote the best interests of their patients applying the best interests of the infant standard of judgment.

Nonmaleficence-The principle of nonmaleficence implies an obligation not to inflict harm on others. Minimizing harm to the newborn. Such harm is generally interpreted as *physical harm*, especially pain, disability, or death.

JUSTICE- Justice in the distribution of resources would require that (1) patients in similar situations have access to the same health care, and (2) the level of health care available for one set of patients takes into account the effect of such a use of resources on other patients.

Role and responsibility of NICU nurse

- Nurses working in the NICU are the backbone of the unit they have to spend most of the time with the newborn, they should be the advocates of the standard of care
- Follow all the rules of dressing in the NICU in perspective of infection prevention
- Have collaboration with the team and work with the team
- Each nurse in the NICU should have patients assigned to her/him during the shift
- Have to take and interpret and timely act or report to responsible physician on the abnormal finding
- Practice and advocate strict hand hygiene, infection prevention practice on procedures
- Be able to do neonatal resuscitation

- Has to record and document what has been done on the chart
- Hand over patient before living shift
- Be involved in the round of his/her patients

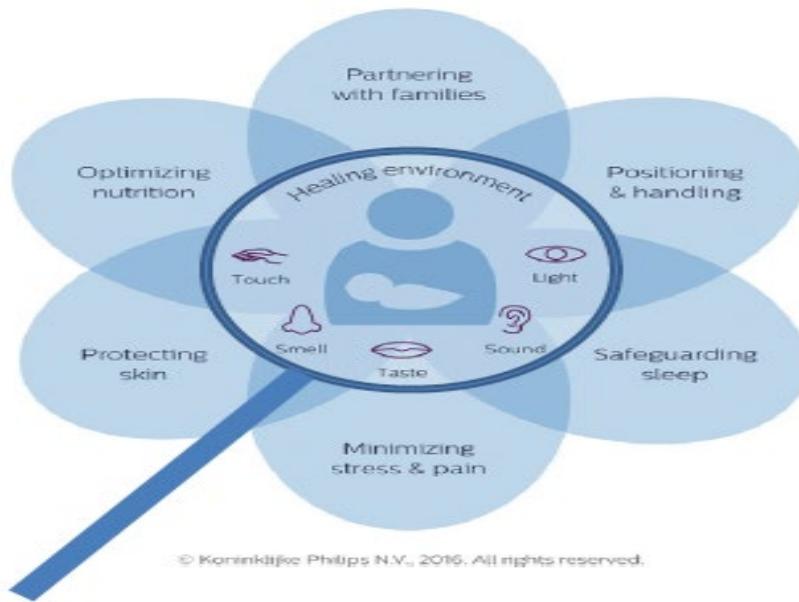
GUIDELINES FOR RESPECTFUL COMMUNICATION WITH PARENTS

- Create an environment for communication that encourages parents' participation and their becoming as fully informed as possible.
- Identify and remove barriers that limit parents' role in communication (e.g., language, physical distance).
- Communicate with parents: at the time of admission, at any crisis point in their child's NICU course, via periodic reviews of longer stay patients, and other unstructured opportunities.
- Encourage parents to seek clarification of information at any point by requesting an appointment with the child's responsible physician.
- Provide open, truthful communication at all times.
- Provide information as accurately as possible and with as much certainty of diagnosis and prognosis as is possible in each clinical situation.
- Identify areas of medical uncertainty.
- Use easily understandable language, and pay attention to health care "literacy" issues.
- Assess family communication preferences, and attempt to communicate within those parameters.
- Be pre-emptive in communication (i.e. foresee what problems or issues may arise in the child's course).
- Be proactive in communication in any clinical situation in which a poor outcome is predicted.
- Convene meetings with both parents when important decisions need to be made.
- Keep parents informed of any special investigations/tests that are planned in the course of management of their child.
- Recognize the need for time to process and absorb information.
- Ensure consistency and continuity of communication in the face of medical staff changes and handovers.
- Practice open, honest, and timely disclosure regarding medical error.

Developmentally Supportive Care NICU Environment

Definition:

By providing a developmentally supportive NICU environment, neonatal caregivers can support neurologic and sensory development and potentially minimize later developmental issues in preterm and medically fragile infants. The acutely ill term infant also requires environmental modifications that reduce stress and promote sleep and recovery. When possible, anticipation of an infant's environmental needs prior to admission is ideal. The influence of the environment is of practical concern for short- and long-term development.



1. Tastes and Odors

Exposure to biologically meaningful odors and tastes such as maternal scent, colostrum, and breastmilk eventually might prove beneficial as a means of fostering parent recognition, calming, and pleasurable experience. Even infants who are not yet orally fed might enjoy the scent of milk or a small taste of breast milk applied to the lips.

- Maternal odor reduces crying and increases mouthing behaviors
- The sweetness of sucrose modulates pain response in term and preterm infants

2. Sound

Sudden loud sounds in the NICU cause physiologic and behavioral responses in term and preterm infants including sleep disruption, agitation, crying, tachycardia/bradycardia, tachypnea, irregular respiration/apnea, decreased oxygen saturations, mottled skin, peripheral vasoconstriction or increased systemic blood pressure. Such disruptions can interfere with an infant's clinical progress and stable behavioral functioning.

Noise levels from 70 to 75 dB disrupt sleep states in one half of healthy term infants after only 3 minutes and in all infants after 12 minutes. Many infants wake from light sleep after exposure to just 55 to 65 dB. Preterm infants are in light sleep for almost 70% of the day, causing them to be particularly vulnerable to fluctuating sound levels.

As a precaution, **both sound intensity and frequency** should be monitored in the NICU and a plan developed to minimize the infant's exposure to potentially deleterious levels of sound.

Keep the sound DB not more than 60 DB; include an equivalent noise to 60 DB eg TV, Trim the content further make it precise;

Practical sound limitation measures include

- speak in low to moderate volumes
- conduct rounds and report away from the bedside of sleeping or sound sensitive infants
- keep phones on vibrate mode
- close incubator portholes quietly

- avoid placing equipment on top of incubators
- Rouse infants gently with soft speech or gentle touch to prevent rapid state changes before examination or other tactile procedures.
- Encourage parent-infant time together.

3. Light

For acutely ill and preterm infants, reduced lighting appears to be a safe alternative to continuous, bright lighting in the NICU. Providing cycled lighting from 34 weeks may be beneficial. Development of circadian rhythm is more likely to be supported by infant maturation, cycled lighting, and decreased nighttime disruptions for care. Careful attention to physiologic and behavioral manifestations of each infant, term or preterm, provides information concerning individual tolerance for light and visual stimulation.

How should the NICU look like?

For preterm babies: simulating nature is recommended, windows should be covered with dark window sticker.

4. Parents: The Natural Environment

The most natural environment possible for any infant includes the touch of the mother's breast or father's chest, the gentle motion of rocking or of parents' breathing, the odor and taste of breast milk, and the scents, tender vocalizations, and heartbeats of the parents.

Developmentally Supportive Care NICU Practices

The goal of developmentally supportive care practice is to maximize rest, minimize stress, and optimize healing and growth.

1. Positioning

The goals of positioning are to facilitate flexed and midline positioning of extremities, stabilize respiratory patterns, and lessen physiologic stress. The use of "nesting materials" (e.g., soft blanket rolls, commercially available positioning devices) or swaddling is useful in minimizing the upper/lower extremity abduction, scapular retraction, and cervical hyperextension typical of preterm infants. Nesting needs to allow sufficient room for the infant to push against boundaries, to facilitate continuing development of the neuro-motor and skeletal systems. (See picture)



2. Feeding.

Breastfeeding is the preferred method, and breast milk is recommended for both preterm and term infants. The transition to oral feeding from tube feeding requires skilled assessment and judgment on the part of the caregiver.

3. Touch

- a. **Hand containment** can be done by parents soon after admission. This technique reduces pain responses during painful and non-painful events. Parents can be taught how to touch their infant in ways that are nurturing and won't create stress. Describing what a nurturing touch is....
- b. **Kangaroo care** is a technique consistently associated with improved infant outcomes (i.e., fewer respiratory complications, improved weight gain, and temperature regulation) and maternal outcomes (i.e., improved maternal competence and longer breastfeeding duration). /See Chapter on KMC/

Pain and Stress minimization

Pain assessment and management is a basic right of *all* patients. /See chapter pain management/. High-stress situations need to be identified and modified to minimize the impact on the ill or preterm infant. Examples of potential high-stress conditions include delivery room care, transport to NICU, admission process, and diagnostic procedures that often produce pain or discomfort along with stress.

Chapter 3: Early Childhood Development

Section 1: Early Childhood Development

Early childhood represents the period from conception to six years of age and is critical for brain development. The period is classified in three distinct stages: from conception to three years (during which health, nutrition and stimulation are essential for the rapidly growing brain); from three to five years (when special preschool care and education plays a pivotal role in the development and maturation of the child's brain); and five to six years (which is a critical time for school readiness). Most (80%) of the growth and development of the brain occurs in the first three years and this stage is a foundation for health and wellbeing later in life. Early Childhood Development is a process of continuous maturation in terms of cognitive, linguistic and executive functions, as well as mental, emotional and behavioral development in early childhood.

Brain Development

Development of the brain starts at the fetal stage and continues throughout pregnancy and during childhood. The rate of brain growth and development is very rapid in the first three years of life. The size of the brain doubles in the first year and grows to 50 per cent of its adult size by age two, continuing to grow to 80 per cent by the age of three. The first three years of life are therefore the most important for ensuring the best start in life but can result in impaired development if not managed properly.

The everyday experiences and relationships between a child and his/her family and surroundings significantly affect the brain as it grows. Moreover, as children spend most of their time under the control or care of others, families and caregivers have an important ongoing influence on their growth and development. Children learn and develop through play and interaction with their environment, which gives them the opportunity to observe, experiment, and engage to solve problems. This enables children to improve their existing skills and acquire new ones in order to progress to the next level of development. To develop continuously, therefore, the brains of young children require nurturing care to protect them from adverse life experiences and to provide a favorable environment for proper growth and wellbeing

The Nurturing Care (NC)

The NC follows a continuum of care across the lifespan. It starts before conception, when maternal health and mental readiness for pregnancy and childbirth plays a significant role in the health and development of the newborn. Care then continues during pregnancy and throughout early childhood. Curative, preventive and promotive health interventions during antenatal, delivery and postnatal care, with the aim of ensuring the health and nutrition of the mother and her child, are all essential components of the NCF. The NC for ECD has five components essential for the optimal growth and development of young children.

The five components of NC interventions are:

1. **Good health:** to ensure that children and their parents have good health so that children grow and develop well.
2. **Adequate nutrition:** to ensure children, mothers and adolescents are getting adequate nutrition and are protected from malnutrition.
3. **Safety and security:** to ensure that children and their parents/caregivers are living in conducive and stable environments favorable for life, including water, sanitation and hygiene (WASH).
4. **Responsive caregiving:** to ensure that children's needs and demands are recognized, and timely and appropriate care is provided to support children's growth and development.
5. **Opportunity for early learning/Early stimulation:** to ensure that young children are given the opportunity for learning and education through play, and to explore their environment throughout early life.



Figure 2: NCF, adopted from the nurturing care ECD framework

Investing on ECD

There is today a growing body of evidence about ECD, the findings of which demand action. A recent report from the Lancet series on child development in developing countries

indicated that about 200 million children under five are not reaching their full developmental potential because of poverty, a lack of stimulation and responsive care, poor health and nutrition. This limits children's readiness for schooling and their subsequent performance - both of which will affect their productivity in adulthood.

Another reason to invest in young children is the high rate of return on ECD interventions made through the NCF during the first few years of life. Various controlled studies in different settings have shown positive returns for investments made in ECD, with respect to individual achievement, future income, physical and mental health during both childhood and later life. A WHO study found that for every \$1 spent on ECD interventions, the return can be as high as \$13 (WHO, 2018).

By the time children reach the end of early childhood, they should be well-developed in physical, mental, cognitive, linguistic and social emotional dimensions - so that they can benefit further from opportunities linked to education and health later in life.

Section 2: Caring for baby's brain while in the NICU

Baby's brain development naturally starts to develop when the baby is inside the mother's womb. The natural environment in the womb gives it adequate stimulation to develop, together with nutrition and protection. **However, since babies in the NICU are either preterm or critically ill, various factors can alter their development such as:**

- Unfortunate events/injuries after birth while in the NICU and later
- External environment in NICU (and home after baby is discharged)

Some of the effects are reversible and some are not. However there is a window of opportunity to work and help the brain re-wire, which is most crucial in early months to years.

Hence stimulation is very important, which begins right here in the NICU and then continues at home.

Understanding the baby's cues and knowing when he/she is ready to be stimulated

There is a need to stabilize the baby first before going to stimulate him/her. Moreover, there are different signs, depending on the baby's stage of development, that the baby shows whether he/she is ready or not to be stimulated. So it is very important to get to know the baby and understand his/her cues before initiating stimulation.

The baby is not ready or needs a break when...

▪ Breathing is very fast, slow, irregular or gasping

- Skin color is pale, purple/dusky
- Startles easily
- Trembles/jerky movements
- Sudden movements of arms and legs away from body
- Squirming/restless
- Inconsolable/excessive crying
- Fussiness
- Yawning and wanting to sleep
- Looks away from you
- Does not want to engage
- Arching back

The baby is ready to interact when...

- Breathing is smooth and regular
- Color is pink
- Looks comfortable with arms and legs more close to the body
- Holding hands close to face
- Awake and trying to make eye contact
- Looking around
- Cooing
- Trying to open and close their mouth
- Seeking something to put in their mouth
- Moving arms and legs smoothly

Stimulating different areas of brain and working towards overall neuro-development

Different areas of the brain need to be stimulated in order to help the baby's brain to develop

1. **Sense of hearing:** stimulate the hearing sense for development of auditory and language centres of brain
2. **Sense of touch:** this enhances the development of sensory area of brain
3. **Sense of vision:** stimulate the vision sense for development of visual area of brain

1. Sense of hearing

Babies are able to hear as early as 20 weeks of gestational age during pregnancy, and their hearing continues to develop as they grow. They are especially able to recognize their mother's voice, rhythmic sounds which simulate Heartbeat, respiratory breathing and bowel sounds.

Activities that can be done in the NICU either by the mother, caregiver and/or the care provider:

- Talk to the baby in a soft and sweet voice
- Sing in soft tones
- Read to the baby

This can be done from a few minutes to a few hours in a day, increasing the time as he/she grows. The mother/caregiver should be advised to continue doing this at home. Stimulating the Sense of hearing far along helps in the development of Speech, Language and Memory.

Importance of sense of hearing stimulation

- Strengthen Mother-baby bonding
- Forms new connections in brain
- Increases size of hearing center of brain
- Decreases heart rate and blood pressure
- Language development
- Memory development

2. Sense of touch (sensory stimulation)

Before the babies are born they are surrounded by fluid, which constantly gives them a sense of touch. Babies also experience different position changes and joint movements as they move around inside the womb.

Depending on the baby's medical condition the following can be done in the NICU for stimulating sense of touch.

- Skin-to-skin contact

- Kangaroo mother care
- Gentle but constant touch, placing hand on the baby's arm/leg/body
- Let the baby hold onto your finger

Once the baby is about 31-33 weeks and again, depending on his/her medical condition, the mother/caregiver and/or the care provider can do:

- Massaging (*see annexed PNC poster*)
- Very gentle rocking by holding baby in your arms
- Moving the joints
- Stretching

Importance of sense of touch stimulation

- Mother-baby bonding immensely
- Increases brain maturation

Kangaroo mother care has especially been shown to:

- Lower risk of death
- Decreases risk of infection
- Stabilizes heart rate, breathing and blood pressure
- Helps with temperature control and blood glucose levels
- Helps the mother to start breast feeding
- Decreases their pain and improves oxygen saturation
- Leads to increased head growth
- Decreases risk of depression in mother

Massaging and stretching:

- Helps with weight gain and calcium deposition in bones
- Improves coordination
- Improves muscle tone
- Decreases length of hospital stay

3. Visual stimulation

The visual system starts to develop when baby is in the last trimester and is not yet well-formed at birth. This is especially true if baby is born early. Vision rapidly develops during the first few months after birth. Hence, during early phases in NICU when your baby is extremely small, eyes have to be protected from light and any kind of stimulation as much as possible.

When the babies are medically stable and is able to open their eyes and starts showing interest, the following can be done in the NICU:

- Start with making direct eye contact for a few seconds to minutes
- Talk and sing to your baby while maintaining eye contact
- Bright objects can be introduced later
- Different patterns with contrasting colors also helps

Importance of visual stimulation

- The eyes and brain have special nerves associated with the visual system in the brain that are highly influenced by visual stimulation after birth
- This does not only helps the visual system but also aids in the growth of hearing and coordination centers within the brain
- Increases bonding with the baby which later helps in forming a strong mother-baby relationship

Section 3: Counselling the caregivers

The first hour of life after birth is the ideal time for maternal-newborn bonding to proceed. This process enables parents and infants to involuntarily establish a nurturing connection, which is essential for an infant's future development. However, when a newborn is admitted to NICU the natural maternal-newborn bonding and attachment process will be hindered.

Hence the health professionals in the NICU need to have effective communication with the mother/caregiver in order to facilitate maternal-newborn bonding and capacitate/counsel the mother/caregiver on how she/he can stimulate the new-born. So that the mother/caregiver is confident enough to provide stimulation for the baby.

Follow the counselling steps, described in the box, to provide counselling for the mother/caregiver on stimulating the baby:

- | |
|-----------------------------------------------------------------------------------------------------------------------|
| 1. GREET: greet care givers in a friendly way whenever and wherever you see them, and build good relationships |
| 2. ASK: Can you show me how you stimulate your baby? |
| 3. OBSERVE: Is the caregiver properly stimulating the baby? |
| 4. PRAISE caregiver for any stimulation action: "I noticed that you ...". |
| 5. Help caregiver TRY a new stimulation activity for the baby. Praise the caregiver |
| 6. EXPLAIN how stimulation help the baby develop |
| 7. Help caregiver SOLVE PROBLEMS |

Caregivers are more likely to adopt new behaviours when they:

- Feel listened to and supported (i.e., when the provider is responsive to the caregiver needs)
- Feel confident about oneself
- Have a chance to observe new practice and see how the baby responds to it
- Have a chance to practice a new behaviour and to receive positive feedback
- Have a chance to problem-solve how to make this a part of their daily routine
- Have some reminders for themselves.

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Chapter 4: History and physical examination of neonates and classification of newborns

Learning objectives:

At the end of this lecture, the participants will be able to

- Take history in neonatal age group
- Describe the requirements and steps of newborn clinical examination
- Do appropriate newborn physical examination
- Interpret all the findings
- List counseling points to discuss with mothers after the clinical examination

History and Physical examination of the newborn

1. Neonatal history taking

- a. **Maternal profile:** age of the mother, occupation, parity, blood group and Rh, chronic maternal illnesses (diabetes, hypertension, HIV, TB, renal diseases, asthma, etc), history of sexually transmitted diseases (ask for symptoms like vaginal discharge, genital ulcers, or investigations like VDRL, HIV test, Hepatitis B virus status)
- b. **Current pregnancy:** LNMP (last normal menstrual period), gestational age, ANC, bleeding, diabetes, thyroid diseases, preeclampsia, eclampsia, acute (eg:UTI, malaria and covid-19) or chronic infection and maternal nutritional history during pregnancy (detailed during first, second and third trimester)
- c.
- d. **Previous pregnancy:** history of abortion, fetal death, early neonatal death, premature and/low birth weight birth, history of early neonatal jaundice, history of birth defect.
- e. **Drug history:** history of alcohol ingestion, cigarette smoking , any medications pregnancy during (anticonvulsants, anti TB, warfarin, HAART, thyroid treatment drugs , antenatal steroid use, contraceptives, cotrimoxazole, Aspirin, Albendazole)
- f. **Social, personal and family history:** Family size, marital status, housing conditions, water source, waste disposal, personal hygiene (hand washing habits, toilet use, bathing)
- g. **Labor and delivery:** onset of labor, status of rapture of membrane in relation to onset of labor (before or after onset of labor), duration of rapture of membranes, duration of labor, mode of delivery, presence of meconium stained amniotic fluid, fetal presentation, APGAR score, breathing condition at birth/crying/activity/color immediately after birth, resuscitation at birth, birth weight.
- h. **Presenting compliant:** like failure to suckle the breast, fever, breathing difficulty, abnormal body movement, yellowish discoloration of the skin (jaundice), altered mentation, vomiting, bleeding, birth defects, etc

Physical examination of newborns

Preparation of examination: The baby should be naked in a thermo-neutral environment to see if there is any birth defect, breathing condition, movement of the baby, cyanosis, pallor and jaundice.

Prepare the following items

- Thermometer
- Measuring rod and tape
- Weighing Scale (for babies)
- Stethoscope
- Watch
- Gloves
- Data collection sheet

Prerequisites

- Review of the obstetrical file and health record.
- Explain to the mother the purpose and process of the examination.
- Wash hands with soap and water.
- Undress and place the baby under a heat source if it is available or prevent heat loss (close shutters and windows, keep baby partially covered, keep examination time short).

At initial examination, the health worker has to focus on the following conditions

- Babies response to the transition from fetal life to extra uterine life
- Any congenital anomalies
- Any sign of infection

APGAR scoring

The APGAR score is now used worldwide to quickly assess the health of an infant one minute and five minutes after birth. The 1-minute APGAR score measures how well the newborn tolerated the birthing process. The 5-minute APGAR score assesses how well the newborn is adapting to the environment.

Note: The APGAR score is not used to determine the need for resuscitation!



AAbove chart shows the methods of scoring for the APGAR Score

Figure 1: A newborn with APGAR score of 9 – 10

Table 1: APGAR score

Sign	Score 0	Score 1	Score 2
Activity	Flaccid	Some flexion	Well flexed
Pulse	Absent	<100 per minute	>100 per minute
Grimace	No response	Grimace	Cough or sneeze
Appearance	Pale/Blue	Blue extremities	Completely pink
Respiration	Absent	Weak	Good cry

Three levels of score:

- Low APGAR score 0-3
- Moderate APGAR score 4-6
- Normal APGAR score 7-10

Note: A newborn with an APGAR score of less than 7 needs special attention.

Key examination points

- Unlike adults , the order of newborn physical examination may not follow the usual cardinal steps, use opportunities as issued.
- **General examination:** look for movement of the extremities, muscle tone (hypotonia/hypertonia), color, posture, respiratory distress
- Take the **vital signs:**
 - Respiratory rate per minute (normal range is 30 to 60 breathes per min)-should be counted for a full minute.
 -
 - Heart rate per minute (normal rate is between 120 and 160 bpm). Check capillary refill.
 - Axillary temperature (normal is between 36.5 and 37.5)
 - Pulse oximetry with and without oxygen (normal >90%)
 - Measure blood pressure using appropriate cuff. The normal range blood pressure of a newborn varies based on birth weight, gestational age and postnatal age. Normal systolic blood pressure should not be less than 60 mmHg. Blood pressure needs frequent measurements.
- Take anthropometric measurement
 - Weigh the baby on a cloth to protect it from temperature loss with a calibrated balance (normal weight range for term babies is 2500g -3999g).
 - Measure the length (normal range is 48-53 cm),
 - Measure head circumference (normal range is 33-38cm),
- **Color:** normal color is pink, should not be: blue, yellow, pale.
- **Examination of HEENT:** examine the skull (caput succedaneum, subgaleal hemorrhage, cephalohematoma), sutures (craniosynostosis), fontanel, face, nose, ears, mouth, neck, clavicles, eye discharge, icterus, cataracts
- **Mammary glands:** enlargement of breast tissue and discharge (physiologic)
- **Respiratory system:**
 - Check for signs of respiratory distress, breathing pattern, respiratory rate, air entry to the lungs, presence of abnormal sounds in the lungs, AP diameter and symmetry of the chest, strider
- **Cardiovascular:** heart rate, heart murmurs, gallop rhythm, femoral pulses
- **Abdomen:** shape (scaphoid, distension), look for any organ enlargement like hepatomegaly, splenomegaly, mass, ascites, kidneys, abdominal wall defect, examination of the umbilical stump (bleeding and discharge), anal patency.
- **External genitalia:** see if there are any abnormalities of the genitalia both in male and female newborns (size of penis, position of testicles, opening of urethral meatus (hypospadias / epispadias) , ambiguous genitalia), vaginal bleeding or discharge.
- **Musculoskeletal:** limb defects (clubfoot, syndactyly, polydactyly), symmetry and movement of extremities to see fractures and birth injuries, spina bifida, joints (hip

should be examined to detect developmental dysplasia of the hip, look gluteal fold symmetry), edema.

- **Skin examination:** rash, jaundice, pallor, plethora, meconium staining, cyanosis, etc. Acral (extremity) cyanosis is a normal finding in newborns
- **Neurological examination:** level of alertness, spontaneous movements, muscle tone, reflexes ...
 - o Moro reflex, check for completeness and symmetry
 - o Rooting reflex, absent or present
 - o Grasp reflex (arm and plantar)
 - o Sucking reflex, absent, weak or vigorous

Classification of the newborn

1. **Based on the gestational age, a newborn could be classified in to:**

- **Preterm :** less than 37 Completed weeks
- **Term :** 37- 42 weeks
- **Post term :** more than 42 weeks

Gestational age could be estimated by one of the following methods

- On the bases of the first day of the last menstrual period
- Ultrasound estimation: gestational age estimate during the first trimester is ultrasonography can be accurate within +/- 5-7 days.
- Based on Ballard score

The new Ballard has two components, neuromuscular and physical maturity scoring and the accuracy is within a range of +/- two weeks.

Neuromuscular maturity

Score	-1	0	1	2	3	4	5	Physical maturity
Posture								
Square window (wrist)	>90°	90°	60°	45°	30°	0°		
Arm recoil		180°	140-180°	110-140°	90-110°	<90°		
Popliteal angle	180°	160°	140°	120°	100°	90°	<90°	
Scarf sign								
Heel to ear								

Figure 2: Maturational assessment of gestational age. Ballard JL et al. New Ballard Score, expanded to include extremely premature infants. J Pediatrics 1991; 119:417

SCORE	-1	0	1	2	3	4	5	Maturity rating
Skin	Sticky friable, transparent	Gelationous, red, translucent	Smooth, pink; visible veins	Superficial peeling and/or rash few veins	Cracking, pale areas; rare veins	Parchment deep cracking; no vessels	Leathery, cracked, wrinkled	
Lanugo	None	Sparse	Abundant	Thinning	Bald areas	Mostly bald		
Plantar surface	Heel-toe 40-50 mm: -1 < 40mm: -2	> 50mm, no crease	Faint red marks	Anterior transverse crease only	Creases anterior 2/3	Creases over entire sole		-10 20
Breast	Imperceptible	Barely perceptible	Flat areola, no bud	Stippled areola, 1-2mm bud	Raised areola, 3-4 mm bud	Full areola 5-10 mm bud		-5 22
Eye/Ear	Lids fused loosely: -1 tightly: -2	Lids open, pinna flat stays folded	Slightly curved pinna; soft ; slow recoil	Well curved pinna; soft but ready recoil	Formed and firm instant recoil	Thick cartilage, ear stiff		0 24
Genitals (male)	Scrotum flat, smooth	Scrotum empty, faint rugae	Testes in upper canal rare rugae	Testes descending, few rugae	Testes down, good rugae	Testes pendulous, deep rugae		5 28
Genitals (female)	Clitoris prominent, labia flat	Clitoris prominent, small labia minora	Clitoris prominent, enlarging minora	Majora and minora equally prominent	Majora large, minora small	Majora cover clitoris and minora		10 28
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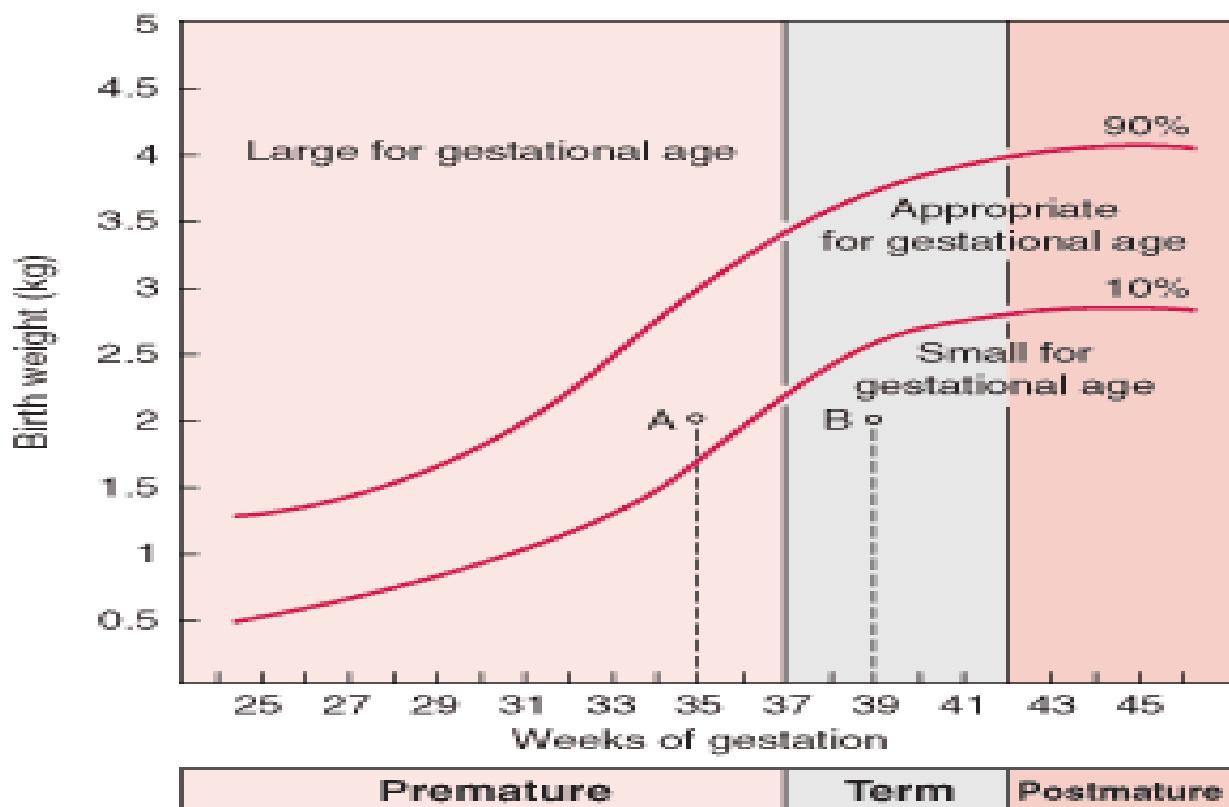
2. Classifications of the newborn based on the birth weight:

- **Macrosomia** : birth weight of 4000 gram and above
- **Normal weight** : 2500 – 3999 grams
- **Low birth weight** : 1500 – 2499 grams
- **Very low birth weight** : 1000 – 1499 grams
- **Extremely low birth weight** : less than 1000 grams

3. A newborn can also be classified with respect to birth weight and gestational age as follows (see figure 3):

- **Appropriate for gestational age (AGA)** if the birth weight is between 10-90%
- **Large for gestational age (LGA)** if birth weight is greater than 90%
- **Small for gestational age (SGA)** if birth weight is less than 10%

Level of intrauterine growth based on birth weight and gestational age of live born, single, white infants.



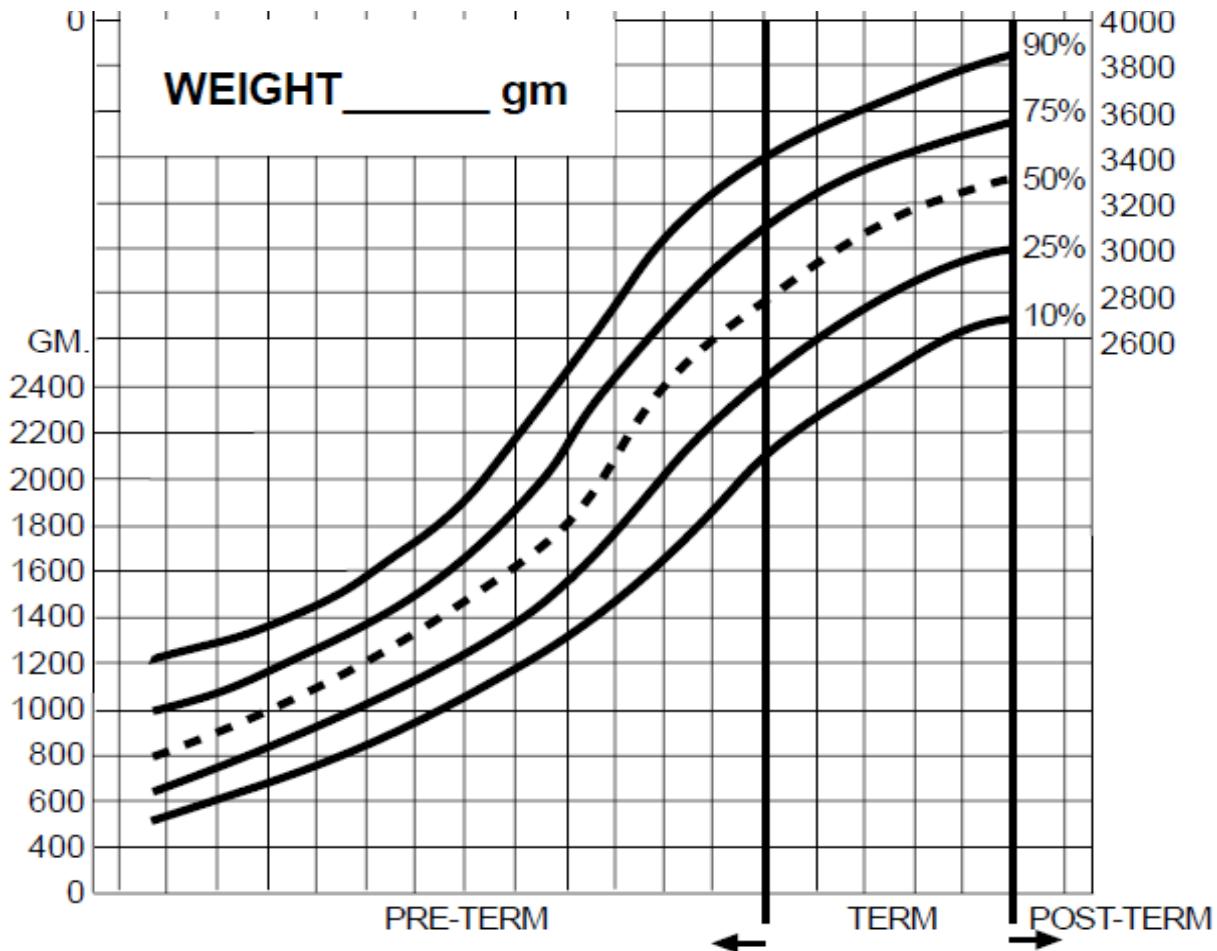


Figure 3: Point A represents a premature infant with appropriate weight for gestational age (AGA). Point B indicates an infant of similar birth weight who is mature but small for gestational age. The growth curves represent the 10th and 90th percentiles for all of the neonates in the sampling. (Adapted from Sweet AY: Classification of the low-birth-weight infant. In *Care of the High-Risk Neonate*, ed. 3, edited by MH Klaus and AA Fanaroff. Philadelphia, WB Saunders Company, 1986;

After the clinical examination of the newborn:

- Record all the findings in the newborn's registration books or chart prepared for the purpose.
- Inform the mother about the results of the examination, provide explanations if needed and emphasize the importance of regular follow-up.
- Make the decision of admitting the newborn, keeping the newborn for additional observation or sending back the newborn depending on your assessment and after referring to the relevant criteria.

Definitions

- **Neonatal period:** a period from birth to 28 completed days of life.
- **Early neonatal period:** this is a period from birth to 7 completed days of life
- **Late neonatal period:** A period from 8 to 28 completed days of life
- **Perinatal period:** This period includes from 28 completed weeks of gestation to 7 days after birth
- **Gestational age:** this is the time counted(in weeks) from the first day of the woman's last menstrual period to the day of delivery (or current date if baby not yet born).
- **Chronologic age:** this is the age of the baby counted from the time of birth
- **Corrected age:** this is the age of the baby which is counted by reducing the Chronological age from the number of weeks born before 40 weeks of gestation

Chapter 5: Essential newborn care (ENC)

Learning objectives

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

- Identify components of ENC
- Recognize importance of ENC
- Recall steps of the components of ENC and apply them at NICU , labor and delivery rooms

Essential newborn care is a care given to all newborn infants at birth to optimize their chances of survival.

Standardized procedures in Essential Newborn Care (ENC)

Step 1: Dry and stimulate

- Immediately dry the whole body including the head and limbs.
- Keep the newborn warm by placing on the abdomen of the mother
- Stimulate by rubbing the back or Slapping or flicking the soles of the feet
- Remove the wet towel
- Let the baby stay in skin-to-skin contact on the abdomen and cover the baby quickly, including the head with a clean dry cloth. Don't let the baby remain wet, as this will cool the body and make it hypothermic.

Step 2: Evaluate Breathing

- Check if the baby is crying while drying it.
- If the baby does not cry, see if the baby is breathing properly.
- If the baby is not breathing and/or is gasping: Call for help. The assistant can provide basic care for the mother while you provide the more specialized care for the baby who is not breathing. Cut the cord rapidly and start resuscitation.
- If the baby breathes well, continue routine essential newborn care.
- Do not do suction of the mouth and nose as a routine. Do it with bulb suctioning only if there is meconium, thick mucus, or blood.

Normal breathing

Normal breathing rate in a newborn baby is 30 to 60 breaths per minute. The baby should not have any chest in-drawing or grunting. Small babies (less than 2.5 kg at birth or born before 37 weeks gestation) may have some mild chest in-drawing and may periodically stop breathing for a few seconds.

Step 3. Cord care

Optimal cord care consists of the following:

- Clamping /tying the cord: If the baby does not need resuscitation, wait for cord pulsations to cease or approximately 1-3 minutes after birth, whichever comes first, and then place one metal clamp /cord tie 2 centimeters from the baby's abdomen and the second clamp / tie another 2 centimeters from the first clamp/tie. Cutting the cord soon after birth can decrease the amount of blood that is transfused to the baby from the placenta and, in preterm babies; it is likely to result in subsequent anemia and increased chances of needing a blood transfusion (1-2)
- Cutting the cord: Cut the cord with sterile scissors or surgical blade, under a piece of gauze in order to avoid splashing of blood. At every delivery, a clean separate pair of scissors or blade should be designated for this purpose. Counseling on cord care:
 - Check for bleeding/oozing and retie if necessary.
 - The cord may be tied by using sterile cotton ties, elastic bands, or pri -sterilized disposable cord tie.
 - Advise the mother not to cover the cord with the diaper
 - Don't use bandages as it may delay healing and introduce infection.
 - Don't use alcohol for cleansing as it may delay healing.
 - Don't apply traditional remedies to the cord as it may cause tetanus and other infections.
 - Apply 4% chlorhexidine immediately after cutting the cord and continue daily for 7 days (3-5).

Watch out for

- Pus discharge from the cord stump.
- Redness around the cord especially if there is swelling.
- Fever (temperature more than 38°C) or other signs of infection.

Step 4. Keep the newborn warm (Prevent Hypothermia)

- Keep the baby warm by placing it in skin-to-skin contact on the mother's chest.
- Cover the baby's body and head with clean cloth. If the room is cool (<25 °C), use a blanket to cover the baby over the mother.

Step 5. Initiate breastfeeding in the first one hour

Skin-to-skin contact and early breastfeeding are the best ways to keep an infant warm and prevent hypoglycaemia. Term and low-birth-weight neonates weighing <2000g who do not have complications and are clinically stable should be put in skin-to-skin contact with the mother soon after birth after they have been dried thoroughly to prevent hypothermia.

Early breastfeeding means breastfeeding within the first hour, with counseling for correct positioning.

Step 6. Administer eye drops/eye ointment

- Wash your hands with soap and water
- Clean eyes immediately after birth with swab soaked in sterile water, using separate swab for each eye.
- Clean from medial to lateral side.
- Give tetracycline eye ointment/drops within 1 hour of birth usually after initiating breast feeding.
- Don't put anything else in baby's eyes as it can cause infection.
- Watch out for discharge from the eyes, especially with redness and swelling around the eyes.

Step 7. Administer vitamin K Intramuscularly (IM)

- 1 mg for babies with gestational age of 34 weeks or above
- 0.5 mg for premature babies less than 34 weeks gestation

Step 8. Place the newborn's identification bands on the wrist and ankle

- Putting the identification bands on the hands and ankle will save you from misshaping babies in busy delivery rooms.

Step 9. Weigh the newborn when it is stable and warm

- Place a clean linen or paper on the pan of the weighing scale.
- Adjust the pointer to zero on the scale with the linen/paper on the pan.
- Place the naked baby on the paper/linen. If the linen is large, cover the baby with the cloth.
- Note the weight of the baby when the scale stops moving.
- Never leave the baby unattended on the scale.
- Record the baby's weight in partographs/maternal/ newborn charts and delivery room register and inform the mother
- Inform the mother about the newborn's weight

Step 10. Record all observations and treatment provided in the registers/appropriate chart/cards

Note:

- Defer bathing for at least 24 hours.
- Clean the newborn of an HIV-infected mother as recommended
- Organize transport if necessary

Figure showing the steps of Essential newborn care

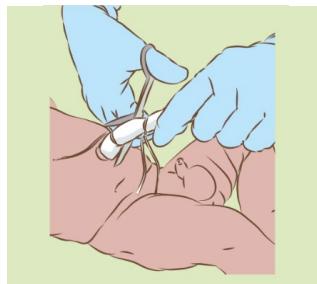
Step 1: Deliver baby on to mother's abdomen or into her arms



Step 2: Dry baby's body with dry towel. Wipe eyes. Wrap with another dry one and cover head



Step 3: Assess breathing and color. If <30 breaths per minute, blue tongue, lips or trunk or if gasping then start resuscitating



Step 4: Tie the cord two fingers from abdomen and another tie two fingers from the 1st one (if no clamp). Cut the cord between the 1st and 2nd tie (clamp)



Step 5: Place the baby in skin-to-skin contact and, on the breast, to initiate breastfeeding.

Step 6: Apply Tetracycline eye ointment



Step 7: Give Vitamin K, 1mg IM on anterior mid-thigh



Step 8: Place the newborn's identification bands on the wrist and ankle



Step 9: Weigh baby (if <1500 gm, refer urgently)

Note: Delay bathing of the baby for 24 hours after birth

Do not remove vernix

Provide postnatal visits during at 6-24 hours, 3 days and 6 weeks

Place the baby in skin-to-skin contact and, on the breast, to initiate breastfeeding.

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Chapter 6: Neonatal resuscitation

Description of chapter

Neonatal resuscitation means to revive or restore life to a baby. Oxygen is essential for survival before and after birth. About 90% of newborns make smooth transition from intrauterine to extrauterine life requiring little or no assistance and 10 to 15% of newborns need some assistance and only 1% require extensive resuscitation. Therefore before any delivery conducted we need to prepare for neonatal resuscitation and follow WHO newborn resuscitation action plan.

At the end of this session

- Identify primary features of fetal and newborn circulation.
- Identify physiologic changes during transition to extrauterine life.
- Identify routine care considerations for a newborn during the transition period.
- Identify signs and symptoms of common problems during transition period.
- Discuss steps for neonatal resuscitation.

Neonatal resuscitation

Definition: Neonatal resuscitation means to revive or restore life to a baby.

Transition from intrauterine to extrauterine life

The successful transition from intrauterine to extrauterine life depends upon significant physiologic changes that occur at birth. In almost all infants, transition changes are successfully completed at delivery without requiring any special assistance. Fetus depends upon the placenta for gas and nutrient exchange. Site of gas exchange for extrauterine life is the lung. Placenta has the lowest vascular resistance and receives 40% of the fetal cardiac output. Fetal lungs are filled with fluid, resulting in a high vascular resistance and less than 10% of the cardiac output going to the lungs. With first breath lung expands and pulmonary pressure drops and blood vessels in the lung tissue relax and pulmonary blood flow increases.

At the completion of this normal transition, the baby is breathing air and using his lungs to get oxygen. His initial crying and deep breaths should be strong enough to help move the fluid from his airways. The oxygen and gaseous distention of the lungs are the main stimuli for the pulmonary blood vessels to relax. As adequate oxygen enters the blood, the baby's skin turns from gray/blue to pink. A baby who has made a normal transition at birth will be term with no meconium, will be crying or have unlabored breathing, and will have good muscle tone.



Figure 1: Baby

who made normal transition

What can go wrong during transition?

A baby may have difficulty before labor, during labor, or after birth. If the difficulty begins in utero, either before or during labor, the problem will usually reflect a compromised blood flow in the placenta or the umbilical cord. The first clinical sign can be a slowing of the fetal heart rate. Problems encountered after birth are more likely to involve the baby's airway. The following are some of the problems that may disrupt normal transition:

- The baby may not breathe sufficiently to force fluid from the alveoli. Foreign material such as meconium may block air from entering the alveoli. As a result, the lungs will not fill with air, preventing oxygen from reaching the blood circulating through the lungs (hypoxemia).
- Excessive blood loss may occur, or there may be poor cardiac function or bradycardia (slow heart rate) from hypoxia (insufficient oxygen to the tissues) and ischemia (inadequate blood to part of the body caused by a blocked artery), so that the expected increase in blood pressure cannot occur (systemic hypotension).
- A lack of oxygen or failure of air to enter the lungs may result in the pulmonary arterioles staying constricted; these arterioles may then remain constricted, thus preventing oxygen from reaching body tissues. (persistent pulmonary hypertension)
- The consequence of inadequate blood perfusion and tissue oxygenation can be brain damage, damage to other organs, or death.

What are the signs of an abnormal transition?



Figure 22: Signs of

abnormal transition

The baby that has transition may exhibit following clinical findings:

difficulty making a normal one or more of the

- Depression of respiratory drive (slow respiratory rate) from insufficient oxygen delivery to the brain
- Poor muscle tone from insufficient oxygen delivery to the brain and muscles
- Cyanosis (blue discoloration of the skin and mucous membranes) from insufficient oxygen in the blood
- Bradycardia (slow heart rate) from insufficient delivery of oxygen to the heart muscle or brain stem

- Poor perfusion from insufficient oxygen to the heart muscle, blood loss, or insufficient blood return from the placenta before or during birth
- Tachypnea (rapid respirations) from failure to absorb fetal lung fluid

Many of these same symptoms may also occur in other conditions, such as infection or hypoglycemia (low blood sugar), or if the baby's respiratory efforts have been depressed by medications, such as narcotics or general anesthetic agents, given to the mother before birth.

Why premature babies are at higher risk

Premature babies have anatomical and physiological characteristics that are quite different from babies born at term. Some of these characteristics are:

- Their lungs may be deficient in surfactant and, therefore, may be more difficult to ventilate. (Surfactant is a substance that lines the inside of the alveoli and prevents them from collapsing). When babies are born prematurely, prior to 34 weeks, they have decreased amounts or lack surfactant, therefore, they have difficulty breathing
- Their thin, permeable skin, large surface-area-to-body-mass ratio, and lack of subcutaneous fat make them more likely to lose heat and have problems with temperature regulation.

Caregivers should be aware of these and other unique characteristics of premature babies and the special challenges they may present during resuscitation.

Risk factors associated with need for resuscitation

Maternal Risk Factors before Labor

Pre-eclampsia and eclampsia	previous fetal or neonatal death
Maternal infection (HIV, STD, Malaria)	Multiple gestation
Premature rupture of membranes	Diminished fetal activity
Post-term gestation	bleeding in second or third trimester
Maternal diabetes	Age <16 or >35 years
Anemia	No prenatal care

Risk Factors during Labor

Foul smelling amniotic fluid	unusual vaginal bleeding before delivery
Prolonged rupture of membranes (>18 hours before delivery)	precipitous labor
Prolonged labor (>24 hours)	Shoulder dystocia
Fetal bradycardia (slowing of heart rate)	Prolapsed cord
Meconium	Forceps or vacuum-assisted delivery
	Narcotics administered to mother

Maternal complications are often unpredictable, but newborn complications are usually predictable based on these factors. Therefore, it is usually possible to anticipate and prepare for resuscitation.

Approximately 90% of newborns make smooth transition from intrauterine to extrauterine life requiring little or no assistance. A 10 to 15% of newborns need some assistance and only 1% require extensive resuscitation

The diagram below illustrates the relationship between resuscitation procedures and the number of newly born babies who need them. At the top are the procedures needed by all newborns. At the bottom are procedures needed by very few.

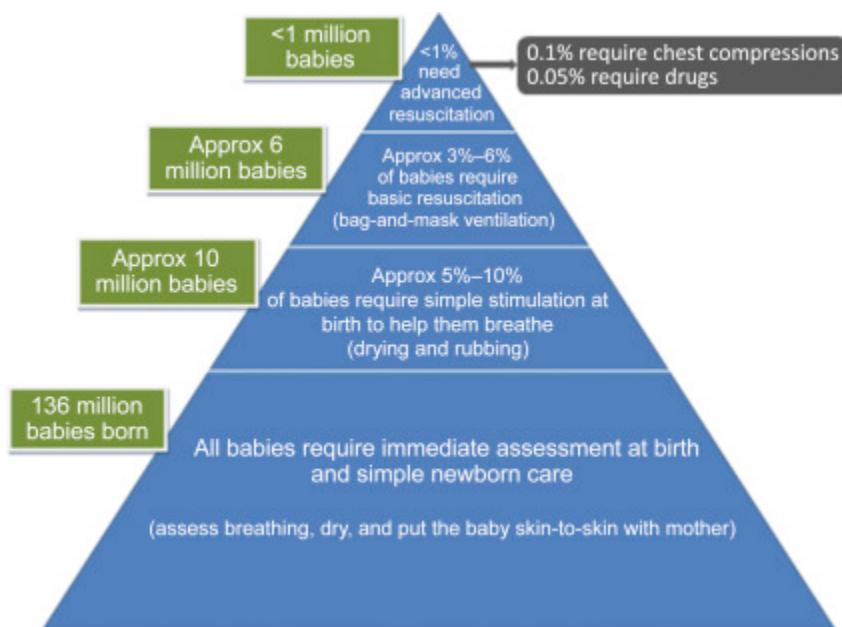


Figure 2: Neonatal resuscitation in Low Resource Settings

Basic steps in resuscitation

For effective resuscitation it is important to:

Anticipate the need for resuscitation based on high risk antepartum and intrapartum factors

Have adequate preparation of equipments: Check the equipment to ensure that there are functional.

Be skillful in resuscitation: A person trained in neonatal resuscitation is required.

Outcomes of asphyxiated newborns can be improved with timely and effective resuscitation.

Essential equipment and supplies

Table : Equipment and Supplies for Neonatal Resuscitation

Suction equipment	Bulb syringe Mechanical suction & tubing Suction catheters (, 8, 10,12Fr)
Bag and mask equipment	Self-inflating bag (250 -750ml) with a pressure release valve, and a reservoir Face masks (term & preterm sizes)

	Oral airways (term & preterm sizes) Laryngeal mask Oxygen source with flowmeter & tubing, if possible O2 blender
Intubation equipment	Laryngoscope with straight blades (No. 00, 0,1) Extra bulbs and batteries ETT (2.5, 3.0, 3.5, 4mm)
Medications	Epinephrine (1:10,000 solution) Volume expanders: normal saline and Ringer's lactate D10W solution & sterile water
Miscellaneous	Radiant warmer Sterile gloves Stethoscope (infant-sized head) Feeding tubes (6, 8Fr) Adhesive tape Syringes Thermometer Pulse oximeter

Neonatal resuscitation flowchart

Neonatal resuscitation can be done using the algorithm developed by NRP, the algorithm is shown in the algorithm below.

Neonatal Resuscitation Algorithm—2015 Update

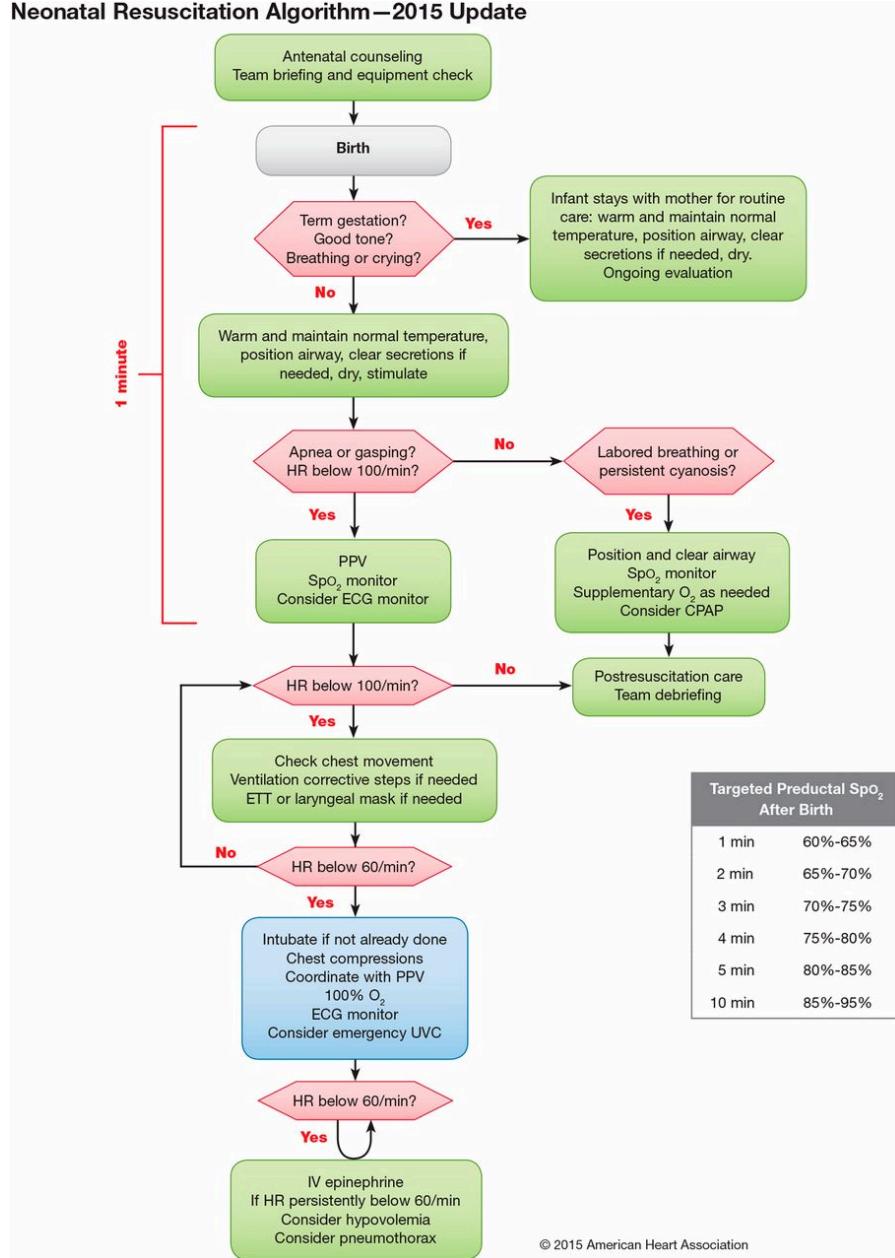


Fig 2: Neonatal Resuscitation Flowchart

Assess for crying/breathing after birth

If crying – provide Routine Care

If baby does not cry immediately after birth,

Initial steps of resuscitation are provided which consist of the following steps:

- Preventing heat loss and providing warmth.
- Drying and removing the wet linen
- **Position head and clear airway** as necessary by placing the newborn on the back with head in midline position and with slight neck extension "sniffing position".

- Suction the mouth first, and then the nose (M before N) gently and briefly by suction bulb or a large-bore suction catheter. Limit suctioning to 5 seconds at a time and avoid aggressive & deep pharyngeal suctioning
- Stimulation of the infant to breathe
 - Apply tactile stimulation by gently rubbing the back or flicking the soles of the feet two-three times.

Evaluation and decision-making are based primarily on respiration, heart rate, **and** color.
Positive pressure ventilation (PPV)

Ventilation of the lungs is the single most effective step in newborn resuscitation.

If there is no response with the above methods, start bag and mask ventilation within the Golden minute.

Indications

- No breathing or gasping respiration, Apnea
- Heart rate less than 100 per minute

Steps

1. Call for help and take to the resuscitation table
2. Position the infant correctly with slight extension at the neck
3. Position the mask correctly and apply a firm seal. Provide 5 breaths and check for rising heart rate, if absent, adequate chest movement.

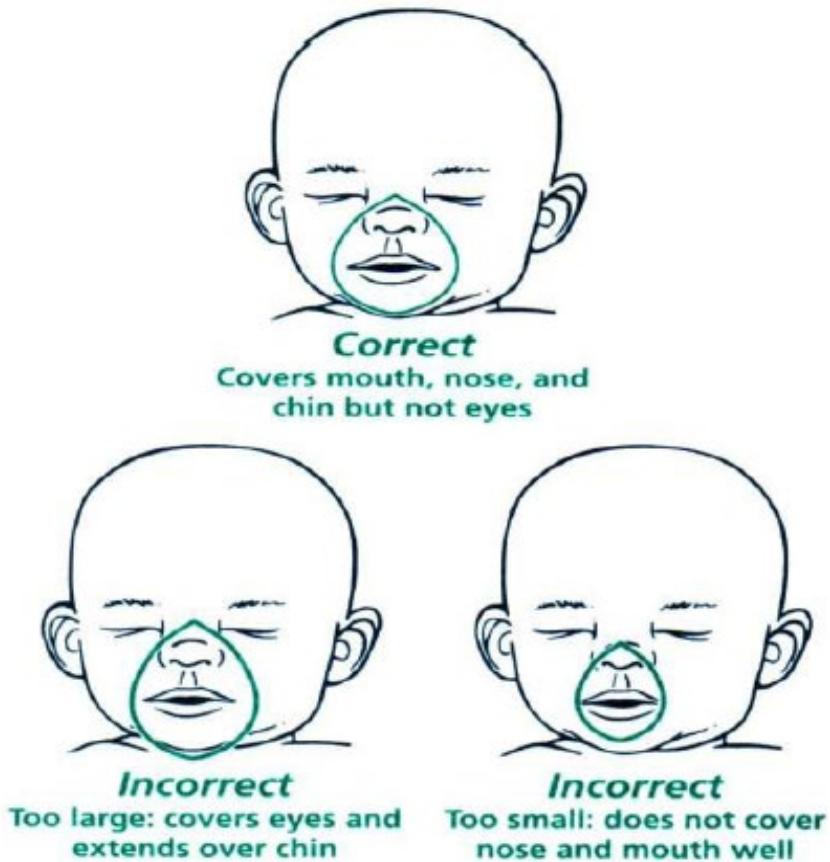


Fig 3: appropriate mask size selection

4. If there is no adequate chest rise, take ventilatory corrective steps (MRSOPA).
 M- Adjust Mask in the face

- R- Reposition the head to open airway
 Re-attempt to ventilate. If not effective then
- S- Suction mouth then nose
- O- Open mouth and lift jaw forward
 Re-attempt to ventilate. If not effective then
- P- Gradually increase Pressure every few breaths until visible chest rise is noted
 Maximum PIP 30 for PT and 40cmH₂O for FT
 If still not effective then
- A- Artificial Airway (ETT or LMA)
5. Once effective ventilation starts, continue for 30 – 60 seconds at 40-60 breaths / minute. In term infants initiate resuscitation with 21% oxygen. If blended oxygen is not available, resuscitation should be initiated with room air. In preterm babies use blender with 21% to 30% oxygen. If blender is not available, a self-inflating bag (with O₂ and without reservoir) provides 40%. The normal pressure required to inflate the lungs is 15 – 40 cm H₂O.

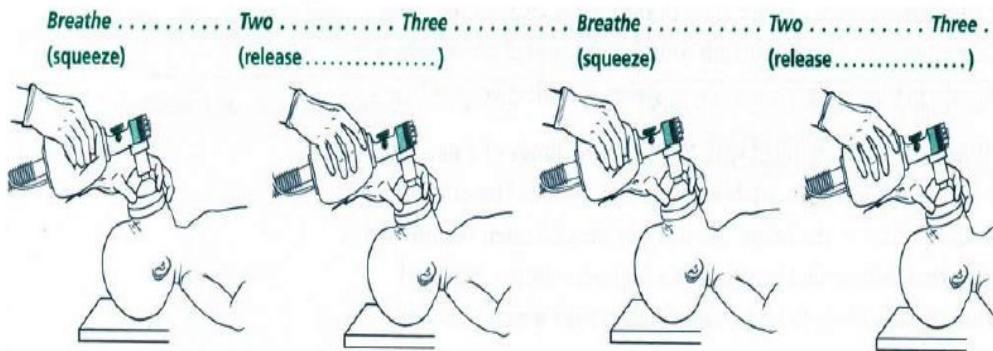


Fig 4: Method of breathing rate counting

1. Evaluate the heart rate after 30 -60 seconds of bag and mask ventilation
2. If heart rate is above 100 and infant has spontaneous respiration, discontinue ventilation
3. Heart rate between 60 & 100 – use corrective steps of ventilation.
4. Heart rate < 60 beats per minute – ensure ventilation with 100% oxygen and initiate chest compression.
5. Pass an oro-gastric tube if bag and mask ventilation is continued for more than 2 minutes.
6. If a baby starts to breath but oxygen saturation (SpO₂) is not within target range, free-flow oxygen administration may begin at 30%.
7. If the newborn has labored breathing or SpO₂ cannot be maintained within target range despite 100% free-flow oxygen, consider a trial of continuous positive airway pressure (CPAP).

Contraindications

- Diaphragmatic hernia

Chest compressions

Indication

If the heart rate less than 60/min despite good assisted ventilation for 60 sec.

Two persons; one to perform chest compression and the other to continue ventilation.

Methods:

- Two-thumb encircling hands method: stand at the infant's foot and grip the chest in both hands; the 2 thumbs press at the junction of the middle and lower thirds of the sternum

(just below an imaginary line joining the nipples); with the fingers wrapped around and supporting the back. Strictly avoiding applying pressure on the xiphoid
Use 100% oxygen during chest compression.

Rate: breathing rate (30 breaths/min), and compression rate (90 compressions/min) (3 compressions in 1 :3 ratio. One & two & three & breathe & One & two & three & breathe &...)

Compression depth: $\frac{1}{3}$ of the chest diameter

Evaluation: After 60 seconds of chest compression, check the heart rate.

If HR < 60/min- Continue compression and ventilation, Initiate medications.

Intubate if possible.

Endotracheal intubation

Indication

- Bag and mask is ineffective or prolonged.
- Before chest compression
- ELBW for administering surfactant
- Tracheal administration of medications is desired.
- Congenital diaphragmatic hernia
- Table 1: ET Tube size based on birth weight and gestational age

TUBE SIZE(ID mm)	B.WEIGHT(g)	GEST. AGEwks)
2.5	<1000	<28
3.0	1000-2000	28-34
3.5	2000-3000	35-38
4.0	>3000	>38

Medication

Epinephrine

Indications: Epinephrine is indicated when heart rate remains <60 after 30-60 seconds of effective ventilations and another 60sec of coordinated compressions and ventilations.(at approximately 2 min of life) .

Dose: 0.1 – 0.3 ml/kg IV or 0.5 - 1 ml/kg Et 1 : 10,000 of epinephrine solution, may be repeated every 3-5 min if required. Endotracheal route is easier, but IV is preferred. Initiate UV cannulation as ET dose is given.

Volume expanders

Volume expansion should be considered when blood loss is known or suspected (pale skin, poor perfusion, weak pulse) and the infant's heart rate has not responded adequately to other resuscitative measures. An isotonic crystalloid solution or blood O-ve may be useful for volume expansion in the delivery room.

Post Resuscitation Care

Infants who require resuscitation are at risk for deterioration after their vital signs have returned to normal. Once adequate ventilation and circulation has been established:

- Stop ventilation.
- Return to mother for skin-to-skin contact as soon as possible.
- Closely monitor breathing difficulties, signs of asphyxia and anticipate need for further care.

Cessation of resuscitation

It is appropriate to consider discontinuing after effective resuscitation efforts if:

- Infant is not breathing and heartbeat is not detectable beyond 10 min, stop resuscitation.
- If no spontaneous breathing and heart rate remains below 60/min after 20 min of effective resuscitation, discontinue active resuscitation.
- Record the event and explain to the mother or parents that the infant has died. Give them the infant to hold if they so wish.

Summary

Although need for resuscitation can be anticipated based on antepartum and intrapartum risk factors and majority of the babies have smooth transition from as they pass from intrauterine to extrauterine life, health workers should have adequate skill and prepare resuscitation equipments in every delivery. Outcomes of asphyxiated newborns can be improved with timely and effective resuscitation.

References

- 1.The neonatal resuscitation is based on the text book of neonatal resuscitation 7th Edition 2015 American Health Association, American Academy of pediatrics as revised by the church of Jesus Christ the Latter Day Saints Charities.
2. Neonatal resuscitation algorithm—2015 update. Reprinted with permission from Weiner GM, Zaichkin J, eds. *Textbook of Neonatal Resuscitation*. 7th ed.
- 3.Berkelhamer S, Kamath-Rayne B, Niermeyer S: Neonatal resuscitation in Low Resource Settings, Clin Perinatol, 2016, Sep;43(3):573-91
- 4.Avory A. Fanaroff and Martin's Neonatal- Perinatal Medicine 10th edition,2015
5. Jone P. Cloherty, Eric C., Anne R. Stark Manual of Neonatal Care 8th edition
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Chapter 7: Perinatal Asphyxia

Perinatal asphyxia is insult to the fetus or newborn due to lack of oxygen (hypoxia) and /or a lack of perfusion (ischemia) to various organs. One of the commonest cause of neonatal mortality is perinatal asphyxia. Careful managements of ventilation, oxygenation, perfusion, metabolic state, and fluid balances are critical to optimizing outcome

Learning objectives:

At the end of this session, the learner is expected to:

- Define perinatal asphyxia
- Recall the basic pathophysiology of asphyxia
- Recognize organ manifestations of asphyxia
- Identify and treat perinatal asphyxia
- State the prognosis of perinatal asphyxia

Important terminologies

- **Anoxia** is a term used to indicate the consequences of complete lack of oxygen as a result of a number of primary causes.
- **Hypoxemia** refers to decreased arterial concentration of oxygen.
- **Hypoxia** refers to a decreased oxygenation to cells or organs.
- **Ischemia** refers to blood flow to cells or organs that is insufficient to maintain their normal function.

Perinatal Asphyxia

Definitions

- World Health Organization (WHO) defines birth asphyxia as failure to initiate and sustain breathing at birth
- It can also be defined as an insult to the fetus or newborn due to lack of oxygen(hypoxia) and /or a lack of perfusion (ischemia) to various organs.

AAP and ACOG Criteria for diagnosis of perinatal asphyxia

- An arterial cord pH < 7.0 and base deficit more than 12
- Apgar score of less than 7 at 5 minutes.
- Evidence of altered neurological status (altered level of consciousness, seizures, hypotonia, obtundation).

This definition using APGAR score is not applicable in

Preterm babies

Babies with birth trauma

Congenital neurologic abnormalities

Epidemiology:

Perinatal asphyxia is the second commonest cause of neonatal mortality only preceded by infection (as in the figure shown below) and the commonest cause of disability in surviving newborns.

Figure 15: Causes of Neonatal Deaths in Ethiopia,

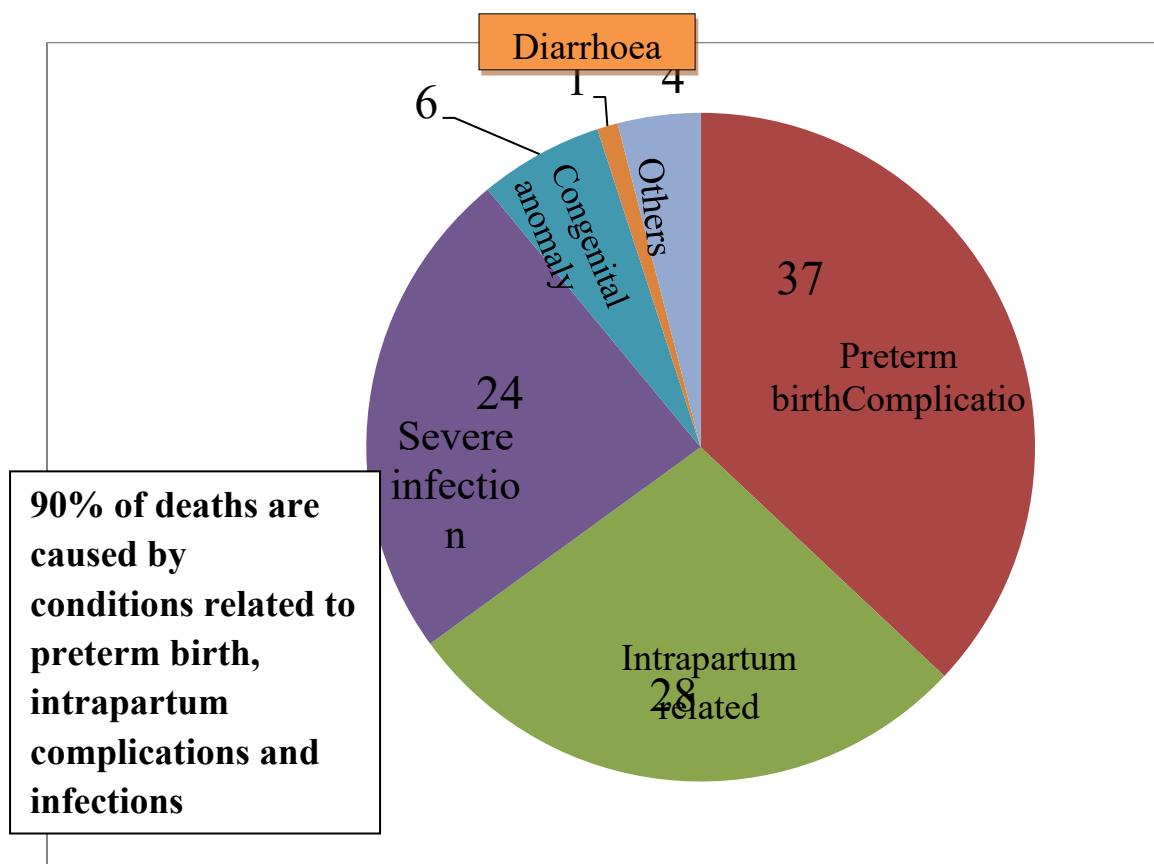


Fig 5: pie graph of common cause of neonatal mortality

Timing of Insult: Asphyxia can occur during antepartum, intrapartum or postpartum period. The following are **risk factors** for asphyxia.

Antepartal events (20%)

- Maternal hypotension
- Severe anemia
- Cardiopulmonary diseases
- Placental abruptio
- Maternal hypertension
- Preeclampsia/eclampsia
- Maternal diabetes

Intrapartum (70%)

- Problems with umbilical circulation (E.g. Cord prolapse)
- Meconium aspiration
- Prolonged labor (maternal/ fetal causes)

Postpartal Asphyxia (10%)

- Prematurity
- Cardiovascular abnormalities
- Pulmonary malformations
- Neurologic abnormalities
- Severe infections
- Bleeding, shock

Generally, risk factors for perinatal asphyxia can be classified as:

- a. Impairment of maternal oxygenation
- b. Decreased blood flow from mother to placenta
- c. Decreased blood flow from placenta to fetus
- d. Increased fetal oxygen requirement

Pathophysiology: When there are factors, which result in low oxygen delivery to the newborn, the initial response is increased respiratory rate followed by apnea. This is a critical time that newborns would require drying and stimulation. If asphyxia is prolonged the following two scenarios would happen.

- **Brief asphyxia:** There is transient increase followed by a decrease in heart rate, elevation of blood pressure and essentially, there will be redistribution of cardiac output. There will be **gasping respiration**. This is followed by increased blood flow to brain, heart and adrenal glands, which is referred to as **DIVING REFLEX**.
- **Prolonged asphyxia:** It leads to decreased blood flow with further compromisation of the heart cascaded by hypotension and increased anaerobic metabolism in the brain. Decreased cerebral flow with anaerobic metabolism later complicates energy failure, increased glucose metabolism and ATP depletion. The final outcome is diffuse cortical and sub cortical injury.

Organ manifestations of perinatal asphyxia

Organ manifestations of perinatal asphyxia

Multisystem organ dysfunction (CNS 72%, renal 42%, heart 29%, intestine 29% and lungs 26%).

Perinatal/neonatal depression: The clinical features of infants may include depressed mental status, muscle hypotonia, and/or disturbances in spontaneous respiration and cardiovascular function in the immediate postnatal period(in the first hour after birth).

Neonatal encephalopathy is a clinical and not an etiologic term that describes an abnormal neurobehavioral state and usually other signs of brainstem and/or motor dysfunction. No specific ethiology.

Hypoxic-ischemic encephalopathy (HIE) is a term that describes clinical evidence of encephalopathy as defined earlier, with objective data to support a hypoxic-ischemic (HI) mechanism as the underlying cause for the encephalopathy.

Hypoxic-ischemic (HI) brain injury refers to neuropathology attributable to hypoxia and/or ischemia as evidenced by neuroimaging, biochemical markers of brain. The diagnosis of HIE and/or HI brain injury is not a diagnosis of exclusion, but ruling out other etiologies of neurologic dysfunction is a critical part of the diagnostic evaluation.

In term infants with asphyxia, renal, CNS, cardiac and lung dysfunction occur in 50%, 28%, 25% and 25% cases, respectively. The extent of organ system dysfunction determines the early outcome of an asphyxiated neonate.

Table 13: Clinical spectrums of HIE includes mild, moderate or severe according to Saranat stages of HIE

SIGNS	STAGE 1	STAGE 2	STAGE 3
Level of consciousness	Hyper alert	Lethargic	Stuporous, coma
Muscle tone	Normal	Hypotonic	Flaccid
Posture	Normal	Flexion	Decerebrate
Tendon reflexes/clonus	Hyperactive	Hyperactive	Absent
Myoclonus	Present	Present	Absent
Moro reflex	Strong	Weak	Absent
Pupils	Mydriasis	Miosis	Unequal, poor light reflex
Seizures	None	Common	Decerebration
Electroencephalographic findings	Normal	Low voltage changing to seizure activity	Burst suppression to isoelectric
Duration	<24 hr if progresses; otherwise, may remain normal	24 hr-14 days	Days to weeks
Outcome	Good	Variable	Death, severe deficits

Renal dysfunction

- Often accompanies prenatal asphyxia
- renal damage ranges from reversible cloudy swelling & hydropic degeneration of tubles to infarction of the entire nephron.
- Decrease in UO(<0.5ml/kg/hr which may last 2 day to 2 weeks
- Protein & cast may present in the urine
- Gross hematuria may present
- Elevation of BUN& creatinine may occur
- Poly urea may flow oliguric phase or they may develop anuria

CVS dysfunction

- May cause myocardial ischemia which usually is transient
- Patients show tachypnea, tachycardia & hepatomegally consistent with heart failure
- Rarely causes cardiogenic shock and death

Pulmonary dysfunction

1. Pulmonary edema

- Due to myocardial dysfunction
- May have sign of respiratory distress

2. Acute respiratory distress syndrome

- Increased pulmonary capillary permeability to plasma protein which leads to inactivation of surfactant

Laboratory evaluation

- CBC
- RBS
- Urine analysis
- Stool for blood
- Renal function
- Liver function test
- Echocardiography as needed
- Serum electrolytes,
- EEG
- CXR
- Brain imaging

Management of asphyxia in the newborn

Management of asphyxia

- A. Keep NPO for severe PNA (because of risk of necrotizing enterocolitis, it can be for 48 hours).
 - Start feeding (with 5 to 10ml) when the neonate is passing meconium, clear gastric content, normoactive bowel sound and then advance as tolerated
- B. Fluid Management - two third of the maintenance fluid (avoid both overload and inadequate circulating volume)
- C. Oxygenation it should be maintained in the normal range (Saturation between 90-95%)
- D. Maintain normal temperature.

Cooling therapy is the standard treatment for hypoxic ischemic encephalopathy. However, it is not available in Ethiopian setup. **See below for further information**

- E. Correction of Metabolic States-
 - Blood glucose has to be kept in the normal range. Hypoglycemia is often seen in asphyxiated newborns. It increases energy deficit. It has to be treated with 2ml/kg of 10% dextrose 4ml/kg (in the presence of seizure) followed by maintenance.
 - Hypocalcemia (can cause seizure and decreased cardiac contractility) administer 1-2ml/kg of 10% calcium gluconate QID or add in to the maintenance fluid.
 - F. Seizure Treatment (refer to the guideline on seizure treatment)
 - G. Management of other organ system dysfunctions
- Congestive heart failure – diuretics, dopamine or dobutamine
Acute renal failure – dopamine
Gastrointestinal – delay oral feeding
Hematologic failure – blood component replacement
- H. Parent counseling has to be the integral part of management!

Therapeutic hypothermia

Evidence shows that artificially lowering body and brain temperature can significantly reduce the deleterious effects of brain injury in newborns. Therapeutic hypothermia (whole body or selective head cooling) is now the standard of care for brain injury control in term infants with perinatal hypoxic ischemic encephalopathy (HIE). Recent studies in newborns have shown a reduction in mortality and long-term neurodevelopmental disability at 12-24 months of age. Induction of therapeutic hypothermia seems to ameliorate the molecular cascade that culminates in neuronal damage. Hypothermia attenuates the toxicity produced by the initial injury that would normally produce reactive oxygen species, neurotransmitters, inflammatory mediators, and apoptosis.

The aim of this apparatus is to reduce the core (rectal) temperature to 33-34° C for 72 hours in a constant manner. Its effectiveness was observed in those babies started within 6 hours of birth and those infants 36 weeks or more gestation and birth weight of >1800gm.

Cooling Apparatus



Therapeutic hypothermia

- Indication :-
- Infants 36 weeks or more gestation and birth weight of >1800gm
- Age less than 6 hours at admission.
- Evidence of moderate to severe encephalopathy.
- Infant must have 2 or more of the following-
 - APGAR score of 5 or less at 10 minutes,
 - Cord or arterial pH <7 or base deficit of 12 or more within 60 minutes of birth
 - ventilation or resuscitation at 10 minutes.

Prevention of prenatal asphyxia

The minimum preventive measure which is provided during perinatal period is much better than a sophisticated care provided to an asphyxiated new born.

Prenatal assessment of changing fetal and placental condition by clinical assessment and ultrasonography

Fetal Biophysical profile

Monitor progress of labor

Effective neonatal resuscitation

Prognosis of HIE

- **Stage I(mild HIE)** 98- 100% of newborns will have a normal neurological outcome and < 1% mortality
- **Stage II(moderate HIE)** 20-37% of them die or have abnormal neurodevelopmental outcome
- **Stage III (Severe HIE)** death is more likely survivors would have one or more major neurodevelopmental disability such as Cerebral palsy, intellectual disability, visual impairment or epilepsy.

Perinatal Asphyxia Follow up chart

The very important thing is anticipation of complications and act accordingly.

Perinatal Asphyxia Follow up chart

Parameters	Day1	Day2	Day 3
PR			
RR			
T°			
SO2			
Wt			
HC			
Input			
Output			
Capillary refill			
RBS			
Urine analysis			
Serum electrolyte			
RFT			
LFT			
Gastric content			
Bowel sound			
Bloody stool			
Mental status			
Neonatal reflexes			
Motor tone			
Seizure			
Progressive patient Assessment			
Treatment plan			

Summary

Early identification and prompt management during prenatal, intrapartum and postpartum periods is crucial to prevent occurrences of perinatal asphyxia. Careful management of ventilation, oxygenation, perfusion, metabolic state, and fluid balances are critical to optimizing outcome

References

- 1.The neonatal resuscitation is based on the text book of neonatal resuscitation 5th Edition 2006 American Health Association, American Academy of pediatrics as revised by the church of Jesus Christ the Latter Day Saints Charities.
- 2.Neonatal resuscitation algorithm—2015 update. Reprinted with permission from Weiner GM, Zaichkin J, eds. *Textbook of Neonatal Resuscitation*. 7th ed.
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- 4.Avory A. Fanaroff and Martin's Neonatal- Perinatal Medicine 10th edition,2015
- 5.Jone P. Cloherty, Eric C., Anne R. Stark Manual of Neonatal Care 8th edition

Chapter 8: Thermoregulation

Course Objectives: at the end of this session, the participants should be able to:

- Know the normal ranges of body temperature
- Understand the thermo-neutral environment for the newborn
- Understand the mechanisms of heat loss and heat gain in newborns
- Know how to prevent and manage hypothermia in newborns

4.1 Neonatal thermoregulation

Newborn survival can be improved by prevention of excessive heat loss, which in turn reduces their bodies' need to perform heat-producing metabolic work.

After birth, newborns must adapt to the new and colder environment by metabolic production of heat since they lack adequate muscular activity (shivering response).

Heat loss can be minimized by keeping newborns in thermo-neutral environment, which is defined as the narrow range of environmental temperature at which a given baby can maintain normal body temperature with minimum calorie (oxygen) consumption.

The normal body temperature of a newborn is between 36.5°C - 37.5°C . Hypothermia is defined as skin (axillary) temperature less than 36.5°C .

In general, newborns and premature and LBW babies in particular are at risk of hypothermia because of their large surface area for small body mass for the following reasons:

- Highly permeable skin which increases epidermal water loss
- Deficient subcutaneous fat with less insulation
- Deficient stores of brown fat
- Immature central thermoregulation
- Poor caloric intake
- Poor oxygen consumption because of associated pulmonary problems

Newborns may lose heat by the following mechanisms:

- **Convection** – where heat is lost from the skin to moving air.
- **Radiation** – where heat is dissipated from the baby to a colder object in the surrounding like to the floor, wall or window.
- **Conduction** – where the baby loses heat to the surface on which he or she lies.
- **Evaporation** – major cause of heat loss immediately after birth where water is evaporated from wet infants skin like evaporation from boiling water.

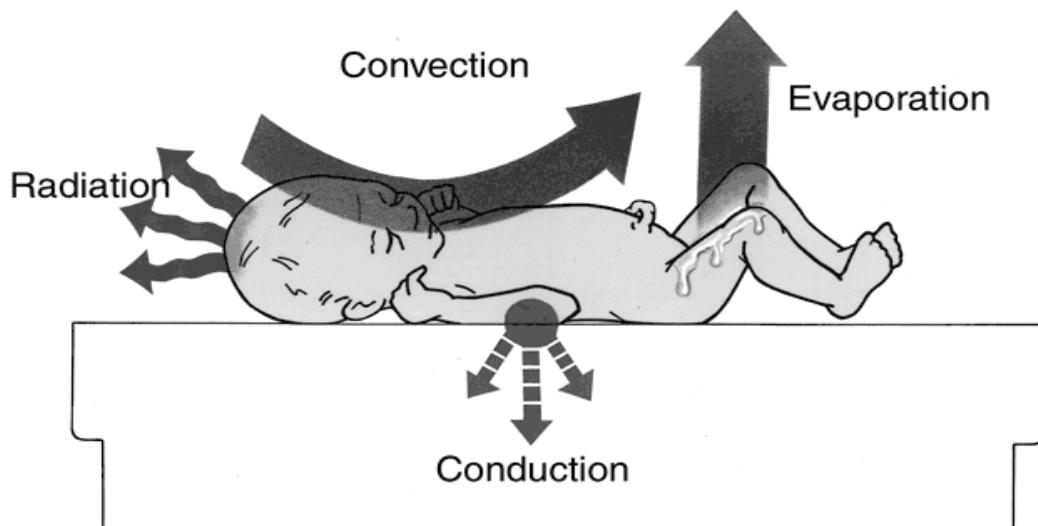


Figure 29: illustrating physical mechanisms of heat loss

4.2 Hypothermia

Classification

Based on its severity hypothermia could be:

- Mild (cold stress) = $36^{\circ}\text{C} - 36.4^{\circ}\text{C}$
- Moderate = $32^{\circ}\text{C} - 35.9^{\circ}\text{C}$ and
- Severe (neonatal cold injury) $< 32^{\circ}\text{C}$

Causes of hypothermia

- Cold environment/room
- Wet or naked baby
- Cold linen
- Transportation without proper precaution
- Procedures without thermal protection
- Early bath
- Sepsis
- Prematurity
- Hypoglycemia
- Hypoxia
- Congenital defects (gastroschisis, omphalocele, neural tube defects etc...)

Clinical manifestations

- Bluish discoloration of extremities (acrocyanosis)
- Cold and mottled extremities
- Sluggish and inactive neonate
- Unsatisfactory weight gain and slow increase in head size

Newborns with severe hypothermia may present with

- Hypoglycemia
- Failure to suckle

- Bradycardia
- Disseminated intravascular coagulation
- Irregular and slow breathing
- Shock

Prevention

Before delivery

- Warm delivery room
- Organize newborn corner with adequate heat source

At delivery

- Deliver the baby on mother's abdomen
- Dry the baby thoroughly immediately after birth and remove wet clothes.
- Use cap to prevent significant heat loss through the scalp
- Keep the newborn in skin to skin contact with the mother
- Keep the newborn under pre heated radiant warmer or a pre-warmed rice bag – if need for resuscitation
- Cover weighing scales with warm towel
- Initiate early breast feeding

Subsequent care

- Arrange appropriate transportation if needed including KMC (see section on transporting the newborn)
- Postpone bathing (after 24 hours)
- Warm hands and stethoscope before touching the baby
- Do examination/resuscitation of the infant in a warm environment
- Practice rooming in wards/post natal rooms
- Keep the newborn away from windows and drafts
- Continue breast feeding

General management

- Identify and treat cause of hypothermia(disease process and environmental conditions)
- Put hypothermic infants on KMC, in incubators or under radiant warmer.
- Warm the new born slowly (*see management of severe hypothermia*)
- Monitor axillary temperature every 30 minutes till newborn temperature becomes stable
- Monitor environmental temperature

Management of newborns with severe hypothermia

- Warm the baby using a pre warmed radiant warmer.
- Remove cold or wet cloths.
- Cover the baby with warm clothes and hat.
- Treat for sepsis, if present
- Measure blood glucose and treat if hypoglycemic.
- Keep IV fluid under the radiant warmer to warm the fluid.
- Measure the baby's temperature every hour.
- If the baby's temperature is increasing at least 0.5 °C per hour in the 1st three hours, re warming is successful.
- Then measure the baby's temperature every two hours.

- If the baby's temperature does not rise or is rising more slowly than 0.5 °C per hour, check and reset temperature of the warmer.
- Once the baby's temperature is normal, measure the temperature every three hours for 12 hours and then 12 hourly.
- Monitor for complications and manage accordingly
 - Look for respiratory problems
 - Monitor vital signs
 - Monitor urine output
 - Monitor blood sugars
 - Look for signs multi organ failure

Dangers of warmers

- Hyperthermia
- Dehydration
- Mask serious infections

4.3 Hyperthermia

It is less frequently seen when compared with hypothermia. It occurs when axillary temperature is above 37.5°C.

Causes

- High environmental temperature
- Dehydration
- Infection
- Over wrapping
- CNS dysfunction and
- Medications

Signs of hyperthermia

- The newborn will be tachypneic
- Irritability and restlessness
- Flushed, bright and pink skin

When environmental temperature is the cause of hyperthermia, the trunk, extremities will have the same temperature, and the infant appears pink/vasodilated. But infants with sepsis are often vasoconstricted and the extremities are 2°C to 3°C colder than the trunk.

When high environmental temperature is suspected as a cause of fever, adjust room temperature, dress them with suitable clothing, expose them to room temperature or immerse them in tepid water and measure temperature.

Management

- Initiate early and frequent breast feeding
- Keep the baby away from source of excessive heat
- Remove extra cloths
- Look for possible causes including infections and treat accordingly.

N.B

- Do not use antipyretics as initial treatment.
- Do not rash to start antibiotics before ruling out other causes

Reference

1. Nelson text book of Pediatrics 21th ediction
2. Jone P. Cloherty, Eric C., Anne R. Stark. Manual of Neonatal Care 8th edition
3. WHO/FHE/MSM/93.2. Thermal control of the Newborn: a practical guide,1994

Chapter 9: Kangaroo mother care (KMC)

At the end of this session the learner will be able to:

- Effectively support mothers and caretakers to practice kangaroo mother care (KMC) by being able to
- Define KMC
- Describe KMC.
- Identify babies eligible for KMC.
- Explain and demonstrate steps of KMC.
- Effectively support the feeding of babies and monitor growth of babies during KMC



What is KMC?

Kangaroo mother care consists of prolonged continuous skin-to-skin care of babies (usually low birth weight or very low birth weight). KMC also promotes early and exclusive breastfeeding, but may be used even when babies are formula fed.

The cornerstones of KMC

Kangaroo Position

Dress the baby in a nappy and cap and place in an upright position against the mother's bare chest, between her breasts and inside her blouse. One may use a special garment, or one can tuck the mother's blouse under the baby or into her waistband. Cover both mother and baby with a Gabi, blanket or jacket if it is cold. You too can be innovative.

Kangaroo Nutrition

Babies who are unable to suckle should be fed expressed breast milk via a nasogastric tube or cup if they can swallow. Keep babies in the KMC position whilst being tube fed. Allow them to try to suckle during the tube feed.

In the KMC position, babies will declare themselves ready to suckle, as their rooting and sucking reflexes become manifest. Once the baby is able to suckle, allow the baby to breast feed on demand but at least every three hours.

Kangaroo Support

It is very important to explain and demonstrate to the mother until she is motivated and confident to try the kangaroo position. Assist the mother with positioning and feeding, and give emotional support. The concept should be explained to other family members (especially the maternal grandmother), and they can also practice KMC (especially the father).

When to discharge from the hospital

Discharge when the baby has a sustained weight gain of at least 15 grams /kg /day. Bring the baby back for follow up in the next few days to ensure that baby is well and growing. It is advised practice to follow up KMC babies in a designated place.

Types of Kangaroo Mother Care

Intermittent KMC

This type of KMC is not done on a 24-hour basis but only for certain periods of the day. The mother stays at home or within the hospital but comes to the neonatal unit to do KMC at specified times; the newborn is left in an incubator for the remainder of the time. Intermittent KMC is mostly used for very small and sick babies, and/or for mothers who do not want or are not yet ready or able to practice continuous KMC. Examples include very LBW infants or mothers who are recovering from surgery (e. g., C-section). Intermittent KMC can be practiced while the baby is still in neonatal unit or delivery room . It is possible even with babies on oxygen and IV therapy. Frequency is determined by how stable baby is. A common sense approach is best.

Continuous KMC:

This is when KMC is practiced 24 hours every day (except for very short periods when the mother has to bathe or attend to other personal needs) and requires support from family members, including the husband. It is the ideal type of KMC for LBW babies. Continuous KMC can be instituted once the baby is stable, sucking well and needs no additional care. The baby can then be transferred to an adjoining KMC ward. Smaller babies may be able to go onto continuous KMC if they are stable and do not require oxygen.

Initiating and maintaining KMC: Why, Where, who, How, When

Why KMC?

Research and experience show that KMC is at least equivalent to conventional care (incubators), in terms of safety and thermal protection. KMC, by facilitating breastfeeding, also offers noticeable advantages in cases of severe morbidity. KMC contributes to the humanization of neonatal care and to better bonding between mother and baby in both low and high-income countries.

Where do we do continuous KMC?

The KMC ward should be in close proximity to the Neonatal unit and under the supervision of the Neonatal staff, with 24-hour nursing coverage. The ward should be comfortable, homely and warm but not heated. There should be no crib.

Who can provide Kangaroo Mother Care?

- Everyone can provide KMC as long as they understand the method and are motivated to practice it.
- All those who want to assist the mother can practice KMC, such as grandmothers, sisters, aunts, husbands, and even friends.

Duration of KMC

Both **Intermittent KMC and Continuous KMC** are practiced as long as possible until the baby no longer tolerates the method. Babies ,who outgrow KMC, become restless and will usually try to get out of the skin-to-skin position. Local KMC protocols may vary regarding the weight when babies are discharged from KMC follow-up. It is important to note, however, that babies should still be breastfed and kept warm even when KMC is no longer practiced.

How to practice kangaroo mother care

When to start KMC

KMC should be started as soon as possible after birth.

Eligibility criteria for KMC

The following criteria should be used to decide whether a mother should begin KMC:

- The willingness of the mother to do KMC
- Babies under phototherapy may be evaluated to receive intermittent KMC.

Start KMC at your health facility

Positioning of the mother and baby

In KMC the baby, wearing only a nappy, socks and a hat, is held upright between the mother's breasts in continuous contact with her skin (skin-to- skin contact). The position of the baby against the mother's chest underneath the cloth should secure the position of the baby's head and neck.



The mother covers her baby with her own clothes and an additional blanket or shawl to cover the baby. While resting, the mother should be in a comfortable, moderately inclined position at about a 30-degree angle, supported with pillows to keep her comfortable.

Figur

When the mother walks around, the baby is still kept upright by a cloth. It is important that the nappy is changed soon after wetting or soiling, not only for the comfort of mother and baby but to reduce the body's heat loss.

Keeping the baby in the KMC position can be demanding for the mother, as continuous KMC practice is a tiring job. To assist the mother when she is tired or is attending to personal needs such as bathing, other family members (such as husbands, grandmothers, mothers-in-law, or older siblings) can be taught how to care for the baby in the kangaroo position so they can give the mother relief when necessary.

Steps in positioning the baby for KMC:

1. Dress the baby in socks, a nappy, and a cap.
2. Place the baby between the mother's breasts.
3. Secure the baby on to the mother's chest with a cloth
4. Put a blanket or a shawl on top for additional warmth.
5. Instruct the mother to put on a front-opened top: a top that opens at the front to allow the face, chest, abdomen, arms and legs of the baby to remain in continuous skin-to-skin contact with the mother's chest and abdomen.
6. Instruct the mother to keep the baby upright when walking or sitting.
7. Advise the mother to have the baby in continuous skin-to-skin contact 24 hours a day (or less in the case of intermittent KMC).
8. Advise the mother to sleep in a half-sitting position in order to maintain the baby in a vertical position.



Figure 32: Position the baby for KMC.
(Illustration adapted from Home Based Life Saving Skills - Baby Information. Buffington, Sibley, Beck and Armbruster. 2004. American College of Nurse-Midwives. ISBN 0-914324-09-8.)



Figure 33: Securely wrap the baby with a cloth tied around the mother. (Illustration adapted from Home Based Life Saving Skills - Baby Information. Buffington, Sibley, Beck and Armbruster. 2004. American College of Nurse-Midwives. ISBN 0-914324-09-8.)



**Figure: Father's turn for KMC
Sleeping and resting in KMC**

The mother will best sleep with the baby in kangaroo position in a reclined or semi recumbent position, about 15 degrees from the horizontal plain. This can be achieved with an adjustable bed, if available, or with several pillows on an ordinary bed (figure 5). It has been observed that this position may decrease the risk of apnoea for the baby. If the mother finds the semi-recumbent position uncomfortable, allow her to sleep as she prefers because the advantages of KMC are much greater than the risk of apnoea. Some mothers prefer sleeping on their sides in a semi reclined bed (the angle makes sleeping on the abdomen impossible) and if the baby is secured as described above there will be no risk of smothering.



Figure : Sleeping and resting during KMC

Daily routine of a KMC Ward

Babies should be weighed daily, and feeds adjusted according to weight gain. If not yet breastfeeding on demand, they should receive 175ml/kg/day of expressed breast milk, in 8 feeds 3 hourly.

Babies on oxygen should have their oxygen saturation monitored 3 hourly.

Discharge from KMC position

Discharge from the kangaroo positions is usually determined by the babies themselves. When babies are about 40 weeks post menstrual or when their weight is about 2500 grams whichever comes first babies will not be comfortable in kangaroo position and moves a lot to indicate that they no more need the position. Then the health worker or the mother needs to discharge the baby from the kangaroo position by then.

ESTABLISHING KMC SERVICES

This section describes the establishment and organization of services which also include provision of suitable space, essential equipment and supplies for mothers and babies, staffing and capacity building of health providers.

1. Conducting a facility assessment

It is important to conduct a facility assessment before setting up a KMC service. This is in order to determine the facility's capacity to provide the service and identify any gaps for resource mobilization. A tool for facility assessment has been provided in annex and the minimum standards for a KMC unit are highlighted in the sections below

2. Implementation

- Provide orientation and awareness sensitization on the result of the assessment to the Hospital management by comparing the existing practice with the recommended standard
- Based on assessment finding arrange space & availed the recommended No of chairs/ beds, supplies refrigerators for KMC service (both for continuous and Intermittent KMC)
- Integrate KMC practice as part of routine neonatal care and sustain KMC service

3. Staffing

Kangaroo Mother Care does not require additional staff at the health facility and it is recommended that the existing staff should have adequate training in all aspects of KMC. The KMC ward should be managed as part of the Newborn Unit. The basic complement of staff should include nurses, clinicians, midwives and health officers.

4. Capacity building requirements

The skills and competencies of the staff providing KMC services should be updated through training, mentorship and supervision. Mentorship and support supervision should be carried out.

5. Facilities, equipment and supplies

KMC does not require special facilities but simple arrangements can be made to make the mother's stay more comfortable to include the following:

Sufficient space that can accommodate enough beds, side cupboards, refrigerator and comfortable chairs. Recommended ratio for KMC bed to newborn bed is 1:3. For every 3 new born care bed we need to have one KMC bed

Essential facilities to go with the room include:

- Bathrooms and toilets
- A facility where they can wash clothing items
- Sinks with running water and soap for effective hand washing

Additional support could include:

- The beds should be comfortable and adjustable with enough pillows to maintain an upright or semi-recumbent position

Rooms should have privacy and adequate warmth (22-24°C). Curtains or screens can

help to ensure privacy. Heaters should be available for periods when temperatures may fall below 22°C.

Facility for health education, promotion and entertainment

Reference

1. WHO recommendation on provision of continuous Kangaroo mother care preterm newborns, Nev, 2015
2. WHO recommendation on provision of Intermittent Kangaroo mother care preterm neonates, if continuous Kangaroo mother care is not possible Nev, 2015
3. Haftom G. et al. Quality of Kangaroo Mother Care Services in Ethiopia: Implication for policy and practice.2019

Chapter 10: Prematurity

Learning Objectives

At the end of this session, the participants should be able to:

- Define prematurity
- Recall the challenges faced after delivery
- Identify risk factors for premature delivery and
- Recognize common problems in preterm newborns

Definition: A newborn delivered before a gestational age of completed 37 weeks (259 days).

Premature newborns have many physiologic challenges when adapting to the extra uterine environment. They additionally have a higher morbidity and mortality when compared to full term (37-42 Gestational Weeks) newborns. Preterm delivery accounts for 75-80% of all neonatal morbidity and mortality.

Causes: prematurity is associated with the following conditions –

- Low socioeconomic status
- Acute or chronic maternal illnesses
- Multiple pregnancy
- Maternal age less than 20 or greater than 35
- Obstetrics factors (hypertensive disorders, Antepartum hemorrhage, cervical incompetence, uterine anomalies)
- Maternal physical stress
- Trauma

Common Problems of Prematurity

Most of the problems of prematurity are related to difficulty in extra uterine adaptation due to immaturity of organ systems. Common problems as follows:

1. Respiratory
 - A. Respiratory distress syndrome (RDS)
 - B. Apnea of prematurity
2. Neurologic
 - A. Respiratory center depression
 - B. Intra cranial hemorrhage
3. Cardiovascular
 - A. Hypotension (due to hypovolemia, sepsis, cardiac problems)
 - B. Patent ductus arteriosus (PDA)
4. Hematologic
 - A. Anemia

- B. Hyperbilirubinemia
- 5. Nutritional and Gastrointestinal
 - A. Content, amount and route of feeding problem
 - B. Necrotizing enterocolitis (NEC)
- 6. Metabolic
 - A. Hypo or hyperglycemia
 - B. Fluid and electrolyte imbalance
- 7. Renal – low glomerular filtration rate and inability to handle water and solute loads
- 8. Temperature regulation
- 9. Immunologic – immature immune defenses
- 10. Ophthalmologic – retinopathy of prematurity (ROP)

Hyaline membrane disease (RDS type 1)

Primarily, it is caused by immaturity of the lung (lack of adequate surfactant substance, which prevents collapse of alveoli at the end of expiration).

Epidemiology

Most cases of hyaline membrane disease occur in babies born before 37 weeks of gestation. Incidence is inversely related to gestational age and birth weight. It is uncommon in full term babies. The incidence based on gestational age is as follows:

- Less than 28 weeks 60 – 80%,
- 32-36 weeks 15-35% in
- >37 weeks 5%.

Uncomplicated course characterized by peak severity at 1-3 days. Onset of recovery is at 72 hrs.

Risk factors:

- Low gestational age, low birth weight, Male predominance, maternal diabetes, perinatal asphyxia, elective caesarian section

Clinical manifestations

- Respiratory distress (Grunting, flaring, retraction, tachypnea)
- Auscultatory findings – markedly decreased air entry bilaterally
- Cyanosis

Investigation

- CBC, chest X-ray, if possible blood gas analysis, septic work up, oxygen saturation

Prevention

- Antenatal corticosteroids (at least 24-48 hrs before delivery) given to pregnant women < 34 weeks of gestational period
- Prevention of preterm delivery

Management

- Nasal CPAP with continuous monitoring (see Neonatal Procedure)
- Fluid and metabolic management
- Surfactant substance administration

Complication and Prognosis

- Air leaks (pneumothorax, pneumomediastinum)
- Intracranial bleeding, pulmonary hemorrhage
- Bronchopulmonary dysplasia
- Retinopathy of prematurity

Nasal Continuous Positive Airway Pressure Ventilation (nCPAP)

Indications:

1. Mild to moderate respiratory distress as a result of:
 - Respiratory distress syndrome-for those <32 weeks, start CPAP as early as possible after delivery even before and during transporting to NICU
 - Wet lung syndrome (Transient Tachypnea of the newborn)
 - Meconium Aspiration Syndrome
2. Apnea of prematurity
3. Atelectasis (and also small lung volume)

Contraindications

1. Upper airway abnormalities
2. Severe cardio-respiratory instability
3. Essential intubation and mechanical ventilation

Dangers (complications)

1. Nasal obstruction as a result of secretions or displaced nasal prongs

2. Nasal prongs displacement
3. Nasal decannulation
4. Water accumulate in circuit and nose
5. Pneumothorax
6. CO₂ retention, impaired pulmonary blood flow
7. Abdominal distension



Figure 57: Setting up the nCPAP Apparatus

Always start at the lowest possible pressure

5cm of water

4cm of water for apnea and gradually increase as needed.

During weaning off of CPAP, follow gradual decreament of the pressure.

Types of Prongs (4 Types)

There are four types of nasal prongs that we can possibly use as shown in the figures below.

1. Argyle
2. Hudson
3. Inca
4. Fisher and paykel

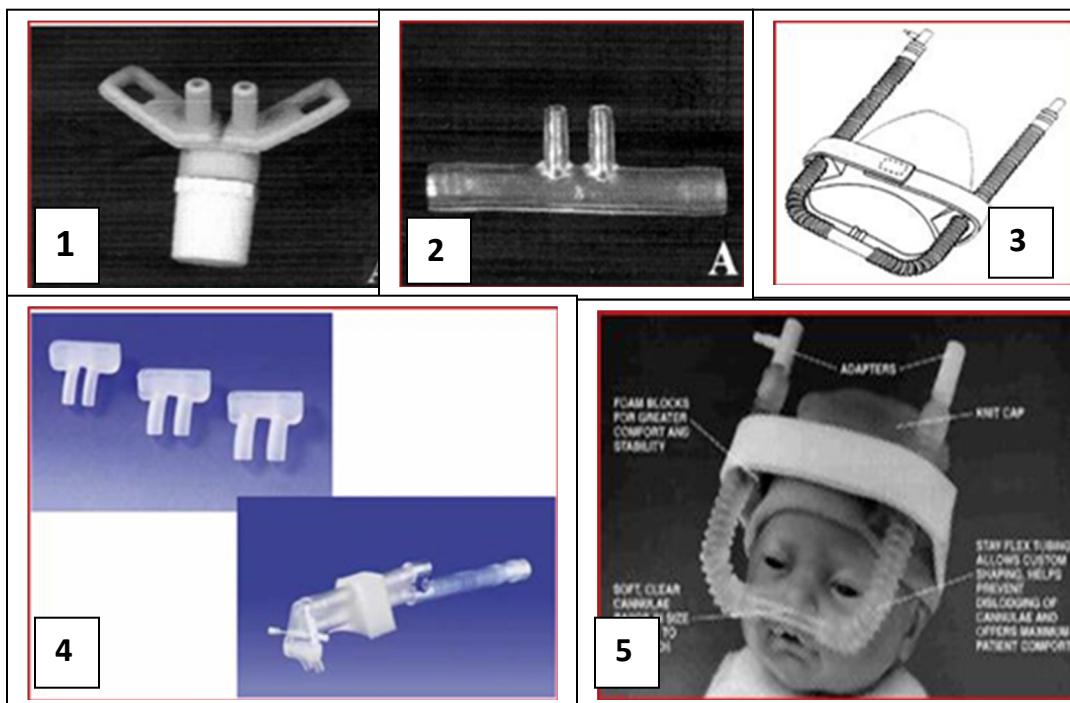


Figure 58: Types of prongs (1-Argyle ,2-Hudson , 3&5 Inca d and 4 Fisher and paykel)

Commence nCPAP as quickly as possible

1. Palace baby supine in overhead radiant heater bed with small rolled up nappy under the shoulders
2. Keep baby NPO initially with orogastric tube on open drainage
3. Begin intravenous infusion

4. Put snug-fitting woolen cap on baby's head
5. Choose correct size of nasal prongs so as to fit comfortably into nostrils. insert without pressing on nasal septum.
6. Connect correct size of nasal prongs to the nosepiece and place in baby's nostrils. The prongs should fit smugly without pressing on the nasal septum.
7. Tie the tapes of the nosepiece to the woolen cap with sticking plaster
8. Check that there is sterile water in the humidifier
9. Commence initial oxygen flow of 6-8litres/minute or 4-5cm H₂O pressure
10. Adapt oxygen concentration (FiO₂) according to saturation.
11. Observe baby and document saturation

APNEA

It is a disorder of respiratory control characterized by absence of air flow for ≥ 20 seconds or less than that if it is accompanied by bradycardia (heart rate $<100/\text{min}$) or cyanosis. It is classified into three types:

1. Central – no airflow, no respiratory efforts
2. Obstructive – no airflow, despite respiratory efforts
3. Mixed – often begins as central and later becomes obstructive

It commonly occurs in premature newborns due to immaturity of brain functions and generally begins 1 or 2 days after birth. In term newborns, it occurs in association with serious identifiable causes.

Etiology

- Prematurity, infection, metabolic abnormalities
- Hypoxemia, anemia, hypo or hyperthermia
- Gastroesophageal reflux
- Upper airway malformations (TEF)

Prevention

- Maintain normal hematocrit, electrolytes and PaO_2
- Avoid neck flexion and abdominal distension
- Kangaroo Mother Care (KMC)

Management

- Methylxanthines
 - Aminophylline
 - Loading dose 8mg/kg IV infusion over 30 minutes.
 - Maintenance – 1.5 to 3mg/kg IV every 8 to 12 hours.
 - Caffeine – loading dose 20 to 25mg/kg IV Slow Push every 24 hrs
- CPAP
- Kangaroo mother care
- Maintain normal hematocrit, electrolytes and PaO_2
- Avoid neck flexion and abdominal distension
- Treat underlying etiology

Necrotizing Enterocolitis (NEC)

NEC is an acute intestinal necrosis syndrome of unknown etiology. Prematurity is the single greatest risk factor. It is a most common serious surgical disorder among newborns and is a significant cause of neonatal morbidity and mortality. Premature newborns tend to get NEC later compared with full terms. The most commonly affected part is the terminal ileum and proximal colon parts of intestine.

Commonly the onset of NEC is related with gestational age and is as follows:

- In <31 weeks onset is 23rd day
- >31 weeks – 11 days
- Full term – 3rd day

Risk Factors

It has multifactorial associations listed as follows the final result being activation of an inflammatory cascade:

- Feeding (Trophic phase should always be considered)
- Prematurity: immature host defense, immature regulation of circulation
- Formula feeding: 90 to 95% affected neonates had been fed formula, decreased risk with breast milk
- Intestinal ischemia
- Abnormal bacterial colonization: reduced number of bacterial species after antibiotic therapy

Clinical manifestations

- Abdominal distention, feeding intolerance, vomiting, blood in stool, loose stools, abdominal wall erythema, systemic instability

Investigations

- CBC (Leucopenia, thrombocytopenia)
- Serum Electrolytes (Hyponatremia, hypokalemia, metabolic acidosis)
- Disseminated intravascular coagulopathy (DIC)
- Glucose instability
- Plain abdominal X-ray (prone with lateral or decubitus)
 - Pneumatosis intestinalis, dilated loops, thickened bowel wall, ileus, pneumoperitoneum

Management of NEC (Refer table below)

Table 11: Management of NEC

Bell staging criteria	Diagnosis	Management (usual attention to respiratory, cardiovascular and hematologic resuscitation presumed)
Stage I (suspect)	Clinical signs and symptoms Non-diagnostic radiograph	<ul style="list-style-type: none"> • NPO with IV fluids • Nasogastric drainage • CBC, electrolytes, Serial Abdominal x-ray • Blood culture • Stool heme test and Clinitest • Ampicillin and gentamicin × 48 hours
Stage II (definite)	Clinical signs and symptoms Pneumatosis intestinalis on radiograph	<ul style="list-style-type: none"> • NPO with parenteral nutrition (by CVL once sepsis ruled out) • Nasogastric drainage • CBC, electrolytes, Abdominal x-ray, Blood culture • Stool heme test and Clinitest • Ampicillin, gentamicin and clindamycin × 14 days • Surgical consultation
Stage III (Advanced)	Clinical signs and symptoms Critically ill Pneumatosis intestinalis or pneumoperitoneum on radiograph	<ul style="list-style-type: none"> • NPO with parenteral nutrition (by CVL once sepsis ruled out) • Nasogastric drainage • CBC, electrolytes, Abdominal x-ray Stool heme test and Clinitest • Ampicillin, gentamicin, and clindamycin × 14 days • Surgical consultation with intervention, if indicated: • Resection with enterostomy or primary anastomosis • In selected cases (usually <1,000 g and unstable), bedside drainage under local anesthesia

AP = anteroposterior; CBC = complete blood count, CVL = central venous line; NPO = nothing by mouth.

N.B. Ampicillin (or penicillin) plus gentamicin plus metronidazole for 10 days is an alternative management (pocket book of hospital care for children; 2nd ed.WHO, 2013)

Complication and prognosis

- Sepsis
- Intestinal strictures,
- Short bowel syndrome,
- Neurodevelopmental delay
- Mortality 30 to 40%
- Recurrence (6%)

Chapter 11: Nutrition: Breastfeeding & Feeding other than breast milk

Learning objectives:

By the end of this session, participants will be able to:

- Describe benefits of breast feeding
- Give counselling and support about breast feeding and lactation to mothers
- Promote breast feeding practices
- Identify and manage feeding problems
- Initiate and maintain preterm feeding
- Manage mothers with breast problems

Ten steps for successful feeding: “WHO-UNICEF Baby-Friendly Hospital Initiative/BFHI”

1. Have a written breastfeeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding within half-hour of birth.
5. Show mothers how to breastfeed, and how to maintain lactation even if they are separated from their infants.
6. Give newborn infants no food or drink other than breast milk, unless medically indicated.
7. Practice rooming-in. Allow mothers and infants to remain together 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no artificial teats or pacifiers (also called dummies or soothers) to breastfeeding infants.
10. Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or clinic.

Energy requirement by a newborn

- Recommended daily Calorie for newborn is 100 – 135 kcal/kg/day
- The calorie requirement for preterm, EVLBW and SGA infants is higher (120-150Kcal/kg/day)
- When baby is sick – (fever, sepsis, hypoxia) Calorie requirement increases by 10 – 30Kcal/kg/day

Protein requirement by newborn

- Generally, Newborn needs more protein per unit of weight than adult
- Preterm needs more protein per body weight per day than term newborn.

Table 5: Protein requirement of newborn

Weight (grams)	g/kg/day	g/100kcal
< 1000	4.0 – 4.5	3.6 – 4.1
1000 – 1800	3.5 – 4.0	3.2 – 3.6
1800 – 2200	3.4	2.6
> 2200 (term)	1.3 – 1.4	1.3 – 1.4

Human milk (Human breast milk)

- Is uniquely adapted to infant's needs
- Is the most appropriate natural milk for infants. It contains carbohydrates, proteins, fat, water, vitamins and minerals.

Table 6: Major constituents of mature human milk

Component	Value	Remarks
Calorie (kal/dl)	67	-
Protein (g/dl)	1.1 – 1.3	7 – 10 % of Calories

Fat (g/dl)	3.8 - 4.5	~ 50 % of Calories
CHO (g/dl)	6.8	~ 40 % of Calories

Nutritional requirement of preterm: To attain fast growth and prevent tissue loss, preterm need relatively high nutrients. Table 9 ...presents protein and energy requirements of premature babies.

Table 9: Protein and energy requirements of premature newborns

Body weight (gm)	Protein (gm/kg/d)	Energy (kcal/kg/d)	Protein/Energy (gm/100kcal)
500 – 700	4.0	105	3.8
700 – 900	4.0	108	3.7
900 – 1200	4.0	119	3.4
1200 – 1500	3.9	125	3.1
1500 – 1800	3.6	128	2.8
1800 – 2200	3.4	131	2.6
Adapted from Ziegler EE, J ped.GI nut 45, 170, 2007			

Benefits or advantages of breast milk and breast milk feeding

Benefit to newborn

- Provides ideal nutrients for the newborn
- Provides nutrients which are readily digested, absorbed and metabolized
- Promote bonding
- Promote improved behavioural and neurodevelopment including IQ.
- Provides protection against various diseases such as (diarrhea, pneumonia, otitis media, meningitis, urinary tract infection etc) because breast milk consists Immunologic and

antibacterial factors such as - (Secretory IgA, complements, Bactericidal enzymes, macrophages, lymphocytes)

- It also promotes growth of Lactobacilli (it protects colonisation by pathogenic bacteria)
- Promotes long term health (protecting from obesity, hypertension, T-I diabetes mellitus, cardiac disease, allergic diseases).

Benefits to the mother

- Most Economical – low cost, no need to prepare it, always clean, available and ready to feed
- Gives her a sense of confidence and feeling of self sufficient to feed her baby
- Protect post-partum haemorrhage (promote contraction and early involution of uterus)
- Family planning (child spacing)
- Protection against breast and cervical cancers

Compositions of Human milk at different stages

Colostrum

- The first and yellow milk after delivery
- May last till 1 week
- Is more immunogenic (1st immunization of the newborn)
- Have higher protein & electrolyte content than mature milk
- It has lower quantity, which is adequate for newborn.

Transitional milk

- Produced after 2nd week.
- Its protein and immunologic content is relatively lower than colostrum but higher than mature milk
- Better quantity when compared with colostrum

- Color become more whiter than colostrum

Mature milk

- Produced after transitional milk usually 2 – 3 weeks after delivery
- The color is whiter, relatively thinner, have higher CHO and fat content but lower protein and immunologic components than transitional milk.
- Nevertheless, it is complete and provides all what newborn needs.

Premature milk

- produced by mother who delivered preterm
- It consists of increased protein and electrolytes (Na, Cl, Mg) than mature milk

NB – All components of milk have Foremilk and Hind milk

- **Foremilk** is the 1st milk coming during each feeding; it is richer with CHO & Proteins
- **Hind milk** is the milk coming at the end of each feeding; it is richer with Fats

Considerations in feeding:

Healthy term and late preterm newborns can be fed directly on breast successfully. Many low-birth-weight infants will be able to suckle at the breast. Infants who can suckle should be breastfed. Those who cannot breastfeed should be given expressed breast milk with a cup and spoon. When the infant is sucking well at the breast and gaining weight, reduce the cup feeds. Infants unable to feed from a cup and spoon should be given intermittent bolus feeds through a gastric tube.

NGT, OGT, CUP is used:

- If baby is in respiratory distress esp. RR > 70/min, NGT is preferable
- If baby is less than 34 weeks of GA (< 1550grams), use cup or NGT/OGT.
- If baby is very sick & unable to suck or swallow, use NGT

Before counselling, try to get important ideas about what the mother decided to feed her newborn

- She might decide to feed breast milk. If so encourage and support this decision.
- She might decide to feed other than breast milk.
 - o Analyse her reasoning, discuss about the preferred feed and breast-feeding in detail.
 - o Compare and contrast and come in to agreement
 - o If mother is persisting on her decision, respect her decision

Mother may not come to decision what to feed her newborn

- Assess maternal health status or any contraindications
- Discuss for the best feeding options
- Discuss about breast feeding, its benefit to the baby and to herself
- Encourage her to decide
- Appreciate and support her decision

A. Feeding term and late preterm (gestational age ≥ 34 weeks) infants

Start feeding within 1st hour of life

- This period is important period for establishment of bonding
- Is basis for future milk production
- Prevent hypoglycemia

Feeding position

- Mother must be relaxed, emotionally and psychologically ready for breast feeding
- Mother must be in a such way that she is comfortable to breast feed her baby

Proper feeding position of baby includes (See pictures below)

- Infant's whole body supported
- Head and body straight

- Infant facing mother
- Infant's body touching mother's abdomen

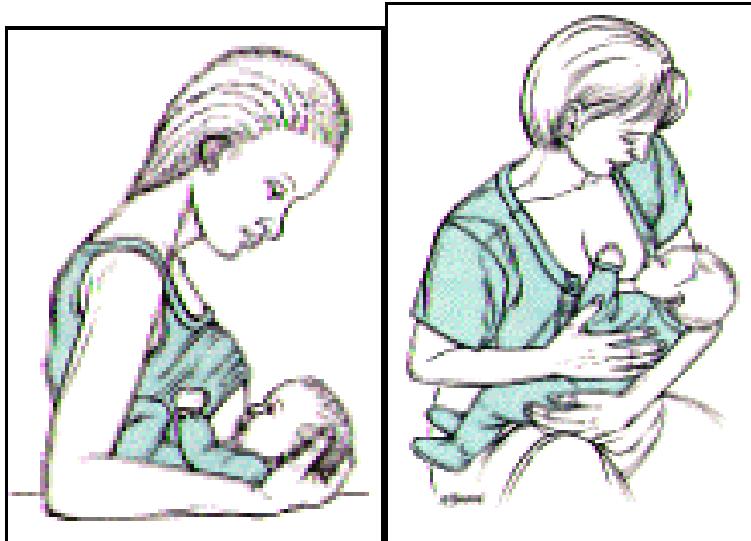


Figure 4: American football position. This type of position avoids maternal belly's preclusion of proper feeding. It is especially used in mothers having, C/S, multiple deliveries

Figure 5: Cradle position (sitting position). This is the usual or classical position, it enable mother to support baby well. To make, both mother and baby remain more comfortable, mother can use special pillows to support the baby. In this way, one hand becomes free so that she can support baby well.



Figure 6: Both mother and baby lying position. This type of position also enable mother to nurse baby comfortably while she is resting. Usually used by mother who is tired, sick or had C/S. It needs close observation

Checking for attachment: in order for the baby to have effective feeding, good attachments are required. Good attachment means:-

- The baby's mouth should wide open
- Lower lips everted out
- More areola seen on upper part of breast
- Chin of baby should touch the breast

Initiating latching on

- See following pictures
- Mother having good grasp of her breast (avoid grasping areola part) and bringing to touch. Baby's upper lip, stimulates the baby to open mouth.

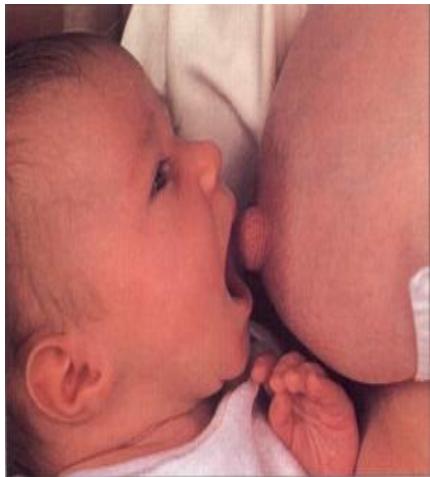


Figure 7: Stimulation of baby's mouth, it's cheek, or its search of proximating herself and drawing in the baby's mouth



Figure 8: Baby latching on with good attachment



Figure 9: Baby latching on with good attachment

Optimal Breastfeeding practice

- Newborn is fed 2-3 hourly intervals day and night
- Baby is dry, not too cold or not too warm and is hungry
- Should be fed day and night and fed at any time on demand
- Must be fed exclusively with no water or fluid or any solid is added.
- Nothing else is given per oral except medication ordered by his doctor.
- Avoid pacifiers, dummies, bottle
- Let baby complete one breast before switching to the other breast
- Start next feeding on the breast that was fed on last in the preceding feeding
- This exclusively feeding is continued till 1st 6 months of baby life and is adequate to support growth.
- Explain and encourage her to start semi-solid or solid complementary diet at 6 months with breast feeding continued.

Clues for adequate breast-feeding include:

- At least 3-5 strong suckling before pausing for breath or rest
- Dimpling of cheeks may be seen while suckling
- Hearing of swallowing gurgle
- Milk may be seen around the mouth leaking out when it is excess

Well and adequately fed baby will be satisfied and

- Go asleep for 2- 4 hours between each feedings
- Will have frequent wet diapers (at least 6 times) indicating that baby has adequate urine.
- Increase weight daily after 7 postnatal days (20 – 30 gm/kg/day). In the 1st 7 postnatal days baby tend to lose 10% of birth weight. This is normal physiology.

Identify feeding problems or feeding difficulties.

Mother may worry that she is not producing enough milk for her baby. Reassure, encourage, support the mother and **explain** that

- In the first 1-2 weeks after delivery the amount of milk produced is lower
- Volume of milk produced will increase after 2-3 weeks of delivery
- Mothers despite difference in, age, body size, breast size, parity, gestation, mode of delivery (SVD or C/S), size or number of babies, socio-economic condition have potential to produce adequate milk her baby/babies.
- Effective, regular **suckling** of the breast by the baby is important stimulus for milk production
- Letting baby to empty breast during each feeding, allows milk to refill for next feed
- Mother should be relaxed, emotionally and psychologically stable
- Mother must get adequate rest, take more fluids & nutritious feedings and also take micronutrients for herself. Maternal nutrition is important to produce more milk and prevent maternal malnutrition

Mother may be concerned if she is on medication

- Drugs can be passed to the milk to some extent BUT most drugs are safe and will not limit breast feeding
- But only few drugs, which are rarely used in our community are toxic

Table 7: Common breastfeeding problems

Difficulty or Condition	Cause & Prevention	Solutions
a. Problems related to the mother		
Engorgement	<ul style="list-style-type: none"> - Usually occurs within 3-5 days as result of copious milk production - Initiating Breastfeeding 	<ul style="list-style-type: none"> - Apply cold compression on the breasts to reduce swelling; apply warm compression to “get milk flowing.” - Decrease by expressing some milk,

Difficulty or Condition	Cause & Prevention	Solutions
	immediately after birth and Regular and frequent (2-3hrly) decreases its occurrence	<p>massage areola</p> <ul style="list-style-type: none"> - Improve infant positioning and attachment - Breastfeed more frequently and regularly (2-3hrly) - Let baby to finish one breast at a time
Sore or Cracked Nipples	<ul style="list-style-type: none"> - Mainly results from increased surface tension by act of suckling especially improper position & attachment - Correct positioning, attachment and latching on decreases its occurrence 	<ul style="list-style-type: none"> - Make sure baby is positioned well at the breast - Make sure baby latches on to the breast correctly - Apply drops of breast milk to nipples and allow to air dry in between feeds. - Whenever you want to remove the baby from the breast, break suckling first with your small finger sliding at the corner of the baby's mouth. - Begin to breastfeed on the side that hurts less - Do not use soap or cream on nipples
Plugged Ducts and Mastitis	<ul style="list-style-type: none"> - Mastitis is acute onset of inflammatory &/or infectious origin, presenting with fatigue, head ache, fever, breast fullness and tenderness - Sore or cracked nipple predispose - Proper technique & skill 	<ul style="list-style-type: none"> - Apply heat & massage before the start of breastfeeding - Increase mother's fluid intake - Advice mother to get adequate rest - Seek medical treatment; analgesics and antibiotics may be necessary for 10-14 days - Continue breastfeeding with proper positioning & attachment.

Difficulty or Condition	Cause & Prevention	Solutions
	<ul style="list-style-type: none"> - of feeding minimizes the occurrence - Avoid holding the breast in scissors hold. sleeping on stomach and tight clothing 	<ul style="list-style-type: none"> - If mother is HIV-positive: express milk and heat-treat or discard.
Breast abscess	<ul style="list-style-type: none"> - If mastitis is not treated lead to abscess - Early recognition and proper treatment of mastitis 	<ul style="list-style-type: none"> - Drainage of abscess - Proper antibiotics - Continue breastfeeding on unaffected breast till improvement
inverted nipple	<ul style="list-style-type: none"> - Poor antenatal preparation - Proper nipple management - Try to pull nipple out and rotate (like turning the knob on a radio). - Make a hole in the nipple area of a bra that the mother is wearing so that the nipple protrudes through the opening. 	<ul style="list-style-type: none"> - Help mother stretching and pulling out of nipple using cut & turned up syringe - Do this repeatedly - See figure 10
b. Problems related to the baby		
Sleepy baby	<ul style="list-style-type: none"> - Always rule out illness 	<ul style="list-style-type: none"> - Do not allow otherwise healthy baby to sleep for more than 4 hours. - Unwrap, pick and hold upright till fully alert before offering breast

Difficulty or Condition	Cause & Prevention	Solutions
Refusing suckling or crying	<ul style="list-style-type: none"> - Improper feeding techniques - Mouth ulcers, thrushes, pain in site of birth trauma, wetting or pain at the diaper area 	<ul style="list-style-type: none"> - Always look for secondary reasons why baby is refusing feeding or crying - Check for positioning and attachments, re- correct if any. - Check for mouth ulcers, thrushes, pain site, diaper area correct or sick treatment - Discourage pacifier or bottle
Suckling difficulties	<ul style="list-style-type: none"> - Tongue tie, craniofacial anomalies like cleft palate, Pierre-Robin sequence or choanal stenosis/atresia, respiratory problems may result in feeding problems 	<ul style="list-style-type: none"> - If tongue tie is a problem for suckling surgical correction is considered - Cleft palate, Pierre-Robin sequence:- modified positioning, obturator, nipple shield is used. - Breathing problems secondary to choanal stenosis: - consulting ENT specialist is needed
regurgitation and vomiting	<ul style="list-style-type: none"> - Regurgitation is return of some of ingested milk during or immediately after feeding. Can be reduced by gentle handling or placing baby on his/her right side after each feeding help eructation of swallowed gas - Vomiting is emptying out of gastric content and always needs careful evaluation of the baby. 	<ul style="list-style-type: none"> - Explain well on techniques of eructation after each feeding - If vomiting, always sick medical evaluation of the baby.

Table 8: Special considerations

Special Situation	Solutions
	-
Sick mother	<ul style="list-style-type: none"> - When the mother is suffering from headaches, backaches, colds, diarrhoea, or any other common illness, she SHOULD CONTINUE TO BREASTFEED HER BABY. - The mother needs to rest and drink a large amount of fluids to help her recover. - If mother does not get better, she should consult a doctor and tell the doctor that she is breastfeeding.
HIV-positive mother who chooses to breastfeed	<ul style="list-style-type: none"> - Mother should practice exclusivebreastfeeding for 6 months. At 6 months mother should introduce appropriate complementary foods. - Mother who experiences breast difficulties such as mastitis, cracked nipples, or breast abscess should breastfeed with the unaffected breast, express, and discard milk from the affected breast. - Mother should seek immediate care for a baby with thrush or oral lesions. - Mother who presents with AIDS-related conditions (prolonged fever, severe cough or diarrhoea, or pneumonia) should visit a health centre immediately. <p>Note: Lactating woman should use condoms to protect herself from exposure to infected semen.</p>

Special Situation	Solutions
HIV-positive mother who chooses to replacement feed	<ul style="list-style-type: none"> - Mother should practice safe and appropriate use of infant formula exclusively for the first 6 months. Encourage to use cup, discourage bottle - Mother should NOT mix-feed – “give only breast milk substitutes, do not breastfeed”.



Inverted nipple

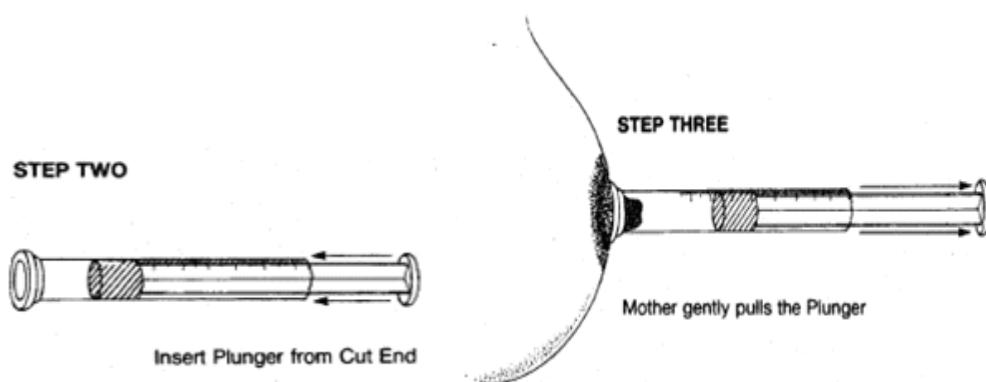


Figure 10: How to manage inverted nipple

B. Feeding preterm newborns (G/A < 34wks)

Source of nutrition for preterm:

Human milk (breast milk): Is the primary nutritional source for premature infant

- Premature milk is specially adapted to preterm
- Well tolerated
- Improved gastric emptying
- Reduced NEC and infections
- Possibly better neurocognitive development

Feeding schedule of preterm infant:

How to feed preterm newborns

- Suckling, swallowing reflexes and coordination with breathing are not well developed
- The newborn might be in respiratory distress or on ventilator
Therefore → Use NGT, OGT or cup to feed

When to start feeding in preterm newborns

- Feeding should not be delayed once baby is stabilized, usually starting from 1st day.
- The 1st feed is called priming or trophic feeding
- It is intended not to provide nutrients to support growth, rather is to facilitate maturation and keep integrity of preterm gut
- Early priming facilitate tolerance and early achievement of full feeding

How to advance daily to full feeding:

The goal is to achieve – Volume: 140 – 150 ml/kg/day & Calorie: 110 – 120 kcal/kg/day

- Infants weighing < 1.5 kg at birth are at the highest risk of feeding problems and necrotizing enterocolitis. The smaller the infant, the higher the risk Initial volume to start is 2ml/kg/feed as trophic.
- Starting on the first day, give 10 ml/kg per day of enteral feeds, preferably expressed breast milk, with the remaining fluid requirement at 50 ml/kg per day met by IV fluids.
The frequency of giving per day varies based on birth weight and or baby's tolerance
- The guide to proceed the next feed is baby's tolerance

- Usually is three or four times per day
- Advancement per day shouldn't exceed 20ml/kg/day see Table 10 for detail
- After full volume feeding is achieved, frequency of feeding is every 2 - 3 hourly
- If the infant is well and active and not receiving IV fluids, give 2–4 ml of expressed breast milk every 2 h through a nasogastric tube, depending on the weight of the infant

Table 10: Recommendation for initiation and advancement of preterm feeding [

Gestational age (weeks)	Volume of initial Feed (ml/kg)	Rate of feeding		
		Frequency	Advancement	
24 – 26	2	6 – 8 hours	Non for 5 – 7 days	10 -15 ml/k/d
26 – 28	2	6 – 8 hours	Non for 3 – 5 days	10 – 20 ml/k/d
28 – 32	2	6 – 8 hours	As tolerated	Aim full feed at 7 postnatal day

NG Tube Feeding

- Use bolus over 20 – 25 minute
- Avoid injecting the milk rapidly since it results gastric distension and intolerance
- Avoid continuous pouring of the milk since it enhances bacterial colonization

Further, follow up of feeding

- Check whether the previously administered milk is emptied before next bolus is given by sucking out gastric content (e.g. If the preterm newborn is getting 10ml every two hours and then if there is retained 5ml, you need to add only 5ml to make a total of 10ml).
- Look for any signs of intolerance
 -

- Vomiting or presence of any gastric content
- Abdominal girth increment more than 2 cm within 24 hrs
- Abdominal distension (decreased or bowel sounds)
- Blood in stools or diarrheal stools
- Temperature instability
- Presence of apnea or respiratory distress
- Hyperglycemia or metabolic acidosis
- Avoid routine residual checking

If any of signs of intolerance is seen or baby is hypothermic, feeding should be temporarily withheld and serious problems like NEC should be ruled out. Keep baby with IV fluid.

Assessing for adequacy of preterm feeding: Remember what we have discussed earlier in the feeding of term & late preterm infant

- Check for adequate urine passage. Usually passage of more than 6 times per day is fair
- Check weight daily. There will be initial about 15% loss of birth weight. In the 1st week.
 - Accepted weight gain in preterm is 15 – 20gm/kg/day until 2kg is reached then in average weight gain is 20 – 30gm/kg/day
 - Once the baby achieved weight of 2 – 2.5 kg, feeding can be switched to full breast milk or preterm formula

Addition of vitamins and minerals

- Preterm is particularly at risk for Iron deficiency anaemia and vitamin D deficiency
- Start Iron drops. Elemental Iron 3mg/kg/day starting from 3rd – 4th weeks of life
- Vitamin D 150 – 400IU. Giving 2 ml/day of cod liver oil (seven seas without vitamin) can provide.

Discharge (refer to guideline on discharge criteria)

C.Expressing breast milk

- Refers to the process by which a woman **expels milk** from her breast manually or using breast pump. The **breast milk** can then be **stored** and **fed** to her baby at a later point in time.
- The best way to establish breast milk production is, to breastfeed, but for various reasons this may not always be possible.
- The alternative way to establish breast milk production is expressing. **Reasons are:-**
 - If baby has difficulty suckling, for example because it was born premature or is unable to attach to the breast
 - If baby is hospitalised and the mother is unable to be in hospital at all the infant's feeding times
 - If mother is hospitalised and it is not possible for the baby to be brought to her for each feed
 - If mother has to go for working and needs to be separated from the baby
 - If mother's breasts feel too full or engorged at times when the infant does not wish to feed.
 - If mother wants to keep a little breast milk stored in the freezer in case there is an emergency which requires her to separate from the infant
 - If mother has mastitis or a blocked duct to ensure her breasts are completely emptied after each breastfeeding session. Also, it may sometimes be necessary to express milk after the baby has finished suckling, to ensure that the breasts are completely empty
 - If nipples are cracked or damaged and need a period free of suckling to heal
 - If mother's milk supply is low, in which case expressing milk can stimulate further production of breast milk

When & how frequent?

- Mother can begin expressing breast milk at any time once breast milk production commences, usually immediately following childbirth.

- The frequency of expressing breast milk depends on the reason why mother has to express breast milk.
 - If baby is premature or sick & not able to suckle, regular expressing every 2-3 hourly or 8-10 times per day or as frequently as every 1.5 hours.
 - Once lactation is established, every 3-4 hours or 6-8 times a day is usually sufficient to maintain sufficient breast milk production.
 - for mother who will be a day away or a night out once in a while need only express breast milk as often as she needs to leave a supply for infant feeding.
 - If mother has to express her breast to relieve breast discomfort, can express milk only at the times when their breasts are feeling too full.
 - If mother had mastitis or blocked ducts, should express as much remaining milk from their breast as possible, each time the baby suckles.
 - If the intention of expressing is to increase the supply of breast milk, expressing should be from each breast until empty, 2-3 times per sitting (in a row), as this will help to establish a larger supply of breast milk over time.

How much milk?

- The correct amount of breast milk to express varies.
- For regular infant feeding, express as much as possible and fully drain both breasts each time. In the 1st day after childbirth, it may be only a few drops or few mls of breast milk. The amount increases daily to be 50-70ml from each breast at 4-5 days to 80-120ml at the end of 1st week. Once regular breast milk production is established women express 440-1,200ml of breast milk each day (90-120ml/session/breast).
- For engorged or uncomfortable breasts, express only as much breast milk as is required to reduce the feeling of engorgement or discomfort.
- For blocked duct or mastitis, express as much breast milk as possible after the infant has finished suckling.
- To store milk for emergency use, express as much milk as is needed for storage.

How is breast milk expressed?

- There are several techniques by which breast milk can be expressed. Regardless of which method is used, there are some basic points, which will make the process easier.
- Women who are attempting to express milk should try to:
 - Find a comfortable place to express breast milk, which is relaxing, warm and free of distractions.
 - Consciously attempt to relax. But if it is not relaxing, try to:
 - Breathe slowly and deeply
 - Have a warm drink just before expressing milk
 - Listen to soft, relaxing music
 - Have a warm shower just before expressing
 - Place a warm towel on the breast for several minutes before trying to express
 - Gently massage the breast and nipple to encourage the let-down reflex (the reflex which stimulates the secretion of breast milk, by stimulating the release of oxytocin which causes the cells around milk ducts to expand and push milk from the breast)
 - Express milk gently to avoid pain and discomfort
 - Express milk frequently as this will help establish breast milk production and result in the production of greater quantities of breast milk compared to less frequent expressing
 - Think about the infant and the benefits breast milk will provide as this encourages the let-down reflex which triggers secretion of breast milk. In order to encourage thoughts about their baby woman might wish to:
 - Sit near or in skin contact with the baby if possible
 - Express milk just after separating from the baby (e.g. if the baby is being bottle fed expressed milk in hospital)
 - Look at a photo of the baby
 - Have something to eat before commencing expressing milk, as this will ensure adequate energy and nutrients are available for the production of breast milk
 - Have a glass of water handy to sip on whilst breastfeeding;

- Maintain a healthy, balanced diet while breastfeeding as breast milk production is dependent on the availability of maternal nutrients. It is important not to skip meals and to drink at least 6 glasses of water per day
- Find a support person to provide encouragement, such as your partner, a friend, relative or a health professional such as a counselor.

Techniques of expressing breast milk

Before starting expressing mother need to know following points:-

- Wash hands thoroughly
- Sterilize the cups and sealed bottles in which expressed milk will be stored and their components (e.g. lids)
- do not touch the inside of containers used for storing breast milk
- Sterilize the breast milk pump and its components if such a device will be used to help express the milk
- Store breast milk in the fridge immediately after expressing or feed right away.

Expressing breast milk by hand

- Ideally, a woman should learn hand-expressing techniques from midwives or other health professionals before being discharged from hospital.
- Begin by massaging the breast and nipple for a couple of minutes to encourage the let-down reflex;

1. Hand expression Position

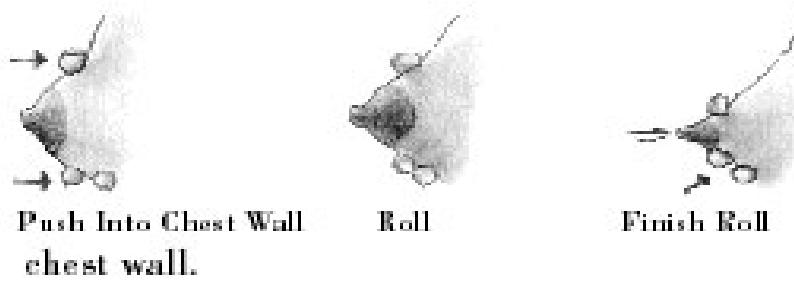
- First, position the thumb above the nipple and first two fingers below the nipple, about 2.5 to 3.8 cm. from the nipple. The fingers do not have to be at the outer edges of the areola, since breasts and areolas vary in size from one woman to another.
- Be sure the hand forms the letter "C" and the finger pads are at 6 and 12 o'clock in line with the nipple.
- Avoid cupping the breast.
- See Figure 11 below



Figure 11: Hand Expression of BM

2. Express the Breast Milk

- Next, push straight in to the chest wall.
- Avoid spreading the fingers apart.
- For large breasts, first lift, and then push in to the chest wall.
- Roll the thumb and fingers forward at the same time. This rolling motion compresses and empties the area where the milk is stored without injuring sensitive breast tissue.
- Repeat this process rhythmically to completely drain reservoirs.
- Position, push, roll ----- Position, push, roll. See Figure -12.



3. Then,

Figure 12: How to manually express BM

- Rotate the thumb and fingers to milk other reservoirs, using both hands on each breast.
- If produced milk is not adequate, do same way on the other breast.
- For right breast use left hand, for left breast use right hand

See Figure – 13 below.



Figure 13: Rotate thumb and fingers to

4. Avoid

- Squeezing the breast, as this can cause bruising.
- Sliding hands over the breast, may cause painful skin burns.
- Pulling the nipple, which may result in tissue damage. See picture -13

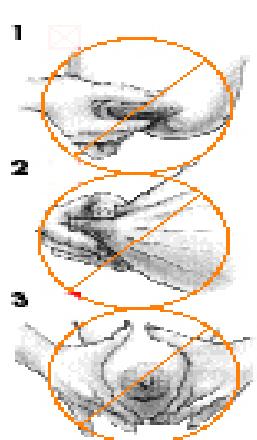


Figure 14: incorrect technique of expressing breast milk

5. Storing the expressed milk

- Label well expressed milk by name of mother or baby, time, date and place
- Freshly expressed breast milk can be stored at room temperature (<26°C) for 6-8 hours
- If it is stored in a refrigerator, (<4°C) breast milk should be placed at the back (not in the door) and will remain fresh for 2-5 days.
- It is also possible to freeze freshly expressed milk in an internal fridge freezer (up to 2 weeks), a fridge freezer with a separate door (3 months) or a deep freeze (6-12 months).

6. Feeding the expressed milk

- **Fresh breast milk does not need heating and can be served.** If the infant does not consume all the fresh breast milk, the remainder can be stored in the refrigerator or freezer for later use.
- **Previously refrigerated breast milk** should be heated in a container of warm water prior to infant feeding. It should not be put in a microwave or heated directly, as over-heating kills many of the nutrients in breast milk. The milk should be heated for not more than ten minutes, or until it feels cool-comfortably warm when dripped onto the wrist. Once reheated, any unused breast milk should be discarded. It should not be re-used.
- **Previously frozen breast milk** should be thawed either in a refrigerator (in which case it can be stored in a refrigerator for up to 24 hours) or in warm water (in which case it should be used immediately and any excess discarded). Once thawed, breast milk should be reheated (but only once, after which any remainder should be discarded) in the same fashion as previously refrigerated breast milk.

PARENTERAL NUTRITION

Many sick newborn infants cannot obtain adequate nutrition via the GI tract and, thus, require parenteral nutritional (PN) support.

Indications

- GA <32 weeks
- Birth weight <1200
- Surgical abdomen and NPO for prolonged days (TEF, NEC, other GI conditions)

•

Administration

Peripheral route is used for partial or supplemental PN. This route is usually used for short-term nutritional support. Peripheral PN solutions cannot exceed 12.5% dextrose (D12.5) or 3.5% amino acids due to the risk of thrombophlebitis and should not contain calcium because of the serious complications resulting from extravasation of calcium.

Protein

- Start amino acids at 2-3 g/kg/d, as much as possible depending on fluid allowance and access.
- Advance by 0.5 gm/kg/d to goal as needed.
- Maximum is 3 g/kg/d in term infants and 3.5 g/kg/d in preterm infants.

Carbohydrate

- Is administered as dextrose monohydrate.
- Start with 4-6 mg/kg/min or D10-D12.5. Alternatively, calculate the glucose infusion rate that the infant is already receiving and advance from there.
- Advance by 1-3 mg/kg/min daily to a maximum of 12-15 mg/kg/min

Fats

- Intravenous lipid emulsions are essential components of TPN.
- They provide essential fatty acids and are a concentrated energy source critical for growth and development of infants not receiving enteral feedings.
- A lipid intake of 0.25-0.5 g/kg/d is required
- Should be started only after day 3 of life
- Dosage is as follows

Gestation	Weight/diagnosis	Initiate	Advance by	Goal is
		0.5g/kg/d	0.5g/kg/d	3g/kg/d by
Preterm	<1,500g, stable	Day of life 3	Day of life 7	Day of life 11
	≥1,500g, stable	Day of life 3	Day of life 4	Day of life 9
	Very unstable (eg severe RDS)	Day of life 3	When status improves	Day of life 9
Term	No pulmonary disease	Day of life 3	Day of life 4	
	Severe pulmonary disease	Consider day of life 7	Day of life 4	

Minerals

Add phosphorus to the TPN and give Ca gluconate separately. Dosage is as follows:

	Calcium (mEq/kg)	Phosphorus (mmol/kg)
Initiate	2	1
Advance every 1-2 days	0.5	0.3-0.5
Goal	3 for preterm 2 for term	1.5 for preterm 1.2 for term

Monitoring

Test	Initial	When stable
Electrolytes BUN/creatinine	Daily	2-3X/week
Glucose	Every 6hrs	Daily More frequently when changing carbohydrate
Calcium, ionized	Daily	2-3X/week
Total calcium, phosphorus, magnesium, bilirubin, ALT, alkaline phosphatase, GGT, albumin	Baseline	Weekly
Triglycerides	When lipid infusion reaches 1.5g/fat/kg/d and 3gfat/kg/d	Weekly
CBC		Weekly

Weaning from TPN

When the patient is tolerating >50 ml/kg/day of enteral feedings, the TPN should be gradually tapered off.

- Determine total fluid allowance for the day.

- Write the TPN for the suggested volume and substrate amounts as indicated by the feeding volume.
- Use the lower end of the feeding volume range specified for your calculations.
- The suggested amounts of the CHO/protein/fat should be compatible except if the patient is significantly fluid restricted.
- The calcium and phosphorus must also be decreased for solubility reasons.
- Specify an IV+po order to keep total fluid intake at the prescribed amount.

Discontinue parenteral nutrition

- PN may be stopped when the infant is tolerating $\geq 100-120$ ml/kg of enteral feedings or is receiving ≤ 25 ml/kg/d of PN.
- The rate of dextrose administration should be tapered to prevent rebound hypoglycemia.
- RBS should be done q6h.
- Lipids may be stopped without tapering.

Complications

- Acidosis
- Elevated BUN
- Hyperammonemia
- Cholestasis with prolonged administration
- Hyperglycemia or hypoglycemia
- Glycosuria and potential osmotic diuresis
- Hyperlipidemia
- Potential risk of kernicterus at low levels of unconjugated bilirubin because of displacement of bilirubin from albumin binding sites by free fatty acids.
- Potential increased risk or exacerbation of chronic lung disease

Potential exacerbation of Persistent Pulmonary Hypertension (PPHN)

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Chapter 12: Infection in Neonates

Learning Objectives

At the end of this session, the students will be able to:

- Identify the common infections in neonates
- Recognize the clinical manifestations
- Recall the management of infection in neonates

Newborn babies are at higher risk of infection because of their weak immune systems related to their age. Most infections in newborn babies are caused by bacteria, and some by viruses. A mother's birth canal contains bacteria, especially if she has an active infection. During childbirth, the baby can swallow or breathe in the fluid in the birth canal, and bacteria or viruses can get into his lungs and blood. Infection in newborn babies can progress fast and early diagnosis and treatment is important for improved outcome.

1. Bacterial Sepsis

- Neonatal sepsis is defined as a clinical syndrome of bacteremia with systemic signs and symptoms of infection in the first 4 weeks of life.
- Neonatal infection is one of the major causes of mortality and morbidity. Bacterial sepsis and meningitis often are linked closely in neonates; meningitis is present with Early-onset sepsis (in 30% of cases), late onset sepsis (in 75% of cases). Considering the high mortality rates, there must be a high index of suspicion for neonatal sepsis.

Classification

Early-onset infections are acquired before or during delivery. Late-onset infections are acquired after delivery in the normal newborn nursery, neonatal intensive care unit (NICU), or the community.

1. **Early Sepsis** (Birth to 7 days, usually less than 72 hrs)
2. **Late Onset Sepsis** (7 - 30 days)

Etiology: Commonest organisms causing bacterial neonatal sepsis in developing countries include Klebsiella, Staphylococcus Aureus, and Escherichia coli, were found to be the in Tikur Anbesa hospital.

Clinical features

- Signs and Symptoms of infection in newborn infants could be non-specific or focal signs of infection may be seen. Neonates may show one or more of the following signs.
- Suspect bacterial infection if the infant has one or more of the following danger signs:
 - Abnormal vital signs
 - Fever (temp >38 °C), hypothermia (temp <36 °C) or temperature instability

- Tachycardia (HR > 180) or bradycardia (HR <80)
 - Tachypnea (RR > 60) or bradypnea (RR < 30) including apnea
 - Poor perfusion: capillary refill time > 3 seconds, hypotension
 - Abnormal breathing: gasping, grunting, severe chest indrawing, nasal flaring or apnea
 - Abnormal color: cyanotic, pale, grey, mottled, jaundiced, erythematous including umbilical flare
 - Abnormal activity: tremors, irritability, seizures, floppiness, stiffness or minimal response to stimulation, lethargy
 - Abnormal feeding: poor feeding, abdominal distention, recurrent vomiting, diarrhea, otherwise unexplained hypo- or hyperglycemia
 - History of convulsions
 - Severe Jaundice
 - Bulging fontanel
 - If the infant has signs or risk factors for sepsis, immediately notify the doctor, obtain blood for laboratory testing and start IV antibiotics.
 - Premature or low birth weight <2.0 kg
- *Localizing signs of infection.* (Signs of pneumonia, many or severe skin pustules, bulging fontanel, painful joints, joint swelling, reduced movement...)

Maternal risk factors for infection

- Maternal fever (temp >38°C) during labor or within 24 hours after delivery
- Maternal urinary tract infection in current pregnancy or bacteriuria
- Duration of membrane rupture > 18 hours before delivery
- Uterine tenderness or foul smelling amniotic fluid
- Obstetric diagnosis of chorioamnionitis
- Meconium stained amniotic fluid
- Resuscitation at birth
- Invasive procedures
- Home delivery

Septic workup

- Consider blood culture and sensitivity whenever possible and modify that treatment accordingly.
- CBC (Complete Blood Count with differential). Concern for sepsis if:
 - Total WBC is abnormal (<5,000 or >20,000)
 - Differential with granulocytes >70%.
- ESR or CRP. Concern for sepsis if positive.
- Consider urinalysis and gram stain if symptoms of urinary tract infection or more general concerns for sepsis in infant >1 week old
- Consider lumbar puncture if concern for meningitis (lethargy, irritability, convulsions, bulging fontanel, meningismus).

- Consider chest x-ray if respiratory distress or oxygen desaturation

Sepsis with meningitis

- A diagnosis of meningitis should be made based on clinical evidence (abnormal neurological exam: seizures, abnormal tone and full fontanelles) and risk of infection for babies less than 72 hours of age , for babies age greater than 72 hours of age diagnosed with sepsis CSF analysis should be done to rule out meningitis despite absence of overt signs of meningitis

CSF analysis suggestive of meningitis:

- Identification of organism on gram stain or culture
- WBC count greater than or equal to 20 cells/mm³
- Low glucose (less than two third of serum value) and
- Protein greater than 150 mg/dl

Treatment: General supportive measures, including respiratory and hemodynamic management, are combined with antibiotic treatment.

For early onset (less than 7 days)

Antibiotic – Ampicillin and Gentamycin

Duration: If positive cultures – minimum 7 days.

- If negative cultures, and clinically well, with normal CRP or ESR– stop after 48 hours
- If negative cultures, but not clinically well, abnormal CXR or elevated CRP – treat as confirmed sepsis.
- If no improvement after 48 hours, or worsens, after repeating blood cultures (if possible) and considering further investigations, consider changing to: **Ceftriaxone and gentamicin**

For late onset (7-30 days)

Antibiotic – Ampicillin and Gentamicin

- In certain cases where patient is critically sick or staphylococcal infection is likely (pustular skin rash, osteomyelitis...) start with triple antibiotics (cloxacillin, ampicillin and gentamycin)
- If no improvement after 48 hours, or the infant's condition worsens. Consider changing antibiotics to: **Cloxacillin, ceftriaxone and gentamicin or vancomycin and gentamicin**

Treatment of neonatal sepsis with meningitis

- Antibiotics the same as for sepsis but with higher dose and prolonged duration (Gentamycin for two weeks the rest for three weeks) .

Table 12: Antibiotic Dosing Chart for Newborns

Medication	Antibiotic Dosing Chart for Newborns			Comments	
	Dose/Frequency		> 14 days		
	< 14 days	< 35 weeks PMA* (if PMA not known use current weight ≤ 2.0 kg)			
Ampicillin or Cloxacillin	150 mg/kg/dose IV every 12 hours If meningitis ruled out: 50 mg/kg/dose IV every 12 hours		50 mg/kg/dose IV every 6 hours Meningitis: 100 mg/kg/dose IV every 6hr.	-	
Gentamycin	3 mg/kg IV once a day and once in 48 hrs in very preterm babies.	4 mg/kg IV once a day	> 1 month: 7.5 mg/kg IV once a day	Use newborn dose through first month.	
Cefotaxime ¹	50 mg/kg IV every 12 hours	50 mg/kg IV every 8 hours	50 mg/kg every 6 hours	Preferred over Ceftriaxone due to improved safety profile	
Ceftriaxone ²	50 mg/kg IV every 12 hours for sepsis/meningitis: 50 mg/kg x1 IM for pus draining from eye For IM injection, dilute to 350 mg/mL. Max dose ½ mL = 175 mg			Contraindicated in setting of jaundice or within 48 hours of IV calcium administration	
Metronidazole	7.5 mg/kg IV every 24 hours	7.5 mg/kg IV every 12 hours	7.5 mg/kg IV every 8 hours	Anaerobic coverage including treatment of necrotizing enterocolitis	
Acyclovir	20 mg/kg IV every 12 hrs	20 mg/kg IV every 8 hours		Treatment of herpes simplex infection: 14 days if localized, 21 days if disseminated	
	20mg/kg PO every 6 hours if IV acyclovir not available				

Management of healthy appearing infant babies born of women with premature rupture of membrane

PROM Score: A protocol based on accepted high risk factors for immediate postnatal assessment and anticipatory treatment

	High risk factors	Scores
1	Gestational age < 34 weeks	2
2	Gestational age 34-37 weeks	1
3	Maternal clinical amnionitis Maternal temperature >38°C Sustained fetal tachycardia >160bpm Presence of PMN or bacteria in stained Sediment of amniotic fluid or infants' gastric fluid	1
4	5th minutes APGAR score < 6	1
5	Active labor >/= 20 hrs during PROM.	1
	Scores	Recommended Management
I	0 – 1	Observation only
II	2	Microbial culture of gastric aspirate, umbilical cord blood, urine followed by observation.
III	>/= 3	As above plus examination and culture of spinal fluid followed by antibiotic therapy.

2. Identifying and treating local infections

2.1. Pustules/ Pyoderma:

- Is superficial skin infection usually caused by *Staphylococcus Aureus*.
- Develop after the first few days of life; they may be bullous, crusted, or pustular. Although they can develop anywhere on the body, the blisters and pustules commonly occur on the diaper area, axillae, and periumbilical skin.
- When the epidermis is shed in large sheets, staphylococcal scalded skin syndrome should be suspected.
- The diagnosis is made by Gram stain and culture of the blister fluid
- Blood cultures should be obtained before initiating systemic antibiotic therapy, even if the infants are usually otherwise well. Give cloxacillin 50 mg/kg every 12 hours (< 8 days) and every 8 hours (> 8 days). It is usually given intravenously.
- If no improvement/if there is a danger sign, consider treating for sepsis.

2.2. Cellulitis/Abscess:

- If there is a fluctuant swelling, incise and drain the abscess.
- If possible, take a specimen of pus using a sterile cotton swab, and send it to the laboratory for gram stain and/or culture and sensitivity, so that treatment will be modified accordingly.
- Give cloxacillin IV or IM according to the baby's age and weight
- Assess the baby's condition at least once daily for signs of improvement:
- If the cellulitis/abscess is improving after five days of treatment with the antibiotic, continue cloxacillin to complete 10 days of treatment.

2.3. Neonatal conjunctivitis:

Red and swollen eyes or eyes draining pus may be caused by bacteria (e.g. gonococcus, Chlamydia, staphylococcus) that are usually transmitted to the baby at the time of birth. Most causes of newborn eye problems will respond to local treatment, but gonococcal and Chlamydia infections need to be identified, as they require systemic antibiotics.

2.3.1. If there is stickiness of eyelids, swelling and/or redness but no pus discharge,

- Clean the eyelids using sterile normal saline or clean (boiled and cooled) water and a clean swab, cleaning from the inside edge of the eye to the outside edge;
- Have the mother do this whenever possible; repeat four times daily until the eye problems have cleared.

If the problem persists after 4 days of the above measures treat for Chlamydia:

- Give erythromycin by mouth for 14 days;
- Apply 1% tetracycline ointment to the affected eye(s) four times daily until the eye(s) is no longer red, swollen, or sticky.

2.3.2. If Eyes draining pus (*Ophthalmia neonatorum*)

a) If the baby is less than 7 days, treat for gonococcal infection.

- *If possible*, take a specimen of pus using a sterile cotton swab, and send it to the laboratory for gram stain and/or culture and sensitivity, so that treatment will be modified accordingly.
- Give Ceftriaxone 50mg/kg IM stat.
- Clean the eyelids using sterile normal saline or clean (boiled and cooled) water and a clean swab, cleaning from the inside edge of the eye to the outside edge;
- Have the mother do this whenever possible and repeat four times daily until the eye problems have cleared.
- Treat the mother and her partner for gonorrhoea if not already treated give
 - Ceftriaxone 250 mg IM as a single dose to the mother;
 - Ciprofloxacin 500 mg by mouth as a single dose to her partner.

b) If the baby is seven days or older or the problem is not resolved after 48 hours of treatment for gonococcal infection , treat for conjunctivitis due to Chlamydia.

3. Viral lesions

Rarely viral lesions like herpes simplex infection and Primary varicella can occur in neonates, manifested by blistering. Intrauterine herpes simplex infection typically manifests with vesicles at birth or within 24 hours. The vesicular eruption may be widespread or even bullous.

- Neonatal herpes simplex may be limited to the skin, eyes, and mouth or may be disseminated, with multiple organ involvement. Typically, the lesions are 1- to 3-mm vesicles that usually occur on the scalp or face.

- Additional findings include low birth weight, microcephaly, chorioretinitis, and neurologic changes.

Treatment: High-dose, prolonged acyclovir therapy

4. Candidiasis

Cutaneous lesions: Consist of erythematous papules and vesicopustules that become confluent, forming a moist, erosive, scaly dermatitis surrounded by satellite pustules.

Treatment: Topical antifungal agents from the imidazole group are the most effective.

Oral thrush: The lesions of thrush are detectable as creamy white patches of friable material on the buccal mucosa, gums, palate, and tongue .

- Differentiate oral thrush from normal smooth coating of tongue seen in first few days. If in doubt, treat as thrush.
- Apply Nystatin oral solution 4 times daily after feeds, continuing for 2 days after lesions have healed.
- Have the mother apply Nystatin cream on her breasts after breastfeeding.
- Ask the mother to clean her breasts *once a day* when bathing, (not repeatedly) with soap and water.
- Topical Miconazole is also effective..

5. Umbilical infection (omphalitis): Stickiness or pus discharge at the base of the cord or inside the umbilicus

- Minor umbilical infection is not associated with swelling or surrounding redness or a foul smell. If any of these or any danger sign is present, treat as a major infection or sepsis.
- Clean the area with 60-90% alcohol or an anti-septic solution 2-3 times a day.
- Take care to lift the cord and apply the antiseptic to the *base* of the cord or, if the cord has fallen off, to the *depth* of the umbilicus.
- Demonstrate the task to the mother and ask the mother to return for follow-up after two days.

6. Congenital syphilis:

Syphilis is a sexually transmitted disease caused by the bacteria *Treponema Palladum* that can result in serious congenital conditions if contracted during prenatal development. Mother-to-child transmission of syphilis is preventable and curable.

Clinical signs

- Often low birth weight
- Palms and soles: red rash, grey patches, blisters or skin peeling
- ‘Snuffles’: rhinitis with nasal obstruction which is highly infectious
- Abdominal distension due to big liver and spleen
- Jaundice
- Anaemia

- Some VLBW babies with syphilis have signs of severe sepsis with lethargy, respiratory distress, skin petechiae or other bleeding

Diagnosis

- VDRL test
- CSF analysis for VDRL, cell count, and protein
- CBC and platelet count
- Long bone radiography

Treatment

- Asymptomatic neonates born to VDRL positive women should receive
 - o Crystalline penicillin G, 100,000–150,000 U/kg/day, administered as 50,000 U/kg/dose IV every 12 hr during the first 7 days of life and every 8 hr thereafter for a total of 10 days or
 - o Benzathine benzyl penicillin 50,000 units/kg in a single intramuscular dose
- Symptomatic infants require treatment with:
 - o Procaine benzyl penicillin 50,000 units/kg as a single dose daily for 10 days or
 - o Crystalline penicillin G, 50,000 units/kg every 12 hours IM or IV for the first 7 days of life and then every 8 hours for a further 3 days.
- Treat the mother and partner for syphilis and check for other sexually transmitted infections.

7. Baby of a mother with Active tuberculosis

If the mother has active lung tuberculosis (sputum smear positive TB) and was treated for less than two months before birth or was diagnosed with tuberculosis after birth:

- Reassure the mother that it is safe for her to breastfeed her baby;
- Do not give the tuberculosis vaccine (BCG) at birth;
- Give prophylactic isoniazid 5 mg/kg body weight by mouth once daily

Follow up and management of baby of mother with active TB

- At the age of six weeks, the baby should be re evaluated
 - o If there are any findings suggestive of active disease, start full antituberculosis treatment according to national guidelines.
 - o If the baby is doing well and tests are negative, continue prophylactic isoniazid to complete six months
- Delay BCG vaccine until two weeks after treatment is completed.
- If BCG was already given, repeat BCG two weeks after the end of the isoniazid treatment.

8. Neonatal Tetanus

Neonatal Tetanus is a generalized tetanus caused by bacterium *Clostridium tetani*, which are universally present in the soil. The disease is caused by the action of a potent neurotoxin produced during the growth of the bacteria in dead tissues, e.g. in dirty wounds or in the

umbilicus following non-sterile delivery. Without good supportive care, case fatality rates can exceed 90%.

Clinical manifestation: diagnosis is clinical as confirming the infection is difficult. The newborn usually exhibits:

- Irritability
- Poor feeding, difficulty in opening the mouth
- Rigidity
- Facial grimacing, and
- Severe spasms with stimulation

Management: Treatment of neonatal tetanus includes administration of tetanus antitoxin and muscle relaxants and parenteral feeding.

- Control of muscle spasms: The patient should be admitted to a quiet, darkened room where all possible auditory, visual, tactile, or other stimuli are minimized.
 - o Diazepam controls spasms better and safer than other options listed below (The initial dose of 0.1–0.2mg/kg every 3–6 hr given intravenously is subsequently titrated to control the tetanic spasms);
 - o Other drugs which can be used in combination with diazepam include:
 - Phenobarbitone (loading dose 20mg/kg, then 2.5mg/kg/dose q12hr, increased to max 5mg/kg/dose q12hr)
 - Chlorpromazine (1-5mg/kg/dose q8hr)
- Antitoxin therapy: human tetanus immunoglobulin should be given intramuscularly in a single dose (3,000 to 6,000 IU). If human serum immunoglobulin is unavailable, tetanus antitoxin should be given, assuming sensitivity reactions to horse serum are negative. The antitoxin is given intravenously and intramuscularly (half of the dose via each route).
- Antimicrobial therapy: Metronidazole (30 mg/kg/day, given at six hour intervals; maximum 4 g/day) or Parenteral penicillin G (100,000 U/kg/day) is an alternative. Treatment for 10 to 14 days is recommended.
- Wound treatment: After the patient has been sedated and received antitoxin, the wound should be thoroughly cleansed and debrided.
- Supportive treatment: Oxygen should be available. During early stages, oral feeding should be avoided because of the danger of aspiration. A continuous intra- venous infusion can provide fluid (such as water and plasma), electrolytes, glucose, and amino acids.
- Tracheotomy: The combination of heavy sedation, difficulty in swallowing, laryngospasm, and accumulation of secretions may lead to obstruction of the airway . A tracheotomy can be lifesaving if performed when appropriately indicated.

Complications

- Laryngospasm
- Hyperactivity of the autonomic nervous system leading to hypertension, abnormal heart rate, or both;

- Fractures of the spine or long bones as a result of sustained contractions and convulsions;
- Coma
- Aspiration pneumonia: a common late complication of tetanus;
- Death: without good supportive care, case fatality rates can exceed 90%. Most deaths from neonatal tetanus occur during the first week of the disease.

Prevention

- Immunization of women of childbearing age with tetanus toxoid.
- General improvements in delivery and post-delivery practices.

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Chapter 13: Jaundice (Hyperbilirubinemia)

Learning objectives

At the end of the training, the trainee will be able to:

- Define jaundice
- Differentiate between physiologic and pathologic jaundice
- Identify the causes of jaundice
- Recall investigation and management of jaundice

Neonatal jaundice

Definition - is a yellowish discoloration of the skin and or sclera due to bilirubin deposition. In newborns, jaundice appears when total bilirubin (TB) is more than 7 mg /dl and almost 97 % healthy full term babies have biochemical hyperbilirubinemia. Neonatal jaundice can be classified as either physiologic or pathologic.

Table 15: Features differentiating Physiological jaundice from Pathological Jaundice

No	Features	Physiologic Jaundice	Pathological Jaundice
1	Clinical onset of jaundice (after birth)	>24 hrs	<24 hrs
2	Jaundice still clinically visible (day after birth)	Term < 8 days Preterm < 14 days	Term ≥ 8 days Preterm > 14 days
3	Peak Total Serum Bilirubin (TSB)	Term < 12 mg/dl Preterm < 15 mg/dl	Term > 12 mg/dl Preterm > 15 mg/dl
4	Rise in TSB	< 5mg/dl/24 hrs	> 5mg/dl/24 hrs
5	Conjugated serum bilirubin level	<2mg/dl	>2mg/dl or 15 % of TB

Causes of Jaundice:

- i. Isoimmune hemolytic disease (Rh and ABO incompatibility)
- ii. Sequestered blood (subgaleal hemorrhage or cephalhematoma)
- iii. Birth Asphyxia or Hypoxic Ischemic Encephalopathy
- iv. Significant lethargy
- v. Temperature instability
- vi. Sepsis
- vii. Polycythemia
- viii. Acidosis (blood pH < 7.15)
- ix. Albumin < 3mg/dL (or TSB:Alb ratio depending on risk category)
- x. Previous sibling received phototherapy, or developed kernicterus
- xi. Jaundice observed in first 24-hours following birth

- xii. Cord bilirubin >4 mg/dL and cord Hb level is < 11g/dL
- xiii. TSB rate of rise > 0.5mg/dL/hr or 5mg/dL/day despite phototherapy
- xiv. Apnea and bradycardia requiring resuscitation during previous 24-hours
- xv. Exclusive breastfeeding, and weight loss excessive (>10%)

Clinical manifestations

- A newborn presents with yellowish discoloration of sclera, skin, mucus membranes
- Depending on severity and time of presentation a newborn may present with signs of bilirubin encephalopathy.

The following risk factors aggravate bilirubin encephalopathy

- Prematurity
- Metabolic acidosis,
- Hypoglycemia,
- Sepsis,
- Temperature instability,
- Significant lethargy
- Low serum albumin

Complications of hyperbilirubinemia

- ***Acute bilirubin encephalopathy*** is an early bilirubin toxicity, which is **transient and reversible**. If it is not recognized or untreated, it may progress to permanent neurologic impairment-Kernicterus.
 - Acute bilirubin encephalopathy has three phases
 - **Phase -1 (1st – 2 Days Of Age):** Poor motor reflex, high pitched cry, Decreased tone, lethargy, poor feeding
 - **Phase- 2 (middle of 1st week age):** Hypertonia, seizure and depressed sensorium, fever, opisthotonus posturing, paralysis of upward gazing.
 - **Phase -3 (after 1week of age):** Hypertonia decreases, Hearing and visual abnormality, poor feeding, Athetosis and seizure may also occur
- ***Chronic bilirubin encephalopathy (Kernicterus) seen after 1 year of age and manifests with***
 - Choroathetoid cerebral palsy
 - Upward gaze palsy
 - Sensorineural hearing loss
 - The intellect may be spared with severe physical handicap

Investigations

- Total bilirubin
- Direct and indirect bilirubin
- Maternal blood group and RH type
- Neonatal blood group and RH type
- Direct/indirect Coombs test
- Hemoglobin (Hgb) or hematocrit (HCT)
- Peripheral RBC morphology
- Reticulocyte production index(RPI)
- Serum albumin level and albumin to bilirubin ratio
- Liver function test (LFT)
- Septic work up.
- Abdominal ultrasound with indication.

Management of Unconjugated Hyperbilirubinemia:

The main goal of treatment is to avoid acute and chronic bilirubin encephalopathy by reducing serum bilirubin level.

Note: Always categorize babies into low, medium or high risk based on the Bhutani curve as shown below before deciding on the management options.

Principles of treatment include:

1. *Phototherapy*
2. *Exchange transfusion*
3. *Other medical managements*

1. **Assess appropriateness for treatment (phototherapy or exchange transfusion) based on Bhutani Curve for infants ≥ 35 weeks gestation, or the table for infants < 35 weeks gestation.**
2. **Admissions for Jaundice with ≥ 1 Risk Factor**
 - a. Put infant under phototherapy, and send serum blood work
 - i. Blood group and Rh factor; compare to mother's results
 - ii. CBC, Peripheral morphology, Reticulocyte count
 - iii. Total and direct serum bilirubin
 - iv. Albumin and Electrolytes
 - b. If infant has decreased feeding or any early signs of bilirubin encephalopathy (hypo / hypertonia, abnormal posturing or opistotones, high pitch cry, fever seizure)
 - i. Give 20 mL Normal Saline over 1-hour to facilitate excretion of bile from the liver
 - ii. Ensure phototherapy is intensive

- iii. Prepare blood for exchange transfusion
- iv. Ensure infant NPO (2-3 hrs. prior and after transfusion), and receiving maintenance IVF.

Table 1. Suggested use of phototherapy and exchange transfusion in preterm infants <35 weeks gestational age

<i>Phototherapy</i>		<i>Exchange transfusion</i>
<i>Gestational age (week)</i>	<i>Initiate phototherapy total serum bilirubin (mg dL⁻¹)</i>	<i>Total serum bilirubin (mg dL⁻¹)</i>
<28 0/7	5–6	11–14
28 0/7–29 6/7	6–8	12–14
30 0/7–31 6/7	8–10	13–16
32 0/7–33 6/7	10–12	15–18
34 0/7–34 6/7	12–14	17–19

Table 46-3 -- Guidelines for the Management of Hyperbilirubinemia Based on the Birthweight and Relative Health of the Newborn

BIRTHWEIGHT	<i>Total Serum Bilirubin Level (mg/dL)</i>				
	<i>Healthy</i>		<i>Sick</i>		
	<i>Phototherapy</i>	<i>Exchange Transfusion</i>	<i>Phototherapy</i>	<i>Exchange Transfusion</i>	
<1000 g	5–7	11 - 13	4–6	10 – 12	
1001–1500 g	7–10	12 - 15	6–8	11 – 13	
1501–2000 g	10–12	15 - 18	8–10	13 – 15	
2001–2500 g	12–15	18 - 20	10–12	15 – 18	

Table 46-2 -- Bilirubin-to-Albumin Ratio as a Determinant of the Need for Exchange Transfusion

RISK CATEGORY	<i>Ratio at Which Exchange Transfusion Should Be Considered</i>	
	<i>TSB (mg/dL) to Albumin (g/dL)</i>	<i>TSB (μmol/L) to Albumin (μmol/L)</i>
Infants ≥38 0/7 weeks	8.0	0.94
Infant 35 0/7 to 37 6/7 weeks and well, or ≥38 0/7 weeks if higher risk or isoimmune hemolytic disease or G6PD deficiency	7.2	0.84
Infant 35 0/7 to 37 6/7 weeks if higher risk or isoimmune hemolytic disease or G6PD deficiency	6.8	0.80
If TSB is at or is approaching the exchange level, send blood for immediate type and cross-		

RISK CATEGORY	<i>Ratio at Which Exchange Transfusion Should Be Considered</i>	
	TSB (mg/dL) to Albumin (g/dL)	TSB ($\mu\text{mol}/\text{L}$) to Albumin ($\mu\text{mol}/\text{L}$)
match. Blood for exchange transfusion is modified whole blood (red blood cells and plasma) cross-matched against the mother and compatible with the infant.		

Required procedure during Phototherapy

1. Keep all jaundice babies and especially very small preterm near the window where they can get natural light and can be evaluated easily.
2. Council mother about the problem of the baby, the benefits and risks of phototherapy.
3. Cover the eyes and the genitalia with diaper and show the mother how to do it. Avoid hat, or additional covering of infant.
4. Cover the bed with a white bed sheet and clean the dust from incubator to maximize the irradiation.
5. The distance between the baby and the phototherapy light should not be > 50 cm; preferably the irradiance should be measured each time when you adjust the distance.
6. Measure the irradiance capacity of the phototherapy machine at list once in a month.
 - a. Conventional phototherapy should deliver spectral irradiances at the infant's level of 8 to 10 $\mu\text{W}/\text{cm}^2/\text{nm}$, 430 to 490 nm, when positioned 20cm above the infant
 - b. Intensive phototherapy delivers at least 30 $\mu\text{W}/\text{cm}^2/\text{nm}$ at that same spectrum.
 - c. All devices should be used according to the manufacturers' instructions to avoid overheating.
 - d. If an incubator is used, there should be a 5- to 8-cm space between it and the lamp cover to prevent overheating
7. Check bilirubin and hematocrit at list once a day and use total serum bilirubin to evaluate.
8. Increase the total amount of fluid by 20 – 30 %, or feed him frequently to replace the insensible water loss.
9. If bilirubin result becomes below the photo range 3 - 4 mg below photo the level, check the bilirubin one more time and continue phototherapy for one day more in high risk babies to avoid rebound elevation.
10. If the baby has early signs of bilirubin encephalopathy (NB- you may not see the classical sign and symptoms in preterm babies [apnea, feeding intolerance, vomiting]), do exchange transfusion after stabilizing.

11. At discharge tell the mother to expose her baby to sun light starting on the same day to prevent the rebound effect and give short appointment (< one week) to check the bilirubin after discharge.

Procedures before and during Exchange transfusion

1. Keep the baby NPO 2-3 hours before and after exchange transfusion, put him on maintenance fluid.
2. Place orogastric tube and remove gastric contents; and leave on open drainage.
3. In Rh incompatibility, (mother Rh negative and newborn Rh positive) prepare blood which is Rh compatible to the mother and blood group compatible to the newborn or O negative blood if prepared prior to delivery.
4. In ABO incompatibility (mother 's blood group O and newborn A,B or AB) Prepare blood which is blood group compatible to the mother (O), and Rh compatible to the mother and newborn. **If available O negative blood is preferred to all type of incompatibility.**
5. In other Isoimmune hemolytic disease the blood should not contain the sensitizing antigen, and should be cross-matched against the mother.
6. In non-immune hyperbilirubinemia blood is typed and cross-matched against the plasma and red cell of the infant.
7. Blood to be exchanged should be less than 5 - 7 days old with Hct of 40-50 % and cross matched.
8. Blood should not be warmed under radiant warmer or put in hot water to avoid hemolysis.
9. Do the procedure under strict aseptic condition, scrub as for major procedure.
 - a. Use a sterile gown, mask and cover your hair
 - b. Prepare a helper, sterile gloves, Umbilical catheter or number 6 NG tube, guide, bled, syringes (5cc, 10cc, and 20cc), procedure set, heparin and Calcium gluconate.
 - c. Three-way stopcocks with locking connections
 - d. Waste receptacle (empty IV bottle or bag)
10. Prepare a helper to monitor the vital signs and record each blood draw.
11. Calculate the total amount of blood you need and the amount you draw each time using the formula for a double volume exchange.
 - For term ($2 \times \text{weight} \times 85 = \text{Total amount blood needed for the exchange}$)
 - Eg. For a 3 kg baby ($2 \times 3\text{kg} \times 85 = 510 \text{ ml blood}$)
 - For preterm ($2 \times \text{weight} \times 100 = \text{Total amount blood needed for the exchange}$)
12. Clean the umbilical stump and the surrounding skin with alcohol then Iodine (do not rub vigorously Iodine can damage the skin)
13. Sterile techniques should be used. Old, dried umbilical cords can be softened with saline-soaked gauze to facilitate locating the vein and insert the catheter 2- 4 cm depth.

If a dirty cord was entered or there was a break in sterile technique, treat with Cloxacillin and Gentamycin for 2 to 3 days.

14. Cover the procedure site with sterile cloth and restrain the extremities loosely after wrapping them with cloth.
15. During the procedure (a) withdraw from patient; (b) clear to waste bag; (c) draw new blood; (d) inject into patient. Always rotate the handle in clockwise direction to follow the proper sequence, and keep connections tight.
16. In the push-pull method, blood is removed in aliquots that are tolerated by the infant.
 - 5 mL for infants <1,500 g
 - 10 mL for infants 1,500 to 2,500 g
 - 15 mL for infants 2,500 to 3,500 g
 - 20 mL for infants >3,500 g

NB - If the baby seems sick draw only 5 ml blood each time, slow the procedure or stop till becomes stable, this will minimizes the stress on the cardiovascular system. The recommended time for exchange transfusion should not be more than one hour and do not use the same blood after 4 hours stay in the ward.

17. The blood should be gently mixed after every deciliter of exchange to prevent the settling of RBCs and the transfusion of anemic blood at the end of the exchange.
18. Keep the baby under radiant warmer or inside incubator during the procedure to avoid hypothermia.
19. Record the vital sign (HR, RR, T) every 15 minutes during the procedure.
20. Manage pain according to pain assessment score (preferably with Sucrose or Glucose).

Post procedure care

21. After the procedure give Calcium gluconate 2 ml/kg diluted with 5% D/W over 10 minutes under strict monitoring of the heart beat to avoid bradycardia and cardiac arrest with subsequent determination of serum Calcium level.
22. After the procedure continue to monitor vital signs closely for at least 4 to 6 hours.
23. Check the random blood glucose after thirty minutes to one hour of time (they can develop rebound hypoglycemia) then every 4-6 hours for the 1st 24 hours.
24. After 6 – 12 hours transfuse the baby with platelet 10ml/kg (if platelet level is < 30,000/mic/L) to replace the lose during the procedure and avoid bleeding disorders.
25. If patient looks congested with fluid overload, consider to give diuretics 1mg/kg.
26. After exchange transfusion, phototherapy is continued and bilirubin levels are measured after 6 – 12 hours (every 4 hours in the best setup).
27. When the exchange transfusion is finished, a silk purse-string suture, the catheter should be removed after the procedure.
28. Check bilirubin 6 - 12 hours after exchange transfusion (Bil decreased by 25 - 45 % due to equilibrium between the intravascular pool), then at least once per day with the Hct.

29. Early bilirubin toxicity is transient and reversible after exchange transfusion in 20-60% of cases.

30. Potential complications include:

- a. Metabolic: Hypocalcemia, hypo- or hyperglycemia, hyperkalemia
- b. Cardiorespiratory: Apnea, bradycardia, hypotension, hypertension arrhythmia, infarction, volume overload and cardiac arrest.
- c. Hematologic: Bleeding, thrombocytopenia, dilutional coagulopathy, neutropenia, disseminated intravascular coagulation
- d. Vascular catheter-related: Vasospasm, perforation, thrombosis, embolization with air or clot (see Chapter 28 and 29)
- e. Gastrointestinal: Feeding intolerance, ischemic injury, necrotizing enterocolitis
- f. Infection: Omphalitis, septicemia

31. Prepare emergency resuscitation equipment including medications and fluids:-

- a. Calcium gluconate 10%
- b. Sodium bicarbonate 8.4%
- c. Glucose 10%
- d. Frusemide (20mg/2ml), give 1mg/kg if any sign of congestion occurs.

32. **You can give Ca gluconate if you see sign and symptoms of hypocalcaemia or low calcium level.** Flush line with 0.9% N/S; administer 1ml of 10% calcium gluconate (diluted with 1ml distilled water) followed by a 0.9% N/S flush. The calcium gluconate should not come into direct contact with donor red cells or clotting may occur.

33. **Cease exchange transfusion** if infant's condition suddenly deteriorates, it can be related to the procedure, underlying condition or an adverse reaction to transfusion.

34. If bleeding tendency seen, **fresh frozen plasma** can be administered, with 10ml/kg over 15-20 minutes at the end of transfusion.

NB - please communicate the ward senior before you decide to do an Exchange transfusion.

Phenobarbital

UGT activity can be increased or induced with administration of Phenobarbital. It stimulates many hepatic enzyme systems and hepatic protein synthesis in general. Phenobarbital reduces TSB concentrations in a child with Crigler Najjar (CN) syndrome type II. Administration to pregnant mothers and their offspring reduce serum TSB concentrations by 50 % caused by Erythroblastosis. Phenobarbital does not augment the effect of phototherapy and It's also addictive and may lead to excessive sedation of the newborn, and has other potent metabolic effects, **for these reasons, its use has been reserved largely for specific high-risk populations.**

BILIRUBIN TOXICITY.

This area remains highly controversial. The problem is that bilirubin levels that are toxic to one infant may not be toxic to another, so decision should be made based on the risk factors and clinical condition of the baby.

Bilirubin levels - Refer to total bilirubin, direct bilirubin is not subtracted from the total unless it constitutes >50% of total bilirubin.

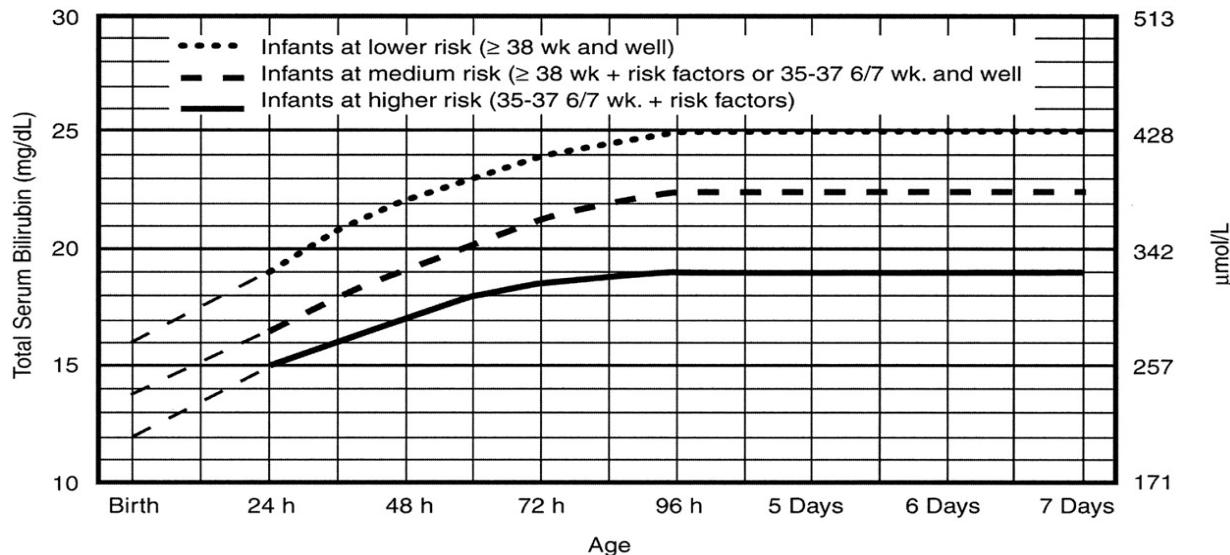
Immunoglobulin should be considered when serum bilirubin rise despite phototherapy and if the level or level is within 2 - 3 mg/dl of the exchange level. 500 – 1,000 mg/kg IV given over 2-4 hours has been used to reduce bilirubin levels.

If bilirubin persists consider other differentials.

Table I. BIND score*

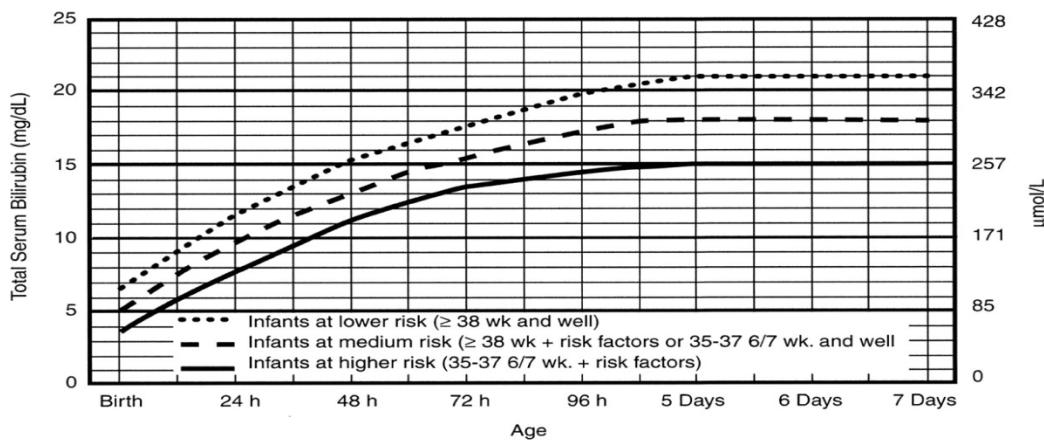
Scores	Clinical sign
Mental status	
0	Normal
1	Sleepy, poor feeding
2	Lethargic, irritable, jittery
3	Unable to feed, apnea, seizures, coma
Muscle tone	
0	Normal flexed tone (awake)
1	Hypertonia alternating with hypotonia
2	Neck stiffness, flexor spasm, beginning of neck and back arching, hypertonia
3	Persistent retropcollis and opisthotonus, bicycling, twitching of hands and feet, fisting, severe hypotonia with limp posture
Cry pattern	
0	Normal
1	High pitched cry
2	Shrill cry even if intermittent
3	Weak or absent cry. Inconsolable cry
Total score	Sum of highest score in each category

*Adapted from Johnson et al⁹.



- The dashed lines for the first 24 hours indicate uncertainty due to a wide range of clinical circumstances and a range of responses to phototherapy.
- Immediate exchange transfusion is recommended if infant shows signs of acute bilirubin encephalopathy (hypertonia, arching, retrocollis, opisthotonus, fever, high pitched cry) or if TSB is ≥ 5 mg/dL ($85 \mu\text{mol}/\text{L}$) above these lines.
- Risk factors - isoimmune hemolytic disease, G6PD deficiency, asphyxia, significant lethargy, temperature instability, sepsis, acidosis.
- Measure serum albumin and calculate B/A ratio (See legend)
- Use total bilirubin. Do not subtract direct reacting or conjugated bilirubin
- If infant is well and 35-37 6/7 wk (median risk) can individualize TSB levels for exchange based on actual gestational age.

Figure 18.6. Guidelines for exchange transfusion in hospitalized infants of 35 or more weeks' gestation.



- Use total bilirubin. Do not subtract direct reacting or conjugated bilirubin.
- Risk factors = isoimmune hemolytic disease, G6PD deficiency, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, or albumin $< 3.0 \text{ g/dL}$ (if measured)
- For well infants 35-37 6/7 wk can adjust TSB levels for intervention around the medium risk line. It is an option to intervene at lower TSB levels for infants closer to 35 wks and at higher TSB levels for those closer to 37 6/7 wk.
- It is an option to provide conventional phototherapy in hospital or at home at TSB levels 2-3 mg/dL (35-50 mmol/L) below those shown but home phototherapy should not be used in any infant with risk factors.

Fig 15: Bhutani curve: phototherapy indication in hospitalized infants of 35 or more weeks' gestation.

References

1. Manual of Neonatal Care, 7th edition
2. Neonatology Fanaroff and Martin, 9th edition.
3. Procedure in Neonatology

Chapter 14: Metabolic disorder

Learning Objectives:

At the end of this session, students will be able to :

- Recognize clinical manifestation and management of common metabolic disorders in neonates

Metabolic Disorders of the Newborn

- *Hypoglycemia*
- *Hyperglycemia*
- *Thermoregulation (See chapter 4)*
- *Hypocalcemia – discussed in fluid and electrolyte section*

Hypoglycemia

Hypoglycemia is common metabolic problem in NICUs. This is because of abrupt cease in glucose supply following clamping of the umbilical cord at birth. Some neonates are symptomatic whereas most are asymptomatic despite very low blood glucose levels. This variability is due to number of factors including:

- Gestational age
- Birth weight
- Post natal age
- Feeding status
- Presence or absence of associated illnesses

The diagnosis of hypoglycemia depends on the clinical setting but not solely on specific blood glucose level. For intervention or further evaluation, hypoglycemia could be defined as blood glucose level less than 40mg/dl.

There are two types of neonatal hypoglycemia, transient and persistent. Most neonates will have transient hypoglycemia, which responds to treatment and is associated with good prognosis.

Causes of hypoglycemia

Transient hypoglycemia could be:

- I. Related with changes in maternal metabolism
 - Intrapartum glucose administration
 - Diabetes in pregnancy-infant of diabetic mother
 - Maternal drugs (tocolytics , propranolol ,thiazide diuretics)
- II. Related with neonatal problems
 - Intrauterine growth retardation
 - Prematurity

- Delayed onset of feeding
- Birth asphyxia
- Infection
- Post exchange transfusion
- Hypothermia
- Delayed feeding
- Polycythemia
- Erythroblastosis fetalis

Clinical manifestations

The clinical manifestations of neonatal hypoglycemia are non-specific and they may confuse with other disorders of the newborn.

The newborn may present with:

- Abnormal crying (weak or high-pitched cry).
- Tremors, jitteriness, irritability, hypotonia.
- Seizures ,lethargy or coma
- Poor feeding , vomiting
- Grunting, tachypnea, tachycardia
- Apnea, cyanosis
- Hypothermia

Who should be evaluated?

Healthy term appropriate for gestational age (AGA) neonates without any risk factors for hypoglycemia does not need evaluation of their blood glucose level.

Newborns at risk for hypoglycemia include:

- Preterm infants
- Small for gestational age(SGA)
- Large for gestational age(LGA)
- Infants of diabetic mothers(IDM)
- Sick infants who require intensive care (e.g. sepsis, asphyxia, respiratory distress)
- Post exchange blood transfusion
- Infants on intravenous fluids or parenteral fluids
- Infants whose mothers were treated with beta adrenergic or oral hypoglycemic agents
- Intrapartum dextrose infusions
- Infants with polycythemia
- Hypothermic newborns

Diagnosis is based on

- Supportive perinatal history (risk factors).
- Signs and symptoms of hypoglycemia.
- Whole blood glucose less than 40mg/dl.

Note that

- Glucometers measure whole blood glucose, which is 15% lower than plasma glucose levels.
- Newborns with persistent or recurrent hypoglycemia need additional testing including hormone analysis and imaging studies.

Management of neonatal hypoglycemia

The overall management of neonatal hypoglycemia should include:

1. Anticipation and prevention in those who are at high risk.
2. Correction of hypoglycemia in those who are symptomatic and
3. Investigation and treatment of the cause of hypoglycemia, when it is possible to identify the cause.

a) Treatment of asymptomatic hypoglycemia

Feeding

Feeding is the initial treatment in an asymptomatic term infants,

- Immediately offer breast-feeding.
- Check blood glucose 30 minutes after feeding to insure normal glucose level before the next feeding.
- If repeated blood glucose is > 40mg/dl continue to offer feedings at 2-3 hours interval.

Indications of **IV infusions** in asymptomatic hypoglycemia (use same infusion as symptomatic hypoglycemia)

- Blood glucose < 25mg/dl.
- Blood glucose remains < 40mg/dl after one attempt of feeding
- If infant becomes symptomatic
- If oral feeding is contraindicated

b) Treatment of symptomatic hypoglycemia

Many neonates have asymptomatic (chemical) hypoglycemia. In contrast to the frequency of chemical hypoglycemia, the incidence of symptomatic hypoglycemia is highest in small for gestational age infants. The exact incidence of symptomatic hypoglycemia has been difficult to establish because many of the symptoms in neonates occur **together** with other conditions

Immediate treatment

- Secure IV line

- Give 2ml/kg of 10% glucose IV bolus over one minute if signs other than seizure
- Give 4 ml/kg of 10% glucose as a bolus over one minute if seizure is present.
- The small bolus minimizes hyperglycemia that can provoke insulin secretion and possibly prolong hypoglycemia.

10% dextrose for IV bolus can be prepared using 40% dextrose, which is available in our country by taking one part of 40% dextrose and three parts of distilled water.

Example; for a symptomatic infant weighing 4kgs ,the total volume of 10% dextrose will be $4 \times 2\text{ml} = 8\text{ml}$.To prepare this 8 ml take one part(2ml)from 40% dextrose and three parts (6ml) from distilled water.

Continuous therapy

- Put on 10% glucose infusion at glucose infusion rate (GIR) of 6mg/kg/minutes (~ 90ml/kg/day) as maintenance.
- Recheck blood glucose after 30 minutes and if it remains above 40mg/dl frequency of checking can be decreased to one hourly then every six hourly.
- If blood glucose remains <40mg/dl, increase the GIR by 2mg/kg/minutes every 30 minutes until repeat values are above 40mg/dl.
- Once the blood glucose values stabilize above 40mg/dl for 24 hours, the GIR can be tapered off at 2 ml/kg/min every six hourly with proportional increment of oral feeds.
- If the neonate requires GIR > 12mg/kg/minutes, persistent hypoglycemia should be considered.

Glucose infusion rate (GIR) can be calculated using the following formula

$$\text{GIR in mg/kg/min} = \frac{\text{dextrose \% []} \times \frac{\text{ml}}{\text{kg/day}}}{144}$$

Example: for an infant taking 10% D/W at 100ml/kg/day, the GIR will be $\frac{10 \times 100}{144} = 6.9$

mg/kg/min (~ 0.07 ml/kg/min).

See Chapter 4 on fluid and electrolyte management for how to calculate 10% dextrose for maintenance fluid from 5% and 40% dextrose solutions.

Practical points

- Do not use > 12 % dextrose infusion through a peripheral vein due to the risk of thrombophlebitis.
- In addition to glucose infusion and monitoring, reduce energy needs by correcting acidosis, maintaining a thermo neutral environment and treatment of other underlying conditions like sepsis.
- Do not stop an IV infusion of glucose abruptly, severe rebound hypoglycemia may occur.

- If the patient needs repeated boluses, this may be an indication for increasing the rate of continuous glucose infusion, and for considering other causes.

Neonatal hyperglycemia

Hyperglycemia, a high blood glucose concentration is less frequently observed in newborn infants than hypoglycemia.

It is usually defined as whole blood glucose level >125 mg/dl.

Causes

- High rates of parenteral glucose infusion.
- Stress like Asphyxia
- Sepsis
- Drugs (steroids, caffeine, aminophylline...)
- Prematurity
- Neonatal diabetes mellitus(rare cause)

Diagnosis of hyperglycemia will be made based on:

- Perinatal risk factors (asphyxia, sepsis...)
- Clinical manifestations (weight loss, signs of dehydration, polyuria).
- Laboratory (blood glucose >125 mg/dl., ketone & glucose on urine analysis)

Management of neonatal hyperglycemia

- Prevent of hyperglycemia by carefully adjusting GIR and frequent monitoring of blood glucose should be the primary goal.
- If the neonate has signs of dehydration or in shock treat accordingly
- Decrease glucose infusion by 2mg/kg/min (30ml/kg/day) every 6 hrs and stop gradually.
- If the newborn was not on infusion put on 5% glucose with rate of 4mg/kg/min.(~ 60ml/kg/day)
- Look for and treat underlying causes.

Chapter 15: Meconium Aspiration Syndrome

Decsreption of chapter

Meconium stained amniotic fluid (MSAF) complicates approximately 10 – 15 % of deliveriy and 3 to 4% of neonate born through MSAF develop meconium aspiration Syndrome (MAS).

Routine suctioning of nonvigorous infants born through Meconium stained amniotic fluid is no longer recommended. Air leak frequently complicates meconium aspiration Syndrome.

Learning objectives:

At the end of this session, the trainees will be able to:

- Recognize Meconium aspiration syndrome
- List the risk factors for meconium aspiration
- Recall the management of MAS

Meconium aspiration syndrome (MAS)

- Meconium stained amniotic fluid (MSAF) complicates approximately 10 – 15 % of deliveriy and 3 to 4% of neonate born through MSAF develop meconium aspiration Syndrome (MAS).MAS occurs when a neonate inhales thick, particulate meconium.
- This is usually secondary to fetal hypoxia, which causes increased peristalsis, relaxation of anal sphincters with the release of meconium in to amniotic fluid; and reflex gasping which leads to aspiration of the meconium in to the lungs.
- Meconium is the first stool of the baby, which is odorless, thick, blackish green material, consisting of desquamated cells from GI tract, skin, lanugo, fatty material from the vernix, amniotic fluid and digestive enzymes.
- Prompt Significant aspiration of thick meconium can induce 4 major pulmonary effects:
 - Airway obstruction,
 - Surfactant dysfunction,
 - Chemical pneumonitis and
 - Bacterial pneumonia

Risk factors

- Prolonged labor
- Post maturity
- Maternal illness, diabetes, hypertension
- Umbilical cord complications
- Intrauterine growth retardation

Clinical Features

- Meconium staining, nails, skin, umbilical cord
- Increased AP diameter of the chest
- Tachypnea, retractions, grunting, and cyanosis(see annexe Downe-Vidyasagar Score for grading respiratory distress)
- Pneumothorax, or pneumomediastinum, or both

Monitor closely for deterioration in clinical status or drop in SaO₂.suggestive of air leak syndrome, lung collapse, PPHN.

Intrauterine hypoxia is the single most important risk factor for MAS, and is presumed to relate to the influx of MSAF into the lung during hypoxic fetal gasping. MAS can occur, however, in meconium-stained infants that are in good condition at birth.

Complications

- Persistent pulmonary hypertension
- Air leak — pneumomediastinum, pneumothorax, cystic lung disease
- Pulmonary haemorrhage
- Perinatal asphyxia

Investigation

CXR X-ray chest if moderate to severe RD or mild RD persisting > 2 hours.

Patchy atelectasis, Heterogeneous fluffy or nodular opacities, Dirty lung fields, Hyperinflation & Air leak.

- Septic workup

Management

- Vigorous infants born through meconium-stained fluid do not need routine intubation to aspirate the lungs.
- Most vigorous newborns do not require suctioning at birth. If necessary use a bulb syringe when secretion are obstructing the baby's breathing, and for those having difficulty clearing their secretion. The baby may remain with the mother for the initial steps.
- *If the baby is not vigorous*, bring the baby to the radiant warmer to perform the initial steps. Routine intubation for tracheal suction is not recommended for non vigorous newborns.
- Oxygen is critically important in infants with MAS.
- Antibiotics are indicated, since the clinical picture of MAS and congenital pneumonia are similar.
- Treat the complications (pneumothorax, PPHN and pneumonia, respiratory failure).

Prevention

Timely identification of fetal distress and initiating prompt delivery may reduce the risk of acquiring MAS. However, routine intrapartum nasopharyngeal suctioning in pregnancies with meconium-stained amniotic fluid does not reduce the risk for MAS and, may cause nasopharyngeal trauma or cause a cardiac arrhythmia, no more recommended.

Summary

Infants born through MSAF are at risk for meconium aspiration pneumonia and should be closely observed for respiratory distress. Routine suctioning of nonvigorous infants born through Meconium stained amniotic fluid is no longer recommended. Air leak frequently complicates meconium aspiration Syndrome.

Reference

- 1.Jone P. Cloherty, Eric C., Anne R. Stark Manual of Neonatal Care 8th edition
- 2.WHO Reproductive Health Library. WHO recommendation on newborn routine nasal or oral suction (February 2018). The WHO Reproductive Health Library; Geneva: World Health Organization.
3. Foster JP, Dawson JA, Davis PG, Dahlen HG. Routine oro/nasopharyngeal suction versus no suction at birth. *Cochrane Database Syst Rev*. 2017;4(4):CD010332. Published 2017 Apr 18. doi:10.1002/14651858.CD010332.pub2

Chapter 16: Neonatal Seizure

Learning objectives:

At the end of the session the participants are expected to:

- Identify the type of seizure in neonate
- Investigate neonates with seizure
- Recall how to manage neonatal seizure

Neonatal seizures

Neonatal seizures are one of the few neonatal neurologic conditions that require immediate medical attention. They are usually brief and subtle in clinical appearance, sometimes comprising behaviors that are difficult to recognize and classify. The commonest causes of neonatal convulsion are PNA, hypoglycemia, CNS infection (sepsis).

The clinical manifestations of neonatal seizures differ in many ways from those in older patients. These peculiar clinical characteristics of seizures in the newborn infant likely reflect the incomplete Myelination of neonatal brain. They are not generalized seizures like adults or older infants.

Etiology of seizures

Hypoxia and trauma

- Hypoxic encephalopathy
- Intracranial hemorrhage
- IVH

Perinatal stroke

Metabolic

- Hypoglycemia in neonates of IUGR, Prematurity, asphyxia, IDM, E.tc
- Hypocalcaemia in neonates of Prematurity, asphyxia, IDM,.. E.tc
- Hypomagnesaemia
- Hypo-/hypernatremia
- Pyridoxine deficiency/dependency

CNS infection

- Bacterial meningitis- eg-group B strep ,E coli...etc.
- Viral meningoencephalitis
- TORCHS

Others: like CNS malformation

Clinical diagnosis of Neonatal seizure

Clinical seizure subtypes

Clinical seizure types in newborn may be categorized broadly into four groups: subtle seizure, clonic seizures, tonic seizures, and myoclonic seizures. In many cases, more than one type seizures occur in a new born over time.

A/ Subtle seizures: are the most common subtype, comprising about 50% of all seizures in term and premature new born. Subtle seizure includes a broad spectrum of behavioral phenomena, occurring in isolation or in combination. Ocular phenomena are common and include tonic eye deviation, nystagmus eye movement, and sudden sustained eye opening with visual fixation. Oro-bucco-lingual movements include chewing, sucking, or lip smacking movements, and are often associated with a sudden increase in drooling. Various types of limb movements including pedaling, boxing, rowing, or swimming movements have been described. Autonomic phenomena, including sudden changes in skin color, tachycardia initially, and bradycardia if sustained and possible apnea have been described.

Subtle seizures are not usually associated with EEG seizure and as well poorly respond to conventional anticonvulsant medications.

B/Conic seizures: are stereotypic and repetitive biphasic movements with a fast contraction phase and a slower relaxation phase. It can be univocal, multifocal, or generalized. Clonic seizures that remain unifocal are usually not associate with loss of consciousness. The most common cause for clonic seizures that remain unifocal is neonatal stroke.

C/ Tonic seizures: have a sustained period (seconds) of muscle contraction without repetitive features. It can be generalized or focal. Over all, the prognosis of tonic seizure is very poor.

D/ Myoclonic seizures: are distinguished from clonic seizures by their lightning fast contractions and non-rhythmic characters. It can occur in a multifocal or generalized pattern. Myoclonic seizures are associated with diffuse and usually serious brain dysfunction resulting from etiologies such as PNA, inborn errors of metabolisms, major brain trauma, etc. myoclonic seizures are usually associated with a poor long-term outcome.

Conditions that mimic seizures

In the newborn it may be difficult to distinguish between normal immature behaviors (e.g. non-nutritive sucking), abnormal but no epileptic behaviors (e.g. jitteriness), and true epileptic manifestations. The following clinical features may help distinguish true epileptic seizures from seizure mimics:

- True epileptic seizures are rarely stimulus sensitive
- Epileptic seizures cannot be abolished by passive restraint or repositioning of the infant
- Epileptic seizures are often associated with autonomic changes or ocular phenomena.

Laboratory studies:

- Complete blood count with differential
- Serum electrolyte evaluation
- Blood glucose analysis
- CSF analysis and culture
- Blood culture
- Urine analysis and culture
- Cranial ultrasound, EEG, MRI

Management of neonatal seizures

Initial management:

- Ensure air way:-place the baby in semi prone position and clean oropharyngeal secretions.
- Ensure satisfactory breathing and circulation.
- Arrest the seizures with the following orders:
 - a) **Hypoglycemia:** if glucostix shows hypoglycemia or if there is no facility to test blood sugar, immediately 4 ml/kg of 10% glucose should be given by bolus followed by maintenance.
 - b) **Hypocalcaemia:** if hypoglycemia has been treated or excluded as a cause of seizures, the neonate should receive 2 ml/kg of 10% calcium gluconate IV over 10 minutes, under strict cardiac monitoring. If ionized calcium levels are suggestive of hypocalcemia the new born should receive calcium gluconate at 8 ml/ kg/d in four divided doses for 3 days.
- c) **Anticonvulsants**
 - **Phenobarbitone:** preferred initial drug. An initial IV loading dose of 20 mg/kg may be followed by increments of 10 mg/kg IV to a total of 40 mg/kg, with higher doses associated with improved efficacy. Maintenance dose should be started at 5 mg/kg/day divided twice daily.
 - If there is no IV, use oral dose as above and reload after 4-6 hours as the absorption of oral doses takes long hours. Careful monitoring of cardiac and respiratory function is required in vulnerable infants. Advantages of Phenobarbitone include reduction of cerebral metabolic rate and free radical scavenger.
 - **Phenytoine:** it is the second agent selected when Phenobarbitone fails. Loading dose is 20 mg/kg; maintenance dose is 4-6 mg/kg daily.
 - **Diazepam:** used only when immediate cessation of seizure activity is required. It should be administered after dilution of 0.2 ml of diazepam with 0.8 ml of normal saline. Initial dose is 0.1 -0.3 mg/kg slowly IV until seizures stop.
 - **Disadvantage:** It contains sodium benzoate which interferes with binding of bilirubin to albumin --- jaundice. It has short anticonvulsant effect but prolonged respiratory suppressant effect
 - **Lorazepam:** the current recommended dose is 0.05 mg/kg/dose over 2-5 minute
 - **Pyridoxine deficiency /dependency:** is diagnosed by giving pyridoxine 100 mg IV. Seizures will cease within minutes if pyridoxine dependency or deficiency is causing
 - Maintenance therapy is given for life at 10 to 100 mg daily in case of dependency and 5 mg daily in case of deficiency.

Follow up anticonvulsant medications

If the neonate takes more than one anticonvulsant medication, phenobarbitone will be the last one to be tapered and discontinue.

Discontinuation of drugs before discharge from the NICU is generally recommended, because then clinical assessments of arousal, tone, and behavior will not be hampered by medication effect. However, newborns with congenital or destructive brain lesions on neuroimaging or those with persistently abnormal findings on neurologic examination at the time of discharge may require a slower taper off medication over several weeks or months.

Indications for discontinuations of antiepileptic drugs

- Normal findings on examinations

- Absence of recurrent seizure
- Non-epileptic EEG

Complications:

- Cerebral palsy
- Hydrocephalus
- Epilepsy
- Learning disability, mental retardation

Prognosis

- Long-term sequelae in infants with neonatal seizures, including cerebral palsy and intellectual disabilities, still occur at a high rate of up to 30% to 35%, with postneonatal seizures occurring in up to 20%. The most important factor affecting outcome for infants with neonatal seizures is the **underlying etiology**. For instance, normal development can be expected in infants with benign idiopathic neonatal seizures and in 90% of those with primary subarachnoid hemorrhage, whereas only 50% of those with HIE, and even fewer with a brain malformation, will have normal outcome.

References

1. Avery A. Fanaroff and Martin's Neonatal- Perinatal Medicine 10th edition,2015
2. Jone P. Cloherty, Eric C., Anne R. Stark Manual of Neonatal Care 8th edition

Chapter 17: Neonatal Hematologic problems

Learning Objectives

At the end of this session, the trainee will be able to:

- Identify causes of anemia and polycythemia
- Recognize the clinical manifestations of anemia and polycythemia
- Investigate and manage neonatal hematologic problems
- Recall how to do partial exchange transfusion

Approach to a neonate with bleeding disorder

Introduction

- Neonates have decreased activity of clotting factors (II, VII, IX, X), impaired platelet function, and suboptimal defense against clot formation.
- HDN in well babies and disseminated intravascular coagulations (DIC) in sick babies are among the commonest problems.

Hemorrhagic disease of the newborn (HDN)

- **Definition:** - HDN occurs in the healthy infant due to Vitamin - K deficiency.

Table 14: Classification, risk factors, prevention, treatment and incidence of HDN according to time of onset

Classification	Early onset	Classic disease	Late onset
Age	0 – 24 hrs	2 – 7 days	>1wk – 12 weeks of age
Site of hemorrhage	Cephalhematoma, Subgaleal hemorrhage, Intracranial hemorrhage (ICH) GI and umbilical bleeding Intra abdominal bleeding	Cephalhematoma Mucosal Intracranial Circumcision Cutaneous Injection site	ICH, GI, Cutaneous ENT – mucosal Ear, nose, through Injection site , thoracic
Etiology/ Risk factors	Maternal drug use (Phenobarbital, Phenytoin, Warfarin, Rifampicin, and INH) Inherited coagulopathy	Vitamin – K deficiency(or not given Vitamin K) Breast feeding	Cholestasis- malabsorption of vitamin K (biliary atresia, hepatitis , cystic fibrosis, Warfarin injection Infant treated with broad-spectrum antibiotics
Prevention	Vitamin- K : 0.5 (Preterm) – 1 mg (term) IM at birth. To the mother, 10 mg IM 24 hrs prior to delivery if she takes the above- mentioned drugs.	Vitamin K: 0.5 (Preterm) – 1 mg (term) IM at birth.	Vitamin K : 0.5 (Preterm) – 1 mg (term) IM at birth.

Treatment	Vitamin- K 1mg IV Fresh frozen plasma 10 - 20 ml/kg in serious bleeding, prematurity, liver disease Treat shock by blood transfusion	Vitamin- K 1mg IV Fresh frozen plasma 10 - 20 ml/kg in serious bleeding, prematurity, liver disease Treat shock by blood transfusion	Vitamin- K 1mg at arrival then at 1 wk, 4 wks, and 8 wks *
Incidence	Very rare	2 % if not given Vitamin K	Depends on primary disease

***Vitamin K, 1 mg/week orally may prevent late HDN in infants receiving broad-spectrum antibiotics or infants with malabsorption (liver disease, cystic fibrosis) are at greater risk for vitamin K deficiency and hemorrhagic disease.**

Disseminated intravascular coagulation (DIC)

Definition: DIC is a systemic process producing both thrombosis and hemorrhage due to activation and dysregulation of the hemostatic system.

DIC in newborn is due to infection, cold injury, asphyxia or tissue damage and necrosis. The baby usually appears sick and may have petechiae, gastrointestinal bleeding, oozing from vein puncture.

Laboratory findings are

- Decreased platelet count and
- Increased PT and PTT
- Decreased fibrinogen

Management

- Treat the underlying cause
- Vitamin K 1 mg IV.
- Platelet and fresh-frozen plasma 10-20ml/kg may be considered for moderate-to-severe bleeding
- Cryoprecipitate (5 to 10 ml/kg) is preferred to treat hypofibrinogenemia.
- If bleeding persists, do exchange transfusion and continue to transfuse with fresh-frozen plasma and platelet.

Polycythemia

Definition: Polycythemia is defined as a peripheral venous blood of HCT > 65 %. Capillary blood sample is higher by 10 - 15 % than venous blood.

Causes of Polycythemia :-

- Twin to twin transfusion
- Placental insufficiency (SGA infants, maternal HTN, post maturity, maternal chronic hypoxemia),
- Other conditions (IDM, LGA babies, dehydration, congenital hypothyroidism, trisomy 21, 18 and 13).

Clinical finding – most infants are asymptomatic

- **Central nervous system (CNS)** – poor feeding, lethargy, hypotonia, apnea, tremors, jitteriness, seizures, cerebral venous thrombosis.
- **Cardio-respiratory** – Cyanosis, tachypnea , murmur, congestive heart failure, cardiomegaly, elevated pulmonary vascular resistance, prominent vascular markings on CXR.
- **Renal** – decreased glomerular filtration rate, decreased sodium excretion, renal vein thrombosis, proteinuria.
- **Others** – thrombosis, thrombocytopenia, poor feeding, increased jaundice, persistent hypoglycemia, hypocalcemia, testicular infarcts, NEC, DIC.

Management

Management: Partial exchange transfusion

**The procedure should be done under strict aseptic technique after umbilical catheterization
(LOOK NEONATAL PROCEDURES for detail)**

- Partial exchange transfusion in **symptomatic** patients if venous HCT is > 65%.
- Increase fluid intake and repeat HCT in 4 to 6 hours, in asymptomatic infants with venous HCT between 65% - 70%.
- Partial volume exchange transfusion when the peripheral venous HCT is >70% even in the absence of symptoms.
- Partial volume exchange transfusion is done by withdrawing blood from umbilical vein and replacing it with **Normal saline** using the formula as shown below.
- The amount of blood to be removed at a time is 5ml to 20 ml depending on the gestational age, birth weight and of the infant. The lower range is used for preterm, VLBW, and critically ill infants. The higher amount of aliquot should be utilized in stable newborns that are term with normal birth weight.
- Determine post transfusion hematocrit after 4-6 hours after the procedure
- Monitor RBS every 2-4 hours for the first 24 hours after procedure.
- Keep baby NPO for 4 hours before and after procedure for prevention of NEC and put him on maintenance fluids.

$$\text{Volume of exchange in ml} = \frac{\text{blood volume of newborn} \times (\text{observed HCT} - \text{Desired HCT [55\%]})}{\text{Observed HCT}}$$

Example: What is the amount exchanged in a newborn weighing 3kg infant and hematocrit of 75 % the amount of blood to be exchanged is calculated as follows. Volume of blood for term baby is 85ml/kg and for a preterm to bring HCT to 55 %

$$\begin{aligned}\text{Volume of exchange in ml} &= \frac{85\text{ml} \times 3\text{kg} \times 75 - 55}{75} \\ &= \frac{255 \times 22}{75} \\ &= \mathbf{68 \text{ ml blood will be exchanged with equal amount of normal saline}}\end{aligned}$$

Anemia in newborns

Definition:- Anemia is defined as a hemoglobin (Hgb) or hematocrit (HCT) that is more than 2 standard deviation below for the age or less than normal range for postnatal age and birth weight.(For clinical purpose HCT < 45% in the 1st week of life) .

Causes of neonatal anemia

A. Blood loss

- Hemorrhage
- o Fetal, Placental, traumatic delivery, coagulation defect
- o Bleeding in the neonatal period may be due to:- (Cephalhematoma, uvelectomy, subgaleal hemorrhage, retroperitoneal bleeding, adrenal or renal hemorrhage, gastrointestinal bleeding and bleeding from the umbilicus (HDN)).
- o Iatrogenic causes (excessive blood loss from frequent blood sampling).

- Early umbilical cord clamping (less than one minute)
- Twin – twin transfusion
- Fetal-maternal transfusion

B. Hemolytic anemia

- Alloimmune (RH, ABO, Minor blood group incompatibility disease)
- Nonimmune (Hemoglobinopathy, Thalassemia, Red blood cell enzymatic deficiency, structural RBC defect, Infection, mechanical destruction, etc)

C. Diminished RBC production

- Congenital
- Anemia of prematurity or physiologic anemia of infancy
- Acquired
 - o Syphilis, Parvovirus B19, HIV infection, drug induced, disseminated intravascular coagulation (DIC).

Clinical approach to a newborn with anemia

- Detailed obstetric and neonatal history.
- Physical examination
 - o Look for acute blood loss → shock, tachycardia, poor capillary refill time, poor perfusion and acidosis.
 - o Chronic blood loss associated with pallor, jaundice, hepatosplenomegaly, cardiac failure.
 - o Growing preterm baby may manifest with poor weight gain, apnea, tachypnea or poor feeding.

Investigations

- Complete blood cell count
- Blood group and RH of the newborn and mother.
- Reticulocyte production index (elevates with chronic blood loss and hemolysis, depressed with infection and production defect).
- Blood smear to see the morphology and find evidence for hemolysis (target cells and burr cells).
- Coombs' test and bilirubin level.
- Apt test in case of gastro-intestinal bleeding to differentiate swallowed maternal blood from neonatal bleeding.
- Ultrasound of abdomen and head.
- Screening for infections [(TORCH) toxoplasmosis, rubella, cytomegalovirus infection, herpes simplex infection] and septicemia.
- Bone marrow aspiration (rarely used).

Management

1. Guideline for packed RBC replacement in high-risk neonate

- In severe cardiopulmonary disease: Transfuse if HCT <40%
- For moderate respiratory distress: Transfuse if HCT < 30%
- For major surgery: Transfuse if HCT <30%
- Infant with asymptomatic anemia: Transfuse if HCT <21%
- If the newborn is in shock, refer to the guideline on management of shock.

2. Transfusion Guidelines for Premature Infants

- a.** Asymptomatic infants with Hct ≤18% and reticulocytes <100,000 cells/ μ L (<2%)
- b.** Infants with Hct ≤20% on supplemental oxygen who are not requiring mechanical ventilation but have one or more of the following:
 - i. ≥24 hours of tachycardia (heart rate >180 bpm) or tachypnea (respiratory rate >80 breaths per minute)
 - ii. A doubling oxygen requirement from the previous 48 hours
 - iii. Acute metabolic acidosis (pH <7.20) or lactate ≥2.5 mEq/L
 - iv. Weight gain of <10 g/kg/day for 4 days while receiving ≥120 kcal/kg/day
 - v. If the infant will undergo major surgery within 72 hours
- c.** Infants with Hct ≤25% requiring minimal mechanical ventilation, defined as MAP ≤8 cm H₂O by CPAP or conventional ventilation, or MAP <14 on high-frequency ventilation, and/or FiO₂ ≤0.40
- d.** Infants with Hct ≤30% requiring moderate or significant mechanical ventilation, defined as MAP >8 cm H₂O on conventional ventilation, or MAP >14 on high-frequency ventilation, and/or FiO₂ >0.40
- e.** A transfusion should be considered if acute blood loss of ≥10% associated with symptoms of decreased oxygen delivery occurs, or if significant hemorrhage of ≥20% total blood volume occurs.

3. Suggested Hemoglobin Levels and Hematocrit Thresholds for Transfusing Infants with Anemia of Prematurity

Postnatal Age	Respiratory Support	No Respiratory Support
Week 1	11.5 (35)	10.0 (30)
Week 2	10.0 (30)	8.5 (25)
Week 3 and older	8.5 (25)	7.5 (23)

Volume of Packed red blood cell to be transfused can be calculated as follows.

$$\text{Volume of transfusion} = \frac{\text{Weight in Kg} \times \text{blood volume / Kg (desired HCT- observed HCT)}}{\text{HCT of blood to be given}}$$

- Average HCT of packed RBC is in the range 70-80%
- Transfuse over 2-4 hours time
- The average blood volume for term newborn is 85 ml/kg: 95ml/kg in preterm.

- Always transfuse fresh blood (<7 days old) to avoid related complications decreased PH (7.4 Vs 6.5), Elevated potassium level (4.2mM Vs 78.5mM) and decreased 2, 3-diphosphoglycerol.
- Exchange transfusion with packed RBCs may be required for severely anemic infant if direct transfusion result in circulatory overload.
- Consider Furosemide 1mg/kg through the transfusion to minimize volume load

Whole blood transfusion

- If packed RBC is not available give whole blood 15-20 ml/kg over 2-3 hours period
- In case of acute blood loss, use whole blood 15-20ml/kg over 1-2 hours period.
- Give Furosemide 1mg/kg pre and post transfusion.

Prophylaxis

- Routinely supplement iron in preterm infants at a dose of 2 – 4 mg/kg/day once full enteral feeding is achieved.

Platelet Transfusion

Guidelines for platelet transfusion in neonates

1. Platelet count less than 30,000/cubic mm: transfuse all neonates, even if asymptomatic
2. Platelet count 30,000 to 50,000/cubic mm: consider transfusion in
 - a) Sick or bleeding newborns
 - b) Newborns less than 1000 gm or less than 1 week of age
 - c) Previous major bleeding tendency (IVH grade 3-4)
 - d) Newborns with concurrent coagulopathy
 - e) Requiring surgery or exchange transfusion
3. Platelet count more than 50,000 to 99,000/cubic mm: transfuse only if actively bleeding

Dose : transfuse with 15 mL/kg of platelets and 5ml/Kg can raise the platelet count by approximately 30,000/mm3.

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Chapter 18: Birth Trauma

13.1 Chapter description:

Birth injuries are those sustained during the birth process, which includes labour and delivery. They may be avoidable or unavoidable. It is a common problem with significant neonatal morbidity and mortality. A new born at risk for birth injury should have a thorough examination, including a detailed neurologic evaluation. Particular attention should be paid to asymmetry of structure and function, cranial nerves, range of motion of individual joints, and integrity of the scalp and skin.

13.2 Learning objectives:

At the end of this session, the trainee will be able to recognize risk factors and signs of different types of factors of Birth injuries and recall their management

13.3. Braining storming :

Ask the participants if they have seen cases of newborn injuries following birth process. What actions did they take , how dis they manage the baby ? what was the outcome of the injury.

13.4 Types of birth injuries

13.4.1 Injuries to the skull

Caput succedaneum

It is a commonly occurring subcutaneous, extra periosteal fluid collection that is occasionally hemorrhagic. It has poorly defined margins and can extend over the midline and across suture lines. It extends over the presenting portion of the scalp and is usually associated with molding. The lesion usually resolves spontaneously without sequelae over first several days after birth. It rarely causes significant blood loss or jaundice.

Management:

- The lesion usually resolves spontaneously without sequelae over first several days after birth.
- It needs only observation and reassurance.

Cephalohematoma

It is a subperiosteal collection of blood resulting from rupture of the superficial veins between the skull and periosteum. It is always confined by suture lines and cannot cross the suture lines. An Extensive cephalohematoma can result in significant hyperbilirubinemia and rarely serious enough to necessitate blood transfusion. The risk of infection is very rare. Skull fractures have been associated with 5 – 20% of cases. Picture



Figure 24: Bicornouscephalohematoma-looks like a horn



Figure 25: Unicornous

Management:-

- Observation in most cases
- Incision and aspiration is contraindicated.
- Anemia and jaundice should be treated as needed

Subgaleal hemorrhage

It is hemorrhage under the aponeurosis of the scalp. Because subaponeurotic space extends from the orbital ridges to the nap of the neck and laterally to the ears, the hemorrhage can spread across the entire calvarium. The initial presentation typically includes pallor, poor tone, and a fluctuant swelling on the scalp, which cross the suture lines. The hematoma may grow slowly or increase rapidly and result in shock. With progressive spread, the ears may be displaced anteriorly and periorbital swelling can occur. Ecchymosis of the scalp may develop and it is very painful on manipulation. The blood is desorbed slowly and swelling resolves gradually.

A Subgaleal hemorrhage associated with skin abrasions may become infected; it should be treated with antibiotics and may need drainage.

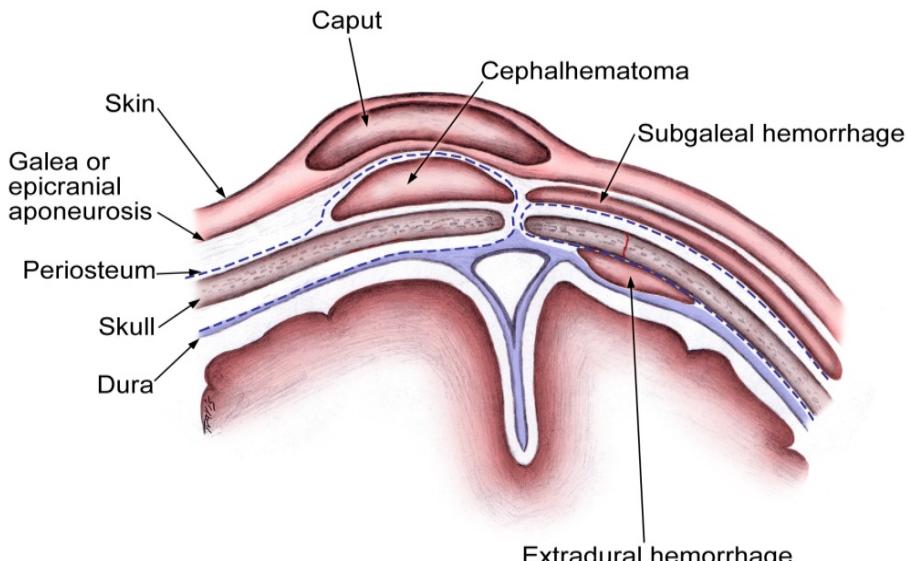


Figure 26:

**Management
and follow**

up:-

1. New born with this lesion should be admitted
2. Assess and treat shock
3. Daily HC measurement and HCT follow-up
4. Minimize manipulation because it is painful
5. Manage anemia and jaundice if needed.

13.4.2 Cervical nerve root injuries

Brachial plexus injury

The cause is excessive traction on the head, neck, and arm during birth. Risk factors include macrosomia, shoulder dystocia, breech presentation. Injury usually involves the nerve root, specially where the roots come together to form the nerve trunk of the plexus .

A. Duchenne-Erb's palsy: - involves the upper trunks (C5, C6 and occasionally C7) and is the most common type of brachial plexus injury.

Clinical presentation: - the arm is typically adducted and internally rotated at the shoulder. There is extension and pronation at the elbow and flexion at the wrist and fingers in the characteristic "waiter's tip" posture. Moro is absent on the affected side. The grasp reflex is intact and sensation is variably affected.

B. Klumpke's palsy: - involves injury C7/C8 to T1 and is the least common injury. In this case, the grasp reflex is absent and there is sensory impairment on the ulnar side of the forearm and hand.

Management of brachial plexus injury: - physical therapy and passive range of motion exercises prevent contractures. It should be started at 7 -10 days when the post injury neuritis recovered. Splinting should be avoided as contractures in the shoulder girdle may develop. Wrist and digits splints may be useful.

Prognosis:-full recovery varies with the extent of injury. If the nerve roots are intact and not avulsed, the prognosis for full recovery is excellent. Notable clinical improvement in the first two weeks indicates that normal or near normal function will return. Most infants recover fully by three months of age. In case with slow recovery, electromyography and nerve conduction studies are indicated

Phrenic nerve injury (C3, 4 or 5) :

Phrenic nerve injury leading to paralysis of the ipsilateral diaphragm may result from stretch injury due to lateral hyperextension of the neck at birth. Risk factors include breech and difficult forceps deliveries. At least 75% of patients also have brachial plexus injury.

Clinical features

- Respiratory distress and cyanosis
- Some infants present with persistent tachypnea and decreased breath sounds at the lung base.
- There may be decreased movement of the affected hemi thorax
- C-X-ray may show elevation of the affected hemi thorax.

Diagnosis – confirmed by U/S or fluoroscopy that shows paradoxical (upward) movement of the diaphragm with inspiration.

Management: - the initial treatment is supportive. CPAP or mechanical ventilation may be needed. Careful airway care to avoid atelectasis and pneumonia.

13.4.3 Skull fracture

Skull fracture may be either linear or depressed. Depressed skull fractures are usually associated with forceps use. Most infants with linear or depressed skull fractures are asymptomatic unless there is an associated intracranial hemorrhage (e.g., subdural or subarachnoid hemorrhage). The diagnosis is made by skull X-ray. Head CT scan should be obtained if intracranial injury is suspected.

Management:

- An uncomplicated linear fracture does not usually require therapy.
- Depressed fractures require neurological evaluation for possible elevation needed.
- Comminuted or large fractures with neurologic findings need immediate neurologic evaluation.
- If leakage of CSF from the nares or ears is noted, antibiotic therapy should be started and neurosurgical consultation obtained.

13.4.4 Bone injuries

Clavicular fracture: - is the most commonly injured bone during delivery. This fracture is seen in vertex presentations with shoulder dystocia or in breech deliveries when the arms are extended. Macrosomia is a risk factor. A green stick or incomplete fracture may be asymptomatic at birth. The first clinical sign may be a callus at 7 – 10 days of age. Signs of a complete fracture include crepitus, palpable bony irregularity, and spasm of the sternocleidomastoid muscle. The affected arm may have a pseudo paralysis because of pain on movement.

Diagnosis: - is confirmed by chest X-ray.

Management: -

- Should be directed at decreasing pain with analgesics.

- The infant's sleeve should be pinned to the shirt to limit movement until the callus begins to form.
- Complete healing is expected and counsel the family

Long bone injuries:-

A. Humeral fracture: - this fracture usually occurs during a difficult delivery of the arms in the breech presentation and/or of the shoulder in vertex presentation. Direct pressure on the hummers may also result in fracture

Clinical presentation:

Loss of spontaneous arm movement on affected side, followed by swelling and pain on passive motion.

Diagnosis is by X-ray of the affected arm

Management: - the fractured humorus requires splinting for two weeks. Displaced fractures require closed reduction and casting.

Prognosis: - complete healing is expected with the above managements.

B.Femoral fracture: - this fracture follows usually a breech delivery. Infants with congenital hypotonia are at increased risk

Clinical features: - obvious deformity of the thigh and swelling of thigh, decreased movement and pain on palpation or passive motion.

Diagnosis: - confirmed by X-ray

Management - fractures, even if unilateral, should be treated with traction and suspension of both legs with a spica cast. Casting is maintained for about four weeks. Complete healing without limb shortening is expected.

13.4.5 Intra- abdominal injuries

Hepatic injury: - liver is the most commonly injured solid organ during birth. Risk factors include macrosomia, hepatomegaly, and breech presentation. The etiology is thought to be direct pressure on the liver.

Clinical features: - sub capsular hematoma are not symptomatic at birth. Non-specific signs of blood loss such as poor feeding, pallor, tachypnea, tachycardia, and onset of jaundice develop during first 1 – 3 days of birth. Serial HCT decline may suggest blood loss. Rupture of the hematoma results discoloration of the abdominal wall and circulatory collapse with shock.

Management: - restoration of blood volume, correction of coagulation disturbances, surgical consultation for possible laparotomy. Every diagnosis and correction of volume loss increases survival.

Splenic injury: - Risk factors include macrosomia, breech presentation and splenomegally (eg- congenital syphilis, erythroblastosisfetalisetc).

Clinical features: - similar with hepatic rupture, a mass is sometimes palpable in the Right Upper Quadrant.

Management: - volume replacement and correction of coagulation disorders. Obtain surgical consultation.

13.5 Summary of the chapter

A new born at risk for birth injury including Prematurity, Small maternal stature (CPD), Prolonged or precipitated labour , Mal presentation and malposition, Instrumental delivery like forceps or vacuum extraction , Versions and extraction , Fetal macrosomia or large fetal head

should have a thorough examination, including a detailed neurologic evaluation. Particular attention should be paid to asymmetry of structure and function, cranial nerves, range of motion of individual joints, and integrity of the scalp and skin for better care.

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Chapter 19: Fluid and electrolytes

Introduction: Fluid management to newborn is challenging, especially in those very preterm and VLBW infant. Because

- Transition from fetal to neonatal life is associated with major changes in water & electrolyte homeostasis.
- Weight loss is mainly loss of water. Ten percent birth weight in term and 15% in preterm.
- Renal function is limited, inefficient to modulate changes in fluid & electrolyte
- Total body water for preterm is greater than term newborns
- Insensible water loss is major component in EVLBW infant

Learning objectives

At the end of this session, the students will be able to:

- Recognize newborns fluid and electrolyte requirements
- Demonstrate adequate fluid preparation for neonates
- Identify clinical signs of electrolyte imbalance and adequate management

Fluid composition of newborn differs from that of adult. See table below for comparison

Table 3: Water composition of newborn and adult

Water	At birth	Adult
Water composition of body	80%	55 – 65%
Extracellular Fluid/ Total Body Water	2/3	1/3
Intracellular Fluid/Total Body Water	1/3	2/3
Water Lose/kg/day	High	Low
Water requirement/kg/day	High	Low

Total body water = ECF + ICF

- Total body water for preterm is > 80% of body weight
- Water is lost through skin & breathing 40 % (Insensible lose), & urine 50-60% (obligatory)
- Water and electrolytes controlled by ADH and Kidneys

A. Fluid and electrolyte requirement

Indications

- Normal healthy term and late preterm newborns usually doesn't need IV infusions
- Fluid usually is started in very preterm (G/A <34 wks) and or sick newborns.

Fluid requirement

- Newborns have high body surface area to body mass and insensible loss of fluid is higher per unit body weight. This is loss of water through skin and breathing
- Passage of water through urine is also higher
- Thus, daily water requirement per unit of body weight is high
- Daily fluid to be given is calculated based on birth weight and in kilograms
- Caloric expenditure to facilitate loss of fluid from the body is basis for initials and for further modification of fluid

What type and how much fluid are required.

- Type of fluid and amount to be given varies with birth weight and postnatal age of newborn infant. See Table 4
- Main goal of fluid therapy is
 - o Weight loss → 1- 2%/k/d in the 1st 7 days
 - o Urine output → 1- 2ml/k/hr. (optimal)
 - o Sp. Gravity → 1.005 – 1.015
 - o Euelectrlytemia and Euglycemia

Table 1: Estimated Maintenance Fluid Requirements based on Weight and Postnatal Age

Birth Weight	Fluid Rate (ml/kg/day)			
	Postnatal Age			
	Day 1	Day 2	Day 3-6	≥ Day 7
<750 gm	100-140	120-160	140-200	140-160
750-1,000 gm	100-120	120-140	130-180	140-160
1,000 - 1,500 gm	80-100	100-120	120-160	150
1,500 - <2,500 gm	60-80	80-100	120-160	150
≥2,500 gm	60-80	80-100	90-150	

The volume of fluids given should be estimated based on the infant's clinical status.

- Term infants: depending on the tolerance of the previous day's fluid therapy, estimations of IWL, and clinical status of the infant, increase of 10-20 ml/kg/day may be considered.
- VLBW infants (during the 1st week of life): depending on weight and serum sodium levels, fluid therapy should be managed to keep serum sodium at a normal range (135-145 mEq/L).
- ELBW infants (especially <750 gm) may have fluid requirements up to 200 ml/kg/day.

NB: This fluid requirement includes total fluid (IV fluid + feeding). *In summary, increase the amount of fluid given over the first 3–5 days (total amount, oral plus IV). Day 1→ 60 ml/kg per day; Day 2→ 90 ml/kg per day; Day 3→ 120 ml/kg per day. Then increase to 150 ml/kg per day when the infant tolerates oral feeds well, the amount of fluid might be increased to 180 ml/kg per*

day after some days. Be careful in giving parenteral IV fluids, which can quickly over hydrate a child.

2. Electrolyte

- Electrolyte is given based on body weight
 - Important electrolytes needed for normal homeostasis of body are:- Sodium, Potassium, Chloride, Calcium, Phosphorus, Magnesium
 - o Sodium (NaCL): 1 – 2meq/kg/d
 - o Potassium (KCL) : 1 – 2meq/kg/d
- 1meq = 74.6mg; if preparation is 10ml/1.5gm,
1gm of KCL = 13.4meq. 2meq = 150mg = 1ml
- o Calcium Gluconate 10%: 2 – 3 ml/k/d or 200 – 300mg/k/d; 1ml = 100mg

B. Fluid and electrolyte management

- Always follow strict aseptic technique
- Select proper peripheral site for IV line, Secure well, check functioning well
- Calculate fluid, label and chart properly.

1. Type of fluid to be started and advancement

Day – 1

- Any birth weight. start with 10% DW
- If there is a concern of hyperglycemia; use 7.5%DW, esp. in EVLBW
- If the baby is < 1200gm or asphyxiated, add Maintenance Calcium gluconate 10%, 2ml/k/d (200mg/kg/d) to the maintenance fluid.

Day – 2

- Electrolyte need to be added
- At Any birth, weight the fluid composition of 10% DW and $\frac{1}{3}$ of Normal Saline (Suitable alternative IV fluids after the first 2 days are half-normal saline and 5% dextrose.).
- Calcium gluconate if added is continued

Day – 3 and onwards

- The composition of the maintenance fluid is as Day – 2.
- Potassium is added based on some conditions, potassium is added from 3rd day of life if renal function is good (urine out - put \geq 1ml/hr.) &/or serum level of potassium is < 5meq/L
- Calcium is added to the maintenance fluid of any newborn if there is IV infusion.

2. Daily increment of fluid during the first few days of life

- Refer the Table 4 above
- The usual daily increment is 10- 20ml/kg/day
- The maximum daily maintenance fluid shouldn't exceed 180ml/kg/day unless there is an indication.

3. Special consideration

- An additional volume of fluid (25 - 30% ml/kg/d) is considered if neonate is :
 - o Fever if due to DHN
 - o Under radiant warmer
 - o Under phototherapy
 - o Having body defects like Gastroschisis
 - o Exchange level hyperbilirubinemia or early sign of ABE
 - o If there is fluid lose in the form of vomiting, secretion of saliva in TEF and NGT drainage then add the same volume.
- Fluid restriction: Fluid restriction to 2/3 daily of maintenance fluid may be required in the following conditions
 - o Depressed or Asphyxiated newborn are at risk for development of ATN, and Syndrome of Inappropriate Secretion of Anti-Diuretic Hormone (SIADH), this leads fluid retention.
- Start by 2/3 of maintenance fluid then subsequent adjustment is based on urine output, urine specific gravity or osmolarity, & clinical responses.
- If newborn is on treatment for PDA with **Indomethacine**, which have tendency for fluid retention, restrict maintenance fluid to 2/3.
- **Features of CHF:** Newborn on protracted treatment for Chronic Lung Disease (CLD) with diuretics needs special attention. Withhold or restrict fluid if
 - o There is weight gain in the 1st few days of life when weight lose is expected (1-2%/k/d)
 - o Weight gain is excess not explained by normal daily weight gain after 7 days of life
 - o Clinical evidence of fluid over load such as edema, increased respiratory rate, tachycardia
 - o If urine output is > 3ml/kg/hr, sp. Gravity < 1.005: → and correct accordingly or consult or refer for re-evaluation and treatment

4. IV Fluid management when feeding is started

- The total calculated fluid includes both parenteral infusions and enteral feedings
- If newborn started feeding the fluid to be administered is obtained by subtracting total daily volume of milk from total fluid.

Example – weight of baby boy is 3kg, total daily fluid is 300ml, he is to be fed with 10ml of milk 3 hourly making total 80ml/day - his IV infusion must be 300 – 80 ml = 220 ml/day

- In addition, whenever fluid is advanced in daily basis, the amount of milk to be given should be taken in to consideration.
- Deduct volume of any other perfusions like transfusion, fluid used for dilution of medication from the maintenance fluid except trophic feeding.
- Once full feeding is achieved, IV fluid is discontinued. (refer to nutrition section for further guidance on this)

5. Monitoring of fluid & electrolytes

- The maintenance fluid should be perfused continuously over 24 hours (Use a monitoring sheet.).
- Fluid converted into drops per minute. 1ml = 20 drops (use drop factor mentioned in the infusion set)
- Fluid drip is monitored each time to check whether or not running (dripping) – Check the drip rate and volume infused every hour
-
- Use perfusor pump if it is available. It is important especially if baby is kept NPO.
- Check for infusion site for any leakage, swellings, redness, or infection.
- Change IV site if sign of factors mentioned above
- Monitor baby with :
 - o Weight daily
 - o Clinical evaluation daily (Watch for facial swelling/fluid overload)
 - o Urine output daily
 - o Electrolyte & glucose (RBS) determination daily

C. Fluid preparation

- Fluid is available in the form of 5% DW, 40% DW, 9% NS, or RL, but there is no readily prepared fluid for newborn or pediatric age group in the market.
- We have to prepare fluid using what is available. To prepare fluid, use following formula.

We need to prepare x% DW from a% DW and b% DW

General formula is

$$V_b = \frac{(a - x) T_v}{(a - x) + (x - b)} \quad V_a = \frac{(x - b) T_v}{(a - x) + (x - b)}$$

Where

x = conc. of DW wanted

a = highest conc. of DW

b = lowest conc. of DW

V_b = volume of b

V_a = volume of a

T_v = total volume needed = (V_b + V_a)

Example 1: How to prepare Total volume (Tv) of 10%DW from 40%DW & 5% DW.**Given**

$$x = 10\%$$

$$a = 40$$

$$b = 5\%$$

 $V_b = \text{Volume of } 5\%$ $V_a = \text{volume of } 40\%$ $Tv = \text{total volume needed} = (V_b + V_a)$

Using the general formula

$$V_b = \frac{(40 - 10) \text{ Tv}}{(40 - 10) + (10 - 5)}$$

$$V_a = \frac{(10 - 5) \text{ Tv}}{(40 - 10) + (10 - 5)}$$

$$V_b = (30) \text{ Tv}/35$$

$$V_a = (5) \text{ Tv}/35$$

Total daily fluid volume required by baby girl weighing 3000gm (3kg) is -

 $3 \times 100 = 300 \text{ ml/day}$ and type of fluid to be given is 10% DW:

Therefore

$$\begin{aligned} \text{Tv} &= 300 \text{ ml}, & V_b &= 30 \times 300/35 \\ && &= 57.1 \text{ ml} & V_a &= 5 \times 300/35 \\ && && &= 42.85 \text{ ml} \end{aligned}$$

$$\begin{aligned} \text{Thus total volume} &= V \text{ of } b (257.1) + V \text{ of } a (42.85) \text{ ml.} \\ &= 299.95 \text{ ml} (\sim 300 \text{ ml}) 10\% \text{ DW} \end{aligned}$$

Example 2: To prepare 15%DW of 200 ml (Tv) from 40%DW & 5% DW :**Given**

$$x = 15\%$$

$$a = 40$$

$$b = 5\%$$

 $V_b = \text{Volume of } 5\%$ $V_a = \text{volume of } 40\%$ $Tv = \text{total volume needed} = (V_b + V_a)$

Using the general formula

$$V_b = \frac{(40 - 15) 200}{(40 - 15) + (15 - 5)}$$

$$V_a = \frac{(15 - 5) 200}{(40 - 15) + (15 - 5)}$$

$$V_b = 5000/35$$

$$V_a = 2000/35$$

$$V_b = 142.86 \text{ ml}$$

$$V_a = 57.14 \text{ ml}$$

$$T_v = V_b + V_a$$

$$T_v = 142.86 \text{ ml} + 57.14 \text{ ml}$$

$$T_v = 200 \text{ ml}$$

This type of fluid (15%DW) is used when preparing 10%DW with $\frac{1}{3}$ NS. If $\frac{1}{3}$ NS is added to 15%DW, the new fluid combination will have concentration of 10%DW, solute effect of the NS assumed to be negligible.**Example -3: To prepare $\frac{1}{3}$ N/S in 10% DW.**

Prepare 10% DW in $\frac{1}{3}$ NS for a baby requiring total fluid volume (Tv) of 300ml from 40%DW & 5%DW

Step – 1: To get proportions of fluid to be combined

a. 1/3 of the fluid is NS : - $\frac{1}{3}$ NS = $Tv/3 = 300/3$

Vol. of NS = 100ml

b. 2/3 of the fluid is from 10% DW = $\frac{2}{3}Tv = \frac{2}{3}300 = 200ml$

Step – 2: Preparing x%DW, which when diluted to $\frac{1}{3}$ NS, gives 10%DW .

Given

x = 15%

Vb = Volume of 5%

a = 40

Va = volume of 40%

b = 5%

Tv = total volume needed = (Vb + Va)

Using the general formula

$$\begin{aligned} Vb &= \frac{(40 - 15) 2/3(300)}{(40 - 15) + (15 - 5)} \\ &= \frac{25 \cdot 2/3(300)}{25} \end{aligned}$$

$$Vb = \frac{5000}{35}$$

$$Vb = 142.86ml$$

$$Va = \frac{2000}{35}$$

$$Va = 57.14ml$$

Step – 3, combine the different type of fluid to get Total volume (TV) required.

$$= \text{Vol. of NS } (1/3Tv) + \text{vol. of } \frac{2}{3}Tv \text{ (DW)}$$

$$= 100ml + 200ml$$

$$= 300ml/d of 10\% DW in 1/3NS.$$

NB: how x =15% was found?

It is calculated from observation that the total volume of fluid (Tv) will consist the same amount of glucose in the $\frac{2}{3}Tv$. i. e. – glucose in Tv = Glucose in $\frac{2}{3}Tv$

Example:

In 300ml $\frac{1}{3}$ NS in 10%DW: glucose is 30gm.this same amount should come from $\frac{2}{3}Tv$ of fluid.

$$DW+NS = 300ml \rightarrow 30gm$$

$$\frac{2}{3} \text{ of } 300ml \rightarrow 30gm$$

$$200ml \rightarrow 30gm$$

$$100ml \rightarrow 15gm \text{ or } 15/100 (15\%)$$

D. Electrolyte imbalance and Management

- If baby is having fluid deficit due to inadequate feeding, excessive lose because of repeated vomiting, diarrhea, 3rd space lose or if he/she has features of dehydration, or if he/she is in shock, then he/she needs urgent treatment

Electrolyte disorder: The approach to a patient with Electrolyte disorder depends on status of fluid volume i.e. Volume depleted or in excess (edema)

- Common electrolytes imbalances in NICU include hyponatremia, hypernatremia, hyperkalemia, hypokalemia, hypocalcemia.
- There should be high index of suspicion of electrolyte imbalance in sick newborn and should be handled by NICU physician.

Table 4: Electrolyte disorder, clinical presentations and management

Electrolyte disorder	Values	Causes	Clinical presentation/ diagnosis	Treatment/ Management
Sodium (Na)				
Hyponatremia	<135 meq/L		<ul style="list-style-type: none"> - Asymptomatic - Symptomatic: usually < 120meq/L, seizure, neurological obtundation 	<ul style="list-style-type: none"> - If asymptomatic restrict fluid intake if serum sodium is >120 mEq/L - If symptomatic, initiate Furosemide (1 mg/kg IV q6 hrs), with Na+ replacement using hypertonic NaCl 3% (1-3 ml/kg) as an initial dose, if:- <ul style="list-style-type: none"> . Serum Na+ <120 mEq/L. . Neurologic signs such as seizures develop. <p><u>Sodium replacement formula</u> $\text{Total Na}^+ \text{ replacement} = (\text{Desired Na}^+ \text{ (mEq)} - \text{Actual Na}^+ \text{ (mEq)}) \times \text{Weight (kg)} \times 0.6$</p> <ul style="list-style-type: none"> • Increment should be 10-12meq/L over 24 hours • Check serum Na+ after 24hours replacement • Target sodium is to make 125meq/L
Hypernatremia		1. With ECF deficit <ul style="list-style-type: none"> - Increased Insensible water lose - Inadequate feeding - Extensive skin lesion - ADH deficiency - Acute Gastroenteritis - <i>Clinical presentation</i> - Weight lose, tachycardia, hypotension, metabolic acidosis 	<ul style="list-style-type: none"> - 1. irritable, restless, weak, lethargic, high-pitched cry and have hyperpnoea - In severe cases:- brain shrinkage leading to cerebral 	<ul style="list-style-type: none"> - Threat DHN or shock with 10-20 ml/kg of bolus Normal saline, repeat the same dose until hemodynamically stable till 60 ml/kg followed by rehydration phase - Rehydrate= (free water deficit+ maintenance) - Fluid deficit in/24 hours = $4 \times \text{wt(kg)} \times 12$ or $= 0.7 \times \text{Wt (kg)} [1- 145/\text{current serum}$

		<p>2. With Excess ECF volume</p> <ul style="list-style-type: none"> - Excessive Administration of Isotonic or hypertonic solution - Administration of Sodium containing medication like NaHCO₃. - Feeding with high solute formula 	<p>hemorrhage, seizures, paralysis, and encephalopathy.</p> <ul style="list-style-type: none"> - Fast correction of deficit can also lead to cerebral edema and death - 2. Increased weight, edema, Increased FE – Na BP, Heart rate, urine output, sp. Gravity may be normal 	<p>sodium or</p> <ul style="list-style-type: none"> - = weight loss (BW - admission wt) = wt loss in gr = fluid deficit in ml - maintenance fluid =(insensible [2-3ml/kg/hr] + losses in ml) .(5% D/W, 0.2% N/S} for:- for mild hypernatremic DHN & .(5% D/W /0.45% N/S) in severe cases. <p>Based on the calculated fluid deficit over 48-72 hrs using formula:-</p> <ul style="list-style-type: none"> - [Water deficit (in L) = [(current Na level in mEq/L ÷ 145 mEq/L) - 1] X 0.6 × weight (kg)] - NB:-Lower the serum sodium level by 12 mEq/L/day and measure serum sodium level after restoration of vascular volume <p>2. Reduce Na concentration in the fluid in case of excess ECF</p>
Syndrome of Inappropriate secretion of Ant-Diuretic Hormone (SIADH)		<ul style="list-style-type: none"> - Asphyxia, IVH, Meningitis, Pulmonary diseases like Pneumothorax, Drugs like Opiates, barbiturates, diuretics, Indomethacin, and Oxytocin. 	<ul style="list-style-type: none"> - Clinical: weight gain, edema, Oliguria - Lab. Ix: Increased urine Na, sp. Gravity and osmolarity - Decrease in serum 	<ul style="list-style-type: none"> - Fluid restriction for 24 hours then readjust based on clinical response - Furosemide (1-2mg/kg/dose) to increase water lose.

			Na but BUN, Cr. May be normal	
Potassium (K)				
Hypokalemia	< 3.5meq/L	- NGT or Ileostomy drainage, Gastroenteritis, NEC, Diuretics, ATN	- Arrhythmia, paralytic Ileus, abdominal distension, feeding intolerance, obtundation or altered level of consciousness - ECG changes: prolonged QT interval, ST interval & T-wave depression, U-wave Treatment	- Reduce Gastrointestinal and renal losses <ul style="list-style-type: none"> Mild (serum level 3–3.5 mmol/L) <ul style="list-style-type: none"> No intervention needed Significant hypokalaemia (serum level <3 mmol/L) <ul style="list-style-type: none"> When significant, treat by slow potassium replacement, either IV or PO (1 mEq/kg KCl → ↑serum K+ by 1 mEq/L), with dose adjustment based on serum K+ level. Oral therapy: 0.5-1 mEq/kg/day divided and given with feedings IV therapy: KCl (1 mEq/kg) over a minimum of 4 hrs. Reassess (maximum infusion rate is 1 mEq/kg/hr).
Hyperkalemia	> 6meq/L	- Sever birth asphyxia, metabolic acidosis, and renal failure - Prematurity - Old blood transfusion - Drugs like Indomethacin - Congenital Adrenal Hyperplasia (CAH)	- Arrhythmia, Heart failure - ECG changes: Tall T-wave, prolonged PR interval, and QRS; absent P-wave, sine Wave, Ventricular tachycardia or	- Discontinue sources of K especially in the IV fluid, ECG monitor <ul style="list-style-type: none"> Cal.gluconate 1-2ml/k over 4 minute with cardiac monitoring NaHCO3 1-2ml/k Furosemide 1mg/k Insulin/glucose drip: bolus 1 0.05u/2ml of 10% glucose then Insulin 0.1u/2-4ml of 10% glucose

			Fibrillation	- If no response peritoneal dialysis or exchange transfusion with fresh blood
Calcium (Ca)		-	-	-
Hypocalcaemia	Total serum calcium <7 mg/dl or ionized calcium <4 mg/d	<p>1. Early onset (1st 3 days)</p> <ul style="list-style-type: none"> - Preterm: transplacentally passage occurs towards end of pregnancy - Infant of Diabetic Mother (IDM): multifactorial- increased demand, Impaired Transplacental transfer from mother... - Birth asphyxia: Impaired PTH function, renal injury, metabolic acidosis <p>2. Late onset (usually after 7th day)</p> <ul style="list-style-type: none"> - Hypoparathyroidism - Vitamin D deficiency - Miscellaneous factors: Hungry bone syndrome- increased demand for Ca (SGA, - Hypoparathyroidism, Increased vitamin. D activity), hyperphosphatemia, hypoalbuminemia, Alkalosis, lipid infusion, Furosemide, sepsis. 	<p>Clinical manifestations</p> <ul style="list-style-type: none"> - Increased excitability, jitteriness, increased tone, clonus hyporeflexia, stridor carpopedal spasms. - In early onset (preterm), usually asymptomatic - In late onset may come with seizures <p>Lab Findings</p> <ul style="list-style-type: none"> - Low serum levels: total < 7mg/dl, ionised < 4mg/dl - Increased phosphate serum level - Thymic shadow may be absent on Chest X ray 	<ul style="list-style-type: none"> - Prevent by providing prophylactic Ca. To preterm, asphyxiated or sick babies - Calcium Gluconate: 2ml/kg/dose every 6 hrs over 20 – 30 minutes (with cardiac monitor) - In emergency situation (seizure, tetany, apnea): 2ml/kg over 5 minute. Repeat this if no response in 10 minute - Monitor till serum level > 7mg/dl, monitor cardiac status each time - Correct underlying problem if possible
Hypercalcemia	>11mg/gl	<ul style="list-style-type: none"> - Hyperparathyroidism, - Hyperthyroidism, - Hypophosphatemia, 	<ul style="list-style-type: none"> - May not be symptomatic till >14mg/dl 	<ul style="list-style-type: none"> - volume expansion with Isotonic solution, if cardiac function is normal 10 – 20ml/kg over 15 – 30 minutes

		<ul style="list-style-type: none"> - Hypophosphatasia, - Hypervitaminosis D, - Hypervitaminosis A, - Decreased Renal clearance 	<ul style="list-style-type: none"> - Hypotonia, lethargy or seizure, hypertension, hypoxia, poor feeding, - Vomiting, constipation, polyuria, in long term hepatosplenomegaly, anemia 	<ul style="list-style-type: none"> - Furosemide 1mg/kg q6-8hrs - Treatment with Phosphate, Glucocorticoids
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Chapter 20: Shock in the Neonates

Learning Objectives

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

- Identify causes of shock
- Diagnose shock in newborns
- Recognize management of shock in neonates

Definition: It is the physiologic state characterized by significant reduction of systemic tissue perfusion, resulting in decreased tissue oxygen and nutrient delivery.

Causes of Neonatal Shock

1. **Hypovolemic shock:** It is the commonest cause of shock in neonates. It follows volume loss due to several reasons, commonly:

- Hemorrhage (Intracranial/ extracranial)
- Inadequate feeding
- Abruptio of placenta
- Feto-maternal hemorrhage
- Twin to twin transfusion
- DIC
- Neonatal infections (Increased capillary leak/ Gastroenteritis)
- Excessive volume depletions (Diuresis)

2. **Distributive shock**

- Sepsis related to increased inflammatory responses
- Rapid heating
- Abnormal vasoresponse

3. **Cardiogenic shock**

- Asphyxia
 - Myocarditis,
 - Arrhythmia
4. **Obstructive shock:** It is due to decreased cardiac output including congenital heart diseases.

Diagnosis: It has two broad manifestations

A. Compensated shock –the body will try to adapt the inadequate perfusion with the following physiologic adjustments so that the metabolism will be maintained

- Tachycardia, BP is maintained normal
- Increased SVR (systemic vascular resistance) – manifested by cold, pale skin, oliguria and ileus
- Wide pulse pressure, hypotension are earlier manifestation in septic shock

B. Decompensated shock

- Decreased systolic BP
- Lethargy
- Irreversible organ damage
- Preterms (ICH)

Management: Shock in newborns is a medical emergency! Specific therapy depends upon the causes of shock.

Supportive treatment

- **ABC** of life
- Correction of hypoglycemia, hypocalcemia and acidosis
- Intranasal oxygenation
- If large amount of fluid is given 2ml/kg/dose of Calcium gluconate 10% can be administered

Fluid treatment in hypovolemic shock

- Secure an IV line if you fail, Catheterize the umbilical vein or inta-osseuc

- Crystalloids (normal saline 20ml/kg bolus within 10 minutes can be given three times (60ml/kg) we need to have end goal directed treatment until V/S, urine output, capillary refill and mentation become stable.
- If the patient is not responding for fluid management transfuse with whole blood. This provides volume, oxygen-carrying capacity, and colloid
- After stabilization, follow the neonate closely.

Acute blood loss

- Whole blood 20ml/kg less than 7 days old over one hour.
- If blood is not available, volume expanders like 0.9% N/S can be used till blood is prepared.

However if the shock is resistant to fluid treatment one should consider septic shock or cardiogenic shock.

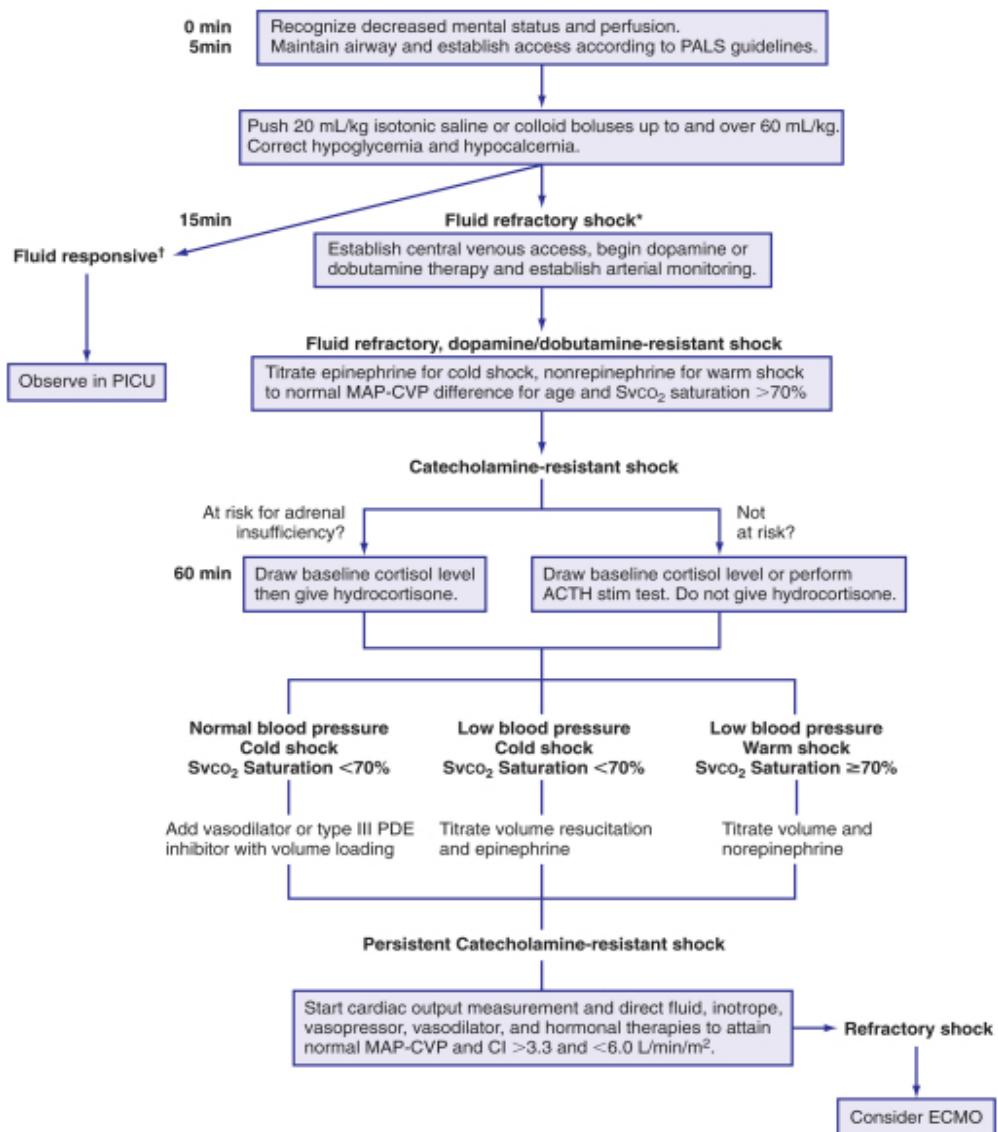
Remember that in septic shock you would give as much as 60-80ml/kg of total fluid followed by blood transfusion 20ml/kg of whole blood and Hydrocortisone administration. Give broad spectrum IV antibiotics in suspected septic shock.

Medications

Inotropes

- **Dopamine** – its action is dose dependent. It is the first line of treatment, use dopamine with strict follow up
 - o **Low dose 2-5mcg/kg/min** stimulates renal, mesenteric and coronary blood flow but little effect on cardiac output.
 - o **Intermediate dose** 5-9mcg/kg/min it has both chronotropic and inotropic effect.
 - o **High dose (vasopressor dose)_10-20mcg/kg/minute**
- **Dobutamine** in a dose 5-15mcg/kg/min increases cardiac output with little effect on heart rate.
- **Epinephrine** (1 in 10,000) it has both inotropic and chronotropic effect. The dose is 0.1-0.3ml/kg IV repeat the dose every 3-5 minutes
 - o It has a beta1-adrenergic effect, which stimulates the heart, but, of more importance, it also has an alpha adrenergic effect that increases noncerebral peripheral resistance.

- **Milrinone** is a phosphodiesterase inhibitor, used to increase intracellular calcium, increasing cardiac contractility. It improves diastolic myocardial function, decreases pulmonary vascular resistance and SVR.



Chapter 21: Congenital malformations in neonates

Learning objectives:

At the end of this session, the trainee will be able to recognize common congenital malformations and their management

Congenital Anomalies

- *Neural tube defects and hydrocephalus*
- *Trisomies-Down syndrome*
- *Pierre Robin syndrome*
- *Choanal atresia*
- *Cleft lip and cleft palate*
- *Esophageal atresia & tracheoesophageal fistula*
- *Hypopspadias*
- *Undescended testis*

Introduction

Congenital anomalies, whether they are isolated (single) or part of syndromes are causes of long-term illness and death. They are contributing for about 4 % of neonatal mortality in Ethiopia. Health personnel working in NICUs are among the first to identify newborns with congenital anomalies so they need to know basic features of these anomalies and immediate treatment of associated and life threatening illnesses before referral. Subsequent management needs team of experts in well-equipped centers.

CNS MALFORMATION

1.Neural tube defects (NTDs)

Neural tube defects (NTDs) are common congenital anomalies of the central nervous system (CNS).

The exact cause is not known but the following risk factors are incriminated: hyperthermia, drugs, malnutrition, chemicals, maternal obesity or diabetes and radiation exposure during pregnancy.

Major NTDs include spina bifida occulta, meningocele, myelomeningocele, encephalocele and anencephaly.

2.Spina bifida occulta

- Is midline defect of the vertebral bodies without protrusion of the spinal cord or meninges.
- Usually occurs in the lumbar and sacral regions of the spinal cord.
- Most patients are asymptomatic and have no neurologic abnormalities.
- May be covered with patches of hair, lipoma or discoloration of the overlying skin.
- The diagnosis can be confirmed by vertebral x –ray which shows the defect in the lumbosacral column.

3.Meningocele

- Is the herniation of the meninges through a defect in the posterior vertebral column
- Appears as midline sac filled with cerebrospinal fluid (CSF) mostly covered by skin.
- Those newborns with leaking cerebrospinal fluid or a thin skin covering need urgent referral for immediate surgical treatment to prevent meningitis.

4.Myelomeningocele

- Most severe form of NTDs, characterized by protrusion of spinal cord and meninges through a defect in the spinal cord.
- Appears as a saclike cystic structure covered by a thin-layered membrane (see *Figure 34*)
- The lumbosacral region accounts for about 75% of the cases.
- May cause bowel and bladder incontinence with loss of pain sensation in the perineal area.
- The covering membrane may rupture easily and results in CSF leak and meningitis.
- The newborn may have flaccid paralysis (weak extremities with diminished tone and deep tendon reflexes) of the lower extremities, lack of response to touch and pain.
- Commonly associated with clubfeet and hydrocephalus.



Figure 34: Myelomeningocele covered with thin membrane

Management of myelomeningocele

Immediate management includes

- Covering the defect with a sterile saline-soaked dressing.
- Prevention of hypothermia.
- Placing the newborn in a prone or lateral position to avoid pressure on the lesion.
- Antibiotics for meningitis
- Anticonvulsants if they have seizure (see management of neonatal seizure)

Parents should be informed about the condition of the neonate, available interventions and referral or neurosurgical consultation should be arranged.

The back lesion should be surgically closed as early as possible (within the first 72 hours) after birth to decrease the risk of CNS infection.

Complications

- Meningitis
- Increased intracranial pressure due to hydrocephalus
- Urinary tract infection

- Bed sore
- Early childhood death

5. Encephalocele

- Is protrusion of meninges with or without brain tissue through a midline defect in the skull (see *Figure 35*).
- Commonly occurs in occipital regions and vary in size from few millimeters to many centimeters.



Figure 35: Encephalocele

6. Anencephaly

- Is a condition where the roof of the skull and the posterior occipital bones are defective or absent exposing remnants of neural tissue (see *Figure 36*)
- This condition is not compatible with survival.



Figure 36: Anencephaly

Prevention of NTDs

- Folic acid supplementation for all women of childbearing age.
- Inform mothers about risk of recurrence and use of folic acid before next pregnancy.

7. Hydrocephalus

It is a condition associated with excessive production or impaired absorption of CSF.

Causes

- Congenital infections (TORCH)
- Meningitis
- Following intracranial hemorrhage
- Intracranial mass lesions
- Congenital malformations of the nervous system

Clinical features

- Big head –head circumference greater than 90th percentile on standard curves
- Full and tense fontanelles
- Markedly separated cranial sutures.
- Setting sun eye sign and broad forehead.
- Seizure

Diagnosis

- Enlarged head circumference at birth.
- Serial measurements cross percentiles in standard head circumference curves
- Signs and symptoms
- Skull x-rays (widening of sutures, prominent convolutional markings on the inner table of the skull and erosion of the sella turcica).
- Transfontanelle ultrasound (ventricular or subarachnoid space enlargement).

Treatment

Treatment depends on the cause and includes therapy for any associated conditions and measures directed toward the hydrocephalus.

Medical management includes:

- Acetazolamide – to decrease CSF production
- Mannitol – to decrease high intracranial pressure (ICP)
- Furosemide – if mannitol is not available
- Removal of CSF by interval lumbar puncture under strict aseptic condition

The above measures may provide temporary relief by reducing the rate of CSF production, but not recommended for long-term use.

Most cases of hydrocephalus require ventriculoperitoneal shunts or ventriculostomy, so referral or neurosurgical consultation should be considered.

Major complications after ventriculoperitoneal shunt include:

- Shunt occlusion / malfunction- vomiting, mental status changes and
- Shunt infection – persistent fever, neck rigidity

UPPER RESPIRATORY AND GASTROINTESTINAL MALFORMATION

1.Pierre Robin syndrome

- This syndrome comprises micrognathia, cleft soft palate, and upper airway obstruction caused by the tongue falling back into the hypopharynx.
- The infants present with varying degrees of respiratory difficulty, cyanotic spells, poor feeding, and failure to thrive.
- An airway can be maintained by positioning the infant prone with the head down; this allows the tongue to fall forward and can prevent obstruction of the airway.
- Many infants, however, cannot be successfully maintained this way and continue to have frequent bouts of cyanosis and aspiration.

- Positioning an endotracheal tube through a nostril into the hypopharynx indicated for infants with frequent bouts of cyanosis.
- With time the mandible develops, and the muscles of the jaw become strong enough to keep the tongue forward.

2.Choanal Atresia

Choanal atresia is the presence of septum between the nose and pharynx resulting obstruction of airflow. Neonates are predominant nose breathers for the first 4 to 6 weeks of life. Bilateral choanal atresia is the most common cause of complete nasal obstruction. Associated anomalies occur in 20% to 50% of infants with choanal atresia.

Clinical feature

Bilateral obstruction always produces symptoms in the neonatal period.

- History of distress when resting that is relieved with agitation and crying.
- Difficulty of feeding, interrupted feeding, worsening of distress while feeding
- Severe asphyxia
- Cyanosis

Diagnosis

- Hold rolled piece of cotton near to nostril and observe whether the cotton is waving while baby is breathing.
- Failure to pass NG tube to each nostril 3-4 cm to the nasopharynx suggests choanal atresia.

Treatment

- Treatment depends on the severity of the obstruction and the clinical presentation of the infant.
- Unilateral atresia rarely requires surgical intervention during infancy and is usually corrected before school begins (4 to 5 years of age).
- For bilateral atresia, put oropharyngeal airway immediately and consult for surgical intervention.
- Start feeding EBM with orogastric tube

N.B.

- Insert NG tube gently and avoid use of excessive force, which may result in trauma.
- Look for and treat associated anomalies.

3.Cleft Lip (CL) and Cleft Palate (CP)

Orofacial clefts (cleft lip and cleft palate) are common birth defects. Cleft lip may occur either in association with cleft palate or in the absence of cleft palate, and is generally referred to as “cleft lip with or without cleft palate” (CL/P). They may occur as part of a syndrome involving multiple other organs or as an isolated malformation. CL may be unilateral in 80% or bilateral in 20% of cases. When unilateral, it is more common on the left side (70%).

Causes

- Folic acid deficiency
- Use of methotrexate in pregnant mother
- Environmental factors such as cigarette smoking and alcohol use in pregnancy
- Use of anticonvulsants (phenytoin and valproic acid)

Clinical features and diagnosis

- CL may vary from a small notch in the vermillion border to a complete separation involving skin, muscle, mucosa, tooth, and bone.
- Deformed, supernumerary or absent teeth are associated findings.
- CP with CL may involve the midline of the soft palate and extend into the hard palate on one or both sides, exposing one or both of the nasal cavities.
- Sub mucosal cleft of palate may present with a bifid uvula, partial separation of muscle with intact mucosa, or a palpable notch at the posterior of the palate.

Management

- Feeding is the immediate challenge for the health personnel working in NICU.
- Use soft artificial nipples with large openings and a squeezable bottle.
- Instruct parents on difficulties of feeding the risk of aspiration.
- Look for associated anomalies (congenital cardiac defects, vertebral anomalies, limb deformities and renal anomalies).
- Refer for subsequent management (surgery, follow up and speech rehabilitation) by a team of experts.

4. Esophageal atresia (EA) & Tracheoesophageal Fistula (TEF)

Esophageal atresia (EA) is the most frequent congenital anomaly of the esophagus ($\approx 1/4,000$ neonates). More than 90% of newborns with EA have an associated tracheoesophageal fistula (TEF). Infants weighing $<1,500$ g at birth have the highest risk for mortality. In about half of the cases this condition is associated with anomalies, most often the **VACTERL** (vertebral, anorectal, cardiac, tracheal, esophageal, renal, radial, limb) syndrome.

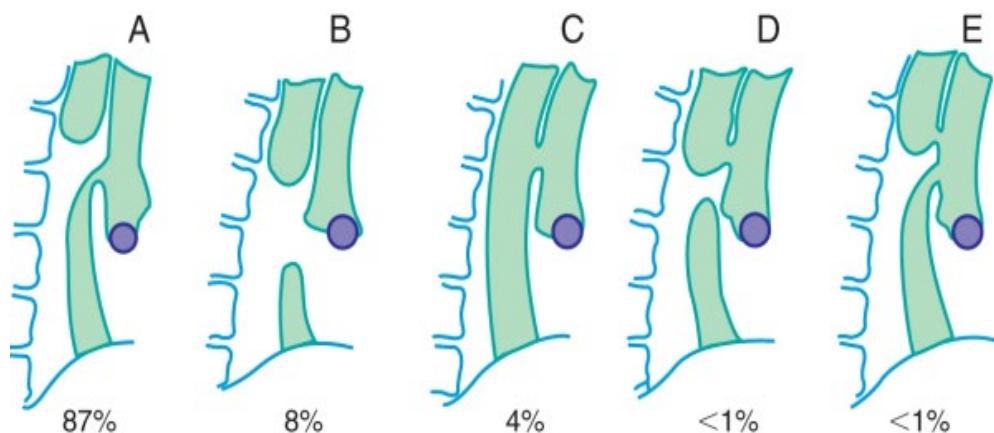


Figure 38: Types EA & TEF with their relative frequencies.

Description of the picture

- Proximal esophageal atresia with distal TEF.
- Proximal and distal EA without fistula
- TEF without atresia
- Proximal TEF and distal EA
- Proximal and distal TEF

Clinical features

- Excessive secretion at the mouth and nose after birth
- Episodes of coughing, cyanosis, and respiratory distress exacerbated by feeding
- In the above picture all are neonatal emergencies except picture C

Diagnosis

- History of maternal polyhydramnios
- Failure to pass a nasogastric tube
- Chest x-ray with NG tube in situ (coiled tube in the esophageal pouch)

Management

- Maintain patent airway with frequent suctioning and positioning
- Keep the newborn NPO and put him/her on maintenance fluid.
- Keep the newborn in prone position to minimize aspiration
N.B. Head of the bed should be elevated 30 degrees to diminish reflux of gastric contents into the fistula and aspiration of oral secretions that may accumulate in the proximal esophageal pouch.
- If possible, CPAP and mechanical ventilation of these babies should be avoided until the fistula is controlled
- Exclude associated anomalies.
- Arrange transportation and referral/consult for surgical management.

N.B

- For suspected cases of EA & TEF avoid feeding before excluding the diagnosis by inserting NG tube.

Table 17: Common Intestinal Obstruction in the Newborn

Site obstruction	Clinical findings	Radiology findings	Management
Duodenal Atresia	Early vomiting, sometimes bilious 30% of cases are associated with Down syndrome They may have sign of DHN	Double bubble" (dilated stomach and proximal duodenum, no air distal)	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
Malrotation and volvulus	Bilious vomiting with onset anytime in the first few weeks	Dilated stomach and proximal duodenum; paucity of air distally (may be normal gas pattern)	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
Jejunoileal atresia, meconium ileus	Bilious gastric contents > 25 mL at birth. Progressive distention and bilious vomiting	Multiple dilated loops of bowel. Intra-abdominal calcifications if in-utero- perforation occurred (meconium peritonitis)	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management

Table 18: Intestinal Obstruction in the Newborn

Intestinal obstruction	Clinical manifestation	Radiology finding	Management
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Imperforated anus	Missing or moved opening to the anus Baby does not pass first stool within 24 - 48 hours after birth Stool passes out of the vagina, base of penis, scrotum, or urethra(if there is fistula)	Distended bowel loop. Absence of rectal air	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
Meconium plug syndrome; Hirsch sprung disease	Abdominal Distention. Delayed passing meconium (> 24 h) May have also bilious type of vomiting	Diffuse bowel distention	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management

Abdominal Wall Defects

Omphalocele

Omphalocele is a membrane-covered herniation of abdominal contents into the base of the umbilical cord. There is a high incidence of associated anomalies (cardiac, GI, and chromosomal—eg, trisomy 13). The sac may contain liver and spleen as well as intestine

Management

Acute management of Omphalocele involves;

- Covering the defect with a sterile dressing soaked with warm saline to prevent fluid loss.
- NGT decompression
- IV fluids and glucose
- Antibiotics
- Keep NPO until the surgical opinion obtained
- Urgent surgical consultation



Figure 20: Omphacele

Gastroschisis

In gastroschisis, the intestine extrudes through an abdominal wall defect lateral to the umbilical cord. There is no membrane or sac and no liver or spleen outside the abdomen. Gastroschisis usually is not associated with other anomalies

Management

- Covering the defect with a sterile dressing
- Soaked with warm saline to prevent fluid loss
- N GT decompression
- Keep NPO
- IV fluids and glucose
- Antibiotics
- Urgent surgical consultation



Figure 21: Gastroschisis

This congenital malformation consists of herniation of abdominal organs into the navel or thorax (usually left) through a postero-lateral defect in the diaphragm

Clinical manifestation

- It presents in the delivery room as severe respiratory distress
- Absence breath sounds and scaphoid abdomen
- Presence of bowel sound in the chest

Management

- Avoid giving bag and mask ventilation
- Prepare for intubation
- Insert NGT for decompression of the GI tract
- Keep NPO
- Start IV infusion of glucose and fluid
- Chest radiograph confirms the diagnosis
- Urgent surgical consultation should be made

RENAL AND ANO-GENITAL MALFORMATION

1. Genitourinary abnormalities.

First void should be noted in all infants. Approximately 90% of babies void in the first 24 hours of life and 99% within the first 48 hours of life. Genitourinary abnormalities should be suspected in babies with maternal severe oligohydramnios, neonatal abdominal distention, ascites, flank masses, persistently distended bladder, bacteriuria, pyuria, or poor growth. Male infants exhibiting these symptoms should be observed for the normal forceful voiding pattern.

1. Posterior urethral valves may cause obstruction.
2. Renal vein thrombosis should be considered in the setting of hematuria with a flank mass. It is more common in infants of diabetic mothers.
 - a. Renal ultrasonography will initially show a large kidney on the side of the thrombosis.

- b.** Doppler ultrasonography show diminished or absent blood flow to involved kidney.
- c.** Current treatment is to starts with medical support in the hope of avoiding surgery

2.Hydronephrosis:- is the most common abnormal finding, reported in >80% of the cases with a kidney abnormality. Nearly 75% of these are confirmed postnatally.

- a.** Initial management of a newborn with prenatally identified hydronephrosis depends on the clinical condition of the patient and the suspected nature of the lesion.
- b.** Unilateral hydronephrosis is more common and is not associated with systemic or pulmonary complications if the contralateral kidney is normal. Postnatal ultrasonographic confirmation may be carried out electively at approximately 2 to 4 weeks of life, depending on severity. Earlier ultrasonographic examination might missed because of physiologic dehydration so repeat the study if done in the first few days after birth.
- c.** Bilateral hydronephrosis is more worrisome, especially if oligohydramnios or pulmonary disease is present. In the male infant, postnatal evaluation (ultrasonography and VCUG) should be performed within the first day to determine the etiology (PUV, ureteropelvic junction [UPJ] obstruction, ureterovesical junction [UVJ] obstruction, prune belly syndrome, or VUR).
- d.** Antibiotic prophylaxis is recommended until VCUG rules out VUR. Nitrofurantoin (1 to 2 mg/kg/day) or trimethoprim-sulfamethoxazole (2 mg of trimethoprim plus 10 mg of sulfamethoxazole per kilogram) are used for UTI prophylaxis in older infants. In infants with postgestational age <48 weeks, nitrofurantoin can cause hemolytic anemia and sulfa displaces bilirubin from albumin and kernicterus can develop. Due to these reasons, amoxicillin (10 mg/kg/day) is the initial drug of choice in infants under a postgestational age of 48 weeks.

3.Hypospadias

Definition and Description

- Hypospadias (*hypo* = below; *spadon* = a fissure or a 'hole') consists of some or all of the following features:
 1. Ventral displacement of the urethral meatus (Hypospadias)
 2. Incomplete formation of the prepuce (dorsal 'hooding')
 3. Ventral curvature (chordee)
- Urethral meatal openings are generally described as being:
 1. Anterior – where the meatus is near the tip of the penis
 2. Middle – where the meatus is along the shaft of the penis
 3. Posterior – where the meatus is near the base of the penis or in the scrotum

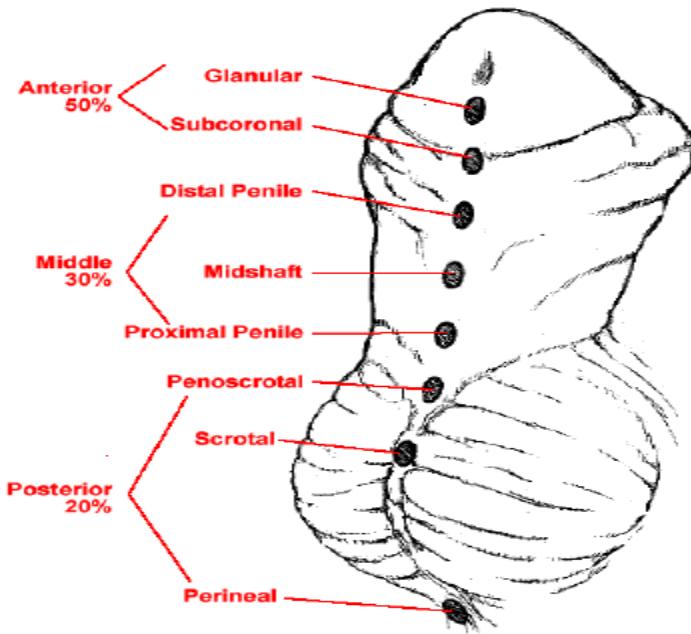


Figure 39: Hypospadias

Early recognition and pediatric urological referral is useful for counseling and planning timing of surgery

Management

- Early recognition and pediatric urological referral is useful for counseling and planning timing of surgery
- Parents should be reassured that hypospadias are common condition which can be corrected with surgery.
- Surgery is usually undertaken between 6 and 18 months.
- It is critical that parents are told that circumcision should not be performed, as the foreskin remnant is required for surgical repair.

4.Undescended testis

- This condition is suspected when the testis are not found in the scrotum on routine examination. It is also called cryptorchidism.
- Most boys with undescended testis will have their testis descended spontaneously in the first six months.
- The testis could be located in the abdomen (non-palpable) or in the inguinal canal (palpable).
- Problems associated with undescended testis include infertility, testicular cancer, hernia and testicular torsion.
- In these infants, empty scrotum and inguinal mass are common findings.
- If a mass is seen in the inguinal area, it should be assessed carefully for size, shape and mobility.
- Parents should be informed about this condition and subsequent follow up should be arranged.
- Surgical management or referral will be considered within 9-15 months if there is no spontaneous descent on follow up.

TRISOMIES

Trisomies are among the major numerical disorders of chromosomes, characterized by the presence of 3 instead of the normal 2 chromosomes. Major trisomies include trisomy 21 (Down syndrome), trisomy 18 (Edwards syndrome) and trisomy 13 (Patau syndrome).

Down syndrome (DS)

Down Syndrome is the most common chromosomal abnormality among live born infants with an incidence of 1 in 750 live births. It is characterized by a variety of dysmorphic features, congenital malformations, and other health problems and medical conditions. The occurrence of DS as it is true for other autosomal trisomies increases with advanced maternal age (≥ 35 yr).

Neonatal features

The following characteristic features are common in newborns with DS and are usually recognized soon after birth.

- Flat facial profile
- Slanted palpebral fissures
- Low-set ears
- Protruded tongue
- Small chin
- Short neck
- Flat occiput
- Thin & silky hair ,
- Hypotonia
- Poor Moro reflex
- Dysplasia of middle phalanx of fifth finger
- Transverse palmar (Simian) crease
- Excessive skin at nape of the neck
- Hyperflexibility of joints
- Dysplasia of pelvis.

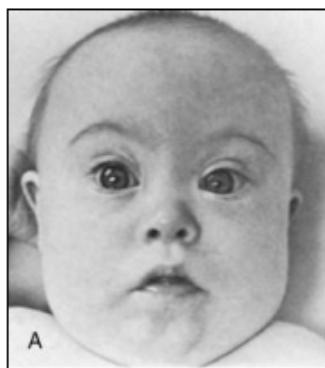


Figure 37: Newborn with features of Down syndrome

DS is also associated with cognitive impairment and congenital heart defects, gastrointestinal anomalies, leukemia, immune dysfunction, hypothyroidism, diabetes mellitus, and problems of hearing and vision.

Newborns with DS will also have hypothermia, jaundice, polycythemia and decreased feeding.

Diagnosis

- Suspected from the characteristic phenotypic/physical features present in the newborn.
- Eight or more of the above dysmorphic features.
- Confirmed with a karyotype, performed on a blood sample.

Laboratory tests

- Determine CBC since they are at risk of polycythemia, transient leukemoid reactions, thrombocytopenia or thrombocytosis.
- Serum bilirubin
- Thyroid function test
- ECG
- Echocardiography

Management

- Inform and counsel parents.
- Treat associated problems (polycythemia, hyperbilirubinemia, hypothyroidism and prevent hypothermia)
- Refer for detailed evaluation and management.

References

- 1- Avory A. Fanaroff and Martin's Neonatal- Perinatal Medicine 10th edition
- 2- Perloff the Clinical Recognition of CHD 4th edition.
- 3- CDC's Activities for Critical CHDs
- 4- Jone P. Cloherty, Eric C., Anne R. Stark Manual of Neonatal Care 8th edition
- 5- Congenital Anomalies from Embryo to the neonate, May, 2018

Chapter 22: Common congenital heart diseases

Learning objectives:

At the end of this session, the trainees will be able to recognize the clinical manifestations of common congenital heart diseases and their management

Introduction

Globally, CHD affects over one million live births annually and is the leading cause of infant mortality attributable to birth defects. Critical congenital heart disease (CCHD) refers to lesions of the cardiovascular system, present at birth, which if left undiagnosed it will result in infant morbidity and mortality.

Transposed great arteries, hypoplastic left heart, total anomalous pulmonary venous drainage, coarctation of the aorta, and interrupted aortic arch account for more than 70% of cyanotic congenital heart disease. Until recently, clinical examination followed by blood gas analysis (100% oxygen challenge) and echocardiogram have been the mainstays for diagnosis.

At birth, Nada's criteria are used to evaluate a newborn and the presence of one Major or two Minor Criteria indicates Presence of Congenital Heart Disease.

Nada's Major Criteria

- Systolic murmur with thrill
- Any diastolic murmur
- Cyanosis (central)
- Congestive cardiac failure

Nada's Minor Criteria

- Systolic murmur without thrill
- Abnormal P2 (accentuated P2)
- Abnormal BP (hypo / hypertension)
- Abnormal CXR
- Abnormal ECG

If the Nada's criteria are positive then, send the baby where he can be definitely diagnose with echocardiography and evaluated further. All babies suspected to have CHD should be managed with cautions in IV fluid administration to avoid congestion.

Approach to neonate with cardiovascular disease

- On physical examination look for :-
 - Cyanosis (Central)
 - Murmur (the presence or absence of murmur doesn't rule out or rule in CHD)
 - Abnormal second heart sound
 - Respiratory distress
 - Cardiac impels

- Hepatomegaly (but not specific)
 - Pulse (compare radial and femoral, rate, irregularity, and volume)
- Blood pressure measurement (on upper and lower extremities)
- Pulse oximetry (both preductal/right hand and postductal/lower extremities to see the ductous arteriosus flow pattern at 24 hr of age. In a baby with no lung problem < 90 % on either or < 95 % on both is a positive pulsoxymetry test).
- Hyperoxic test (give 100 % oxygen and measure the saturation)
 - Patient with pulmonary disease has increases oxygen saturation by > 10%
 - Those fixed with Right → Left shunt (Cyanotic lesions) have a small rise < 10%
 - It does not rule out those lesions with Left → Right shunt (acyanotic CHD)
- Radiologic findings
 - Less informative but helps to see the heart size and pulmonary blood flow
- Electrocardiography (ECG)
 - To look for the rate, rhythm and chamber hypertrophy and axis.
 - Sinus tachycardia, Right QRS axis, relatively small voltage, RV hypertrophy.
- Echocardiography
 - It's a definitive diagnostic method to evaluate the heart

Look for associated syndromes

- Down's syndrome (endocardial cushion defect PDA and VSD)
- Turner syndrome (Coarctation of aorta)
- Trisomy – 13 (VSD, ASD, PDA and dextrocardia)
- Trisomy – 18 (VSD)

Table 16: Time of onset of congestive heart failure

Age	Lesions
Birth - 72 hrs	Pulmonary, Mitral, and Aortic atresia or critical stenosis
4 days - 01 week	Hypoplastic Lt and Rt heart, Transposition of great arteries
1wk - 4wks	VSD and PDA in premature infant and the lesions mentioned above
4 – 6 wks	Endocardic cushion defect (ECD)
6wk – 6 mo	Large VSD, large PDA

Management

- a. Strict cardio respiratory support and monitoring
- b. Supportive oxygen therapy
- c. Restrict fluid intake to one half to two third of daily maintenance.
- d. Treat or correct precipitating factors
- e. Treat metabolic derangements (hypoglycemia, hypothermia)
- f. After stabilization of the patient refer to a higher center for proper diagnosis and management.

References

- 1- Avory A. Fanaroff and Martin's Neonatal- Perinatal Medicine 9th edition
- 2- Perloff the Clinical Recognition of CHD 4th edition.

Chapter 23: Acute/emergency surgical conditions

Learning Objectives

At the end of this session, the trainee will be able to:

- Recognize the most common acute/emergency surgical conditions
- Recall/name their management

Table 20: Common Intestinal Obstruction in the Newborn

Site obstruction	Clinical findings	Radiology findings	Management
Duodenal Atresia	Early vomiting, sometimes bilious 30% of cases are associated with Down syndrome They may have sign of DHN	Double bubble" (dilated stomach and proximal duodenum, no air distal)	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
Malrotation and volvulus	Bilious vomiting with onset anytime in the first few weeks	Dilated stomach and proximal duodenum; paucity of air distally (may be normal gas pattern)	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
Jejunoileal atresia, meconium ileus	Bilious gastric contents > 25 mL at birth. Progressive distention and bilious vomiting	Multiple dilated loops of bowel. Intra-abdominal calcifications if in-utero- perforation occurred (meconium peritonitis)	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management

Table 21: Intestinal Obstruction in the Newborn

Intestinal obstruction	Clinical manifestation	Radiology finding	Management
Imperforated anus	Missing or moved opening to the anus Baby does not pass first stool within 24 - 48 hours after birth Stool passes out of the vagina, base of penis, scrotum, or urethra(if there is fistula)	Distended bowel loop. Absence of rectal air	Supportive treatment (keep NPO, secure IV line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
Meconium plug syndrome; Hirsch	Abdominal distention. Delayed passing	Diffuse bowel distention	Supportive treatment (keep NPO, secure IV

sprung disease	meconium (> 24 h) May have also bilious type of vomiting		line & start IV fluid, insert NGT,) Urgent Consultation for surgical management
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Abdominal Wall Defects

Omphalocele

Omphalocele is a membrane-covered herniation of abdominal contents into the base of the umbilical cord. There is a high incidence of associated anomalies (cardiac, GI, and chromosomal—e.g., trisomy 13). The sac may contain liver and spleen as well as intestine

Management

Acute management of Omphalocele involves:

- Covering the defect with a sterile dressing soaked warm saline to prevent fluid loss.
- NGT decompression
- IV fluids and glucose
- Antibiotics
- Keep NPO until the surgical opinion obtained
- Urgent surgical consultation



Figure 41: Omphalocele

Gastroschisis

In gastroschisis, the intestine extrudes through an abdominal wall defect lateral to the umbilical cord. There is no membrane or sac and no liver or spleen outside the abdomen. Gastroschisis usually is not associated with other anomalies

Management

- Covering the defect with a sterile dressing
- Soaked with warm saline to prevent fluid loss
- NGT decompression
- Keep NPO
- IV fluids and glucose
- Antibiotics
- Urgent surgical consultation



Figure 42: Gastroschisis

Diaphragmatic Hernia

This congenital malformation consists of herniation of abdominal organs through a postero-lateral defect in the diaphragm

(usually left)

Clinical manifestation

- It presents in the delivery room as severe respiratory distress
- Absence breath sounds and scaphoid abdomen
- Presence of bowel sound in the chest

Management

- Avoid giving bag and mask ventilation
- Prepare for intubation
- Insert NGT for decompression of the GI tract
- Keep NPO
- Start IV infusion of glucose and fluid
- Chest radiograph confirms the diagnosis

Urgent surgical consultation should be made

Chapter 24: Perioperative care

Learning objective

At the end of this session, participants are able to

- Know preoperative managements of neonate with surgical problem
- Describe the care during transportation to the OR
- Manage and monitor postoperative neonates at neonatal ward
-

Introduction:

Care of the perioperative neonate requires careful consideration of many aspects including the impact of anaesthesia and surgery on multiple organ systems. Neonatal care should include close attention to achieving homeostasis and stability in the perioperative period.

This chapter will address the critical elements in the management of the surgical neonate.

General Considerations:

Preoperative preparation:

Care of the preoperative surgical neonate starts with a comprehensive history and physical examination on admission. It is important to focus on airway, respiratory, cardiac, Temperature, blood sugar and renal abnormalities which may impact surgery. Preoperative lab studies should include a complete blood count with differential, basic metabolic panel, coagulation studies and cross match blood screening.

The detailed **history** should include:

- Complete neonatal history
- Maternal health during pregnancy
- drug use during labor and delivery
- any measures done for the newborn eg. Transfusion, antibiotics, resuscitation
- Family counseling as to the need for operation, about the procedure, outcome, course

The targeted **physical examination** should include:

- Assessment for dehydration -
- Identification and management of shock Signs of infection and management accordingly
- Presence of congenital malformation -
- Assessment of the respiratory and management accordingly
- Measurement of vital signs every frequently before surgery including blood pressure and weight -
- Ensure functionality of IV line
- Monitoring of fluid input and output and recording on the vital sign sheet
- Pain assessment and pain score should be attached with the card for follow up

Laboratory Investigation

- Blood group and Rh
- Complete blood
- Electrolyte -
- Renal function test

- Imaging based on the diagnosis of the patient
- Echocardiography should be done if there is clinical suspicion

Preparation for surgery should include:

- Length of NPO status should be discussed with the surgeon. For elective procedures requiring anesthesia or sedation the neonate should be NPO for 2 hours for clear fluids, at least 4 hours if fed breast milk and 6 hours if fed formula prior to surgery. But it should be noted that NPO status is at times outweighed by the need for emergency surgery in cases of critical illness.
- Insertion of NG tube or Oro - gastric tube should be considered for decompression in case of bowel obstruction. Cases to strongly consider gastric decompression include surgical necrotizing enterocolitis, Hirschsprung's disease, intestinal atresia, Gastroschisis and omphalocele.
- Maintaining adequate intravenous access is very important. If there is fluid deficit; it should be corrected before surgery.
- Careful estimation of ongoing pathogenic fluid losses is important to determine the best volume and composition of fluid replacement.
- Ensure consent and explain all procedures and treatment to parents.
- Ensure a parent accompanies baby to Theatre.

Operating room

Monitoring equipment's that should be available

- Pulse oximeter
- Monitoring device with neonatal ECG pads and blood pressure cuffs
- Esophageal or rectal thermometer if not available digital thermometer
- Neonatal stethoscope
- Glucometer
- End tidal CO₂ monitor
- Adhesive urine bags or diaper measuring scale
- Blood gas analyzer

Resuscitation equipment

- Appropriate size bags and face mask
- Endotracheal tube numbers ,2.5 , 3.0, 3.5 and 4.0
- Laryngeal mask
- Suction catheters numbers 6, 8, 10
- Laryngoscope sizes 00, 0 and 1
- Adrenaline
- Normal saline
- Easy access for blood products
- Perfuser -
- Radiant Warmer and/or prewarmed matress
- Room thermometer -
- neonatal size Nasal prongs and face mask for oxygen delivery

Drugs for anesthesia

- To be done by the anesthesiologist

Equipment for surgery

- To be done by the surgeon

During surgery

- There should be appropriate follow up with follow up chart prepared specifically for the newborn
- The surgery should be attended by the resident in surgical attachment and pediatrician, follow or neonatologist
- The baby's condition should be monitored continuously during surgery –

Postoperative Care:

Precautions during Transportation:

- The operating room personnel should communicate the NICU unit to bring the baby when they are ready.
- The neonate shouldn't stay in the operating room or corridor waiting for his/her turn and infant needs to be kept warm.
- The NICU staff nurse and a physician with pediatrician should accompany the newborn
- All resuscitating equipment should be at hand during transport – ambu bag, face mask and portable oxygen with tube, drugs like adrenaline.
- If possible transport the baby in infant incubator or use other means like warm blanket to keep baby warm during transport !!
- If the baby was on oxygen has to be maintained during transport
- Fluid should be maintained with perfuser
- On arrival to the OR the babies condition should be assessed with vital sign, blood pressure, temperature, and any output and measure should be taken adequately.
- The perfuser should be used during surgery –
- The nurse hand overs the baby and the equipment's to the OR nurse that she brought make sure the venous access if functional

Immediate Postoperative care

- Post-extubation use T-piece or bag & mask until infant comfortably breathing
- The baby should be transferred to NICU the nurse in the OR calls the NICU nurse when the baby is ready for transfer
- All the resuscitation equipment should be available when transferring back to NICU
- Adequate analgesia should be ready
- Perioperative hypothermia is a common and serious complication of anesthesia and surgery. Therefore, temperature should be maintained normal because the combination of anesthetic-induced impairment of thermoregulatory control and exposure to a cool operating room environment causes most neonates to become hypothermic.-Mild intraoperative hypothermia triples the incidence of postoperative wound infections, triples the incidence of postoperative myocardial events and increases perioperative blood loss. Furthermore, it prolongs postoperative recovery and prolongs the duration of action of almost all anesthetic drugs. What do you have available for surgery.Hence, to maintain intraoperative normothermia installation of methods for active heating during the intraoperative period is necessary.

Thermal mattress is a more effective method to prevent hypothermia in the intra and postoperative period.

- Antibiotic indication should be evaluated with surgeon and given. Prophylactic antibiotics should be given within 1 hour of skin entry. Antibiotic choice should be dependent on disease process. Suspected perforation should be treated with broad-spectrum antibiotics that specifically include Gram-negative and anaerobic coverage. Length of therapy and choice of antibiotics may change depending on the intraoperative findings and culture results.

Post-operative follow up

- Experienced Nursing availability needs to be assured for at least 24 – 48 hours
- The child should be monitored for 12-24 hours post-surgery - Follow vital signs and document q 30 min to 1 hour initially, then q 1 – 2 hours, including HR, O₂ sat BP if possible.
- Monitor input and output regularly by the nurse
- Pediatrician/Neonatologist should monitor and write progress and make sure the post-operative order is taken care
- Pediatrician/ neonatologist should monitor the baby on top of the nurse and the resident
- All appropriate laboratory investigations must be done HCT, serum electrolyte and RBS – Electrolytes within 4-6 hours post op, as well as HCT and RBS. If available, get blood gas as well.
- In case of postoperative complication that may require surgery the surgeon should be informed as soon as possible while preparing the patient
- The surgeon should also evaluate the patient closely.

References

1. Betty R.Vohr Neonatal follow up program in the new millennium. American academy of pediatrics, September 29, 2009
2. Avery A. Fanaroff, Richard J.Martin. Neonatal perinatal medicine 9th edition

Chapter 25: Pain management: Post-surgery, post-traumatic, burn pain management

Learning objectives:

At the end of the session, the trainees will be able to:

- Describe pain assessment modalities
- Explain pain prevention and management in neonates

Management of pain in neonates

Introduction

- Preterm and term newborns demonstrate similar or even exaggerated physiological and hormonal responses to pain compared with those observed in older children and adults. **"If it would hurt you, it hurts them!"**
- Neonates have less ability to demonstrate pain symptoms and thus depend on others to recognize, assess, and manage their pain by recognizing the neonate's associated **behavioral and physiological** responses to pain.
- Exposure to prolonged or severe pain may increase neonatal mortality and affect long-term neurodevelopmental outcome. A lack of behavioral responses (including crying and movement) does not necessarily indicate a lack of pain especially when the infant is extremely immature, acutely ill or the painful stimulus is severe and /or prolonged.

Pain assessment modalities in term and preterm newborns

1. **Behavioral indicators of pain:** Facial expression, body movement and crying
2. **Physiological indicators of pain**
 - Change in heart rate, respiratory rate, blood pressure, Oxygen saturation.
 - Vagal tone, palmar sweating, and plasma cortisol or catecholamine level

Table 17: The Pain Assessment Tool (PAT)

Parameters	Description	Score (0 - 2)
Posture/Tone	Flexed and/or tense	2
	Extended	1
Sleep Pattern	Agitated or withdrawn	2
	Relaxed	0
Expression	Grimace	2
	Frown	1
Cry	Yes	2
	No	0
Colour	Pale/Dusky/Flushed	2
	Pink	0
Respirations	Apnea	2
	Tachypnea	1
Heart rate	Fluctuating	2
	Tachycardia	1
Saturations	Desaturating	2
	Normal	0
Blood Pressure	Hypotensive/ Hypertensive	2
	Normal	0
Nurses Perception:	Yes Pain	2
	No Pain	0
Total Score		

Note: Sedation may mask the neonate's response to painful stimuli and does not provide pain relief!

Advised Interventions Required:

- PAT Score <5: Nursing Comfort Measures (NCM)
- PAT Score >5: Paracetamol and NCM
- PAT Score >10: Paracetamol, NCM and opioid (bolus/ infusion to be commenced)

(Note- these interventions are only a guideline and an individual approach should be used for each patient)

Pain prevention and management

Environmental and behavioral approaches during procedure

- Clustering painful interventions prior to a comforting events (e.g. feeding or holding)
- Swaddling (tightly wrapping with cloth) during the procedure
- Non-nutritive sucking: pacifier
- Change diaper

Following the procedure

- Reducing noise and light
- Touch or massage
- Skin to skin contact (KMC)
- Holding the baby using blanket rolls

Physiological interventions (this are sucrose analgesia and competitive stimulation)

Glucose analgesia:-

- 25 % - 30% sucrose (glucose) 1.5 – 3ml PO ~ 2 minutes prior to the procedure for term newborns
- Suckling a nipple used as analgesia for peripheral venous punctures.

25 % sucrose (glucose) 0.5 – 1.5 ml PO ~2 minutes prior to the procedure for preterm NB

How to prepare glucose analgesia using a simplified formula:-

- **Eg. Prepare 10 ml of 25 % glucose**

$$- \underline{(40\% - 25\%) 10 = 4.28(5\%)}$$

35

$$- \underline{(25\% - 5\%) 10 = 5.7(40\%)}$$

35

$$- \underline{25\% = 6ml of 5\% + 4ml of 40 \%}$$

Competitive stimulation

- Gentle rubbing, taping or vibrating one extremity before and during painful stimulus to another extremity

Table 18: Pharmacologic and physiologic management of pain

Procedures	Intubated and ventilated infants	Non intubated infants
Arterial puncture	25 %– 30 % sucrose (glucose)	25 %– 30 % sucrose (glucose)
Venipuncture	1.5 - 3ml/kg PO	1.5 - 3ml/kg PO
Heel-stick blood draw	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO
Intravenous placement	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO
Lumbar puncture	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO
Dressing change	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO and Morphine sulphate 0.05-0.1 mg/kg IV or Fentanyl 2-3mic gr/kg IV	25 %– 30 % sucrose (glucose) 1.5 - 3ml/kg PO and Morphine sulphate 0.025-0.05 mg/kg IV or Fentanyl 2-3mic gr/kg IV 0.05mg/kg/dose orally.
Endotracheal suctioning (mechanically ventilated)	Morphine sulphate 0.05-0.1 mg/kg IV or Fentanyl 2-3 mic gr/kg IV	
Urinary catheters/Suprapubic bladder tap	-Use pacifier with 25% sucrose 1.5 – 3 ml 2 minutes prior to procedure	-Use pacifier with 24% sucrose 1;5 – 3 ml 2 minutes prior to procedure

Special Considerations

- Morphine is the drug of choice for most situations requiring pain relief
- Wean slowly after prolonged use of morphine, reduce dose by 10-15% of the original dose every 2-3 days as tolerated.

Table 19: Analgesia for invasive procedure

Procedures	None intubated infants	Intubated and ventilated
Palliative Care	-Physical and psychological strategies for pain management -Oral morphine may be used as recommended by the palliative care team	
Chest tube insertion	-Morphine 0.1 mg/kg/dose IV 20 minutes prior to procedure	-Morphine 0.1 mg/kg/dose IV 20 minutes prior to procedure

	<ul style="list-style-type: none"> -Use pacifier with 25% Sucrose 0.5-2.0 ml PO 2 minutes prior to procedure. -Buffered lidocaine 1% SQ as local anesthetic. -Start morphine infusion of 5-10mcg/kg/hr following bolus and assess infant as per guidelines for sub acute pain management 	<ul style="list-style-type: none"> -Buffered lidocaine 1% SQ as local anesthetic. -Start morphine infusion of 5-10mcg/kg/hr following bolus and assess infant as per guidelines for sub acute pain management
Chest tube removal	<ul style="list-style-type: none"> -Use pacifier with 25% Sucrose 1.5-3.0 ml PO 2 minutes prior to procedure 	<ul style="list-style-type: none"> Use pacifier with 25% Sucrose 1.5-3.0 ml PO 2 minutes prior to procedure
Circumcision	<ul style="list-style-type: none"> -30% sucrose 1.5-3ml PO and -Acetaminophen 10-15 mg/kg 2 hrs before and every 6hrs after the procedure (x24 hrs) and -Ring block (lidocaine 0.5%)(max 0.5cc/kg) 	<ul style="list-style-type: none"> Not applicable
Laparotomy	<ul style="list-style-type: none"> Fentanyl 0.25-0.5 micrograms /kg Q 4-6 hrs. or Morphine 0.025-0.05 mg/kg IV or S/C Q 4 hrs or -50 micrograms/kg/dose orally 	<ul style="list-style-type: none"> -Fentanyl 0.25-0.5 micrograms /kg Q 4-6 hrs. or -Morphine 0.025-0.05 mg/kg IV or S/C Q 4 hrs
Thoracotomy	<ul style="list-style-type: none"> -Acetaminophen 10-15 mg/kg Q 6 hrs or -Fentanyl 0.25-0.5 micrograms/kg Q 4-6 hrs. -Morphine 0.025-0.05 mg/kg IV or S/C Q 4 hrs or -50 micrograms/kg/dose orally 	<ul style="list-style-type: none"> -Fentanyl 0.25-0.5 micrograms /kg Q 4-6 hrs. -Morphine 0.025-0.05 mg/kg IV or S/C Q 4 hrs or
Neurosurgical	<ul style="list-style-type: none"> -Acetaminophen 10-15 mg/kg Q 6 hrs or -Fentanyl 0.25-0.5 micrograms /kg Q 4-6 hrs. or -Morphine 0.025-0.05 mg/kg IV or S/C Q 4 hrs or -50 micrograms/kg/dose orally 	<ul style="list-style-type: none"> -Fentanyl 0.25-0.5 micrograms /kg Q 4-6 hrs. or -Morphine 0.025-0.05 mg/kg IV or S/C Q 4 hrs or

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1. J Pain Res. 2012; 5: 573–577. Published online 2012 November 21. Analgesic effect of 30% glucose, milk and non-nutritive sucking in neonates
2. Newborn cerise drug protocol, Reviewed by Dr Kuchel, Simon Rowley and Brenda February 2001
3. Pediatrics 2000;105;454 Section on Surgery and Canadian Paediatric Society, Fetus and Newborn Committee Committee on Fetus and Newborn, Committee on Drugs, Section on Anesthesiology, Prevention and Management of Pain and Stress in the Neonate

Chapter 26: Infection prevention

Learning Objectives: -

At the end of this session, participants will able to

- Discuss what does infection & infection prevention mean
- Describe how can they prevent infection
- Identify predisposing factors to hospital-acquired infection
- Recognize and apply principle of infection prevention

Definition: -

Infection: - means an invasion and multiplication of microorganisms in body tissues.

Infection prevention: -

- Is a measure that a health care facility undertakes to prevent harm caused by infection to patients & health workers or placing barriers between susceptible host and the microorganisms.
- It is an important part of every component of care of a Newborn baby.
- Strict infection prevention protocol should be followed in delivery rooms and NICUs as newborn babies are susceptible to infections because of their immature immune system.
- Neonatal infection is the leading cause of neonatal mortality in Ethiopia, contributing for 31% of neonatal deaths.
- Common causes of health care-associated infections (hospital acquired infections) are seasonal viruses, staphylococci, and gram-negative bacilli.
- Transmission of infectious agents occurs by various routes, but by far the most common and important route is via the **hands**.
- Thermometers and other equipment that come into contact with mucous membranes are special risks.
- Common sites of hospital-acquired infection are - respiratory tract, gastrointestinal tract, bloodstream, skin, and urinary tract.

Predisposing factors to hospital-acquired infection include:

- Host factors

- Damage to skin- Birth injuries
- Anatomic abnormalities like dermoid sinuses, cleft palate,
- Organ dysfunction,
- Intrauterine growth retardation (IUGR)
- Underlying diseases or co-morbidities
- Prior invasive procedures: intravenous and other catheters bypass host defenses; provide direct access to sterile sites.
- Use of catheters and other devices
- Use of antibiotics: Antibiotics often alter normal bowel flora and encourage colonization by resistant flora.
- Exposure to other patients, visitors, or health care providers with contagious diseases

Preventing infection in the newborn at the time of birth

- Keep the baby in a clean area and follow standard precautions for newborn resuscitation.
- Ensure that resuscitation team wears appropriate PPE; non-sterile, fluid-proof, long-sleeved gowns, face-shields or goggles and masks, boots or shoe covers, and non-sterile gloves.
- Wear non-sterile gloves for contact with the newborn until after the first bath.
- Wipe both of the newborn's eyes with a sterile gauze square and discard the wet cloth. Use a separate square for each eye and wipe from the inner corner to the outer corner.
- Keep the newborn warm.

Infection prevention and control within the first hour of life

- Initiate early breastfeeding within 1 hour of birth.
- Encourage exclusive breastfeeding.
- Apply eye drops or ointment (e.g., tetracycline ointment) to both eyes once.
- Administer vitamin K and recommended immunizations (birth dose of oral polio vaccine and HBV vaccine), using safe injection practices and sharps safety.
- Apply relevant IPC precautions (Transmission-Based Precautions and prophylaxis) to those who are exposed or infected during or before birth (e.g., congenital syphilis, rubella, HIV, HBV, and other infectious diseases).

General IPC guidelines for all newborns

- Comply with standard precautions at all times and use transmission-based precautions
- Keep the mother separated from the baby for IPC purposes only when the mother has multi-drug resistant TB or if not possible the mother must be wear N-95 facemask.
- Consult to IPC staff regarding precautions for other infections in the mother.
- Follow patient spacing guidelines in the newborn nursery.
- Encourage exclusive breastfeeding (including appropriate policies, staff capacity, support)

- Manage expressing and storage of breast milk carefully to prevent infection
- Manage the preparation of formula feeds
- Screen visitors and exclude for signs of infection- fever, respiratory infection, diarrhea, and draining skin infection
- Perform recommended cord care:
 - ✓ For newborns born in low NMR settings (in health facilities and home), use clean, dry cord care.
 - ✓ In settings with high NMR (>30 per 1000): Apply 7.1% chlorhexidine gluconate (i.e., 4% chlorhexidine) once a day aqueous solution or gel for 7 days on umbilical cord stumps of infants born at home.

Preventing infection in newborns requiring specialized care

- As the level of care increases so does the risk of infection.
- Requires stricter and more vigilant application of IPC practices than caring for all newborns.
- Hand hygiene before and after contact with each infant is essential
- Not sharing equipment and supplies between infants
- Preventing the acquisition of infection from contaminated feedings, water, or air
- Protecting the infant from infected health care workers and visitors
- Using invasive medical devices judiciously
- Strictly adhering to aseptic techniques
- Newborns receiving care in the nursery, SCN, or NICU are exposed to other infants and more pathogens compared to infants that room in with their mothers
- Health care workers need to have expertise in incorporating these IPC practices into all aspects of workflow at all times.
- Sick and premature newborns are especially vulnerable to organisms acquired from hands-on contact, invasive medical device access, and procedures that occur in the NICU.
- Even small breaches in IPC puts the immuno-compromised newborn at risk
- Use of multi-dose vials should be discouraged, if possible
- Good hand hygiene highly effective in reducing all types of HAs in NICU patients
- Health care workers should perform a wash of their hands and arms to above the elbows, with care to cleaning all parts of the hands and beneath the nails before their shift begins and before handling a newborn.

- Sufficient time should be taken to thoroughly wash and rinse all parts of the hands. Careful hand hygiene between patients is most likely of more benefit than the length of hand scrub upon entry to the nursery.
- Health care workers should perform meticulous hand hygiene before and after each patient contact and after contact with potentially contaminated patient care equipment.
- Staff and parents should wear long-sleeved gowns if they are handling the infant outside of the bassinet/crib/warmer/incubator.
- Gowns should be worn when entering the infant's area (even if not handling the infant) in the following situations:
- Use recommended temperatures and detergents to launder NICU linens.
- Wrap or cover NICU linens during transport from the laundry and store them in closed cabinets to prevent contamination

Preventive strategies or Principles of Infection Prevention

1. Provide routine care of the newborn baby
 - After the first six hours of life or after the baby's temperature is stable, use cotton cloth soaked in warm water to remove blood and other body fluids (e.g. from the birth) from the baby's skin, and then dry the skin, delay bathing until at least the second day of life
 - Use swab to clean the baby if there is excess bleeding & if the baby is meconium stained.
 - Clean the buttocks and perineal area of the baby each time the baby's napkin is changed, or as often as required, using cotton soaked in warm, soapy water, and then carefully dry the area.
2. ***Consider every person (including the baby and staff) as potentially infectious.***
 - Screen visitors and exclude those who have a sign of infection-fever, respiratory infection, diarrhoea and draining skin infections.
 - **Do not allow** staff or visitors to enter the newborn care unit unless they wear room gowns. if they have an acute infection (e.g. respiratory infection unless he/she puts on mask & gown, skin infections or lesions unless he/she puts on gloves & gown to come into direct contact with babies).
 - Limit the number of different individuals handling the baby.
3. ***Hand hygiene:***
 - Hand hygiene is a general term referring to any action of hand cleansing.
 - Reduces the number of disease-causing microorganisms on hands and arms

- Minimize cross-contamination (e.g., from health worker to patient)
- It is the most important way to reduce the spread of infections in the health care setting.

Kinds of Hand Hygiene Practices: -

- Hand washing
- Antiseptic Hand-rub
- Hand Antisepsis
- Surgical Hand scrub

The decision to choose which type of hand hygiene practice to use depends on:

- Intensity of contact with patient and /or blood and body fluids, the likelihood of microbial transmission, Patient's susceptibility to infection, and procedure being performed

Hand washing: -

- mechanically remove soil and debris from skin and reduce the number of transient microorganisms.
- Newborn survival rates potentially increase 44% when hand washing and clean birthing kits are in place.
- Instruct the mother and family members to wash their hands before and after handling the baby.
- Adequate handwashing with water and soap requires 40– 60 seconds.

NB: - Hand washing is the single most important measure in reducing the spread of infection. And you must wash hands or hand rubbed before getting in NICU.

when you wash your hands?

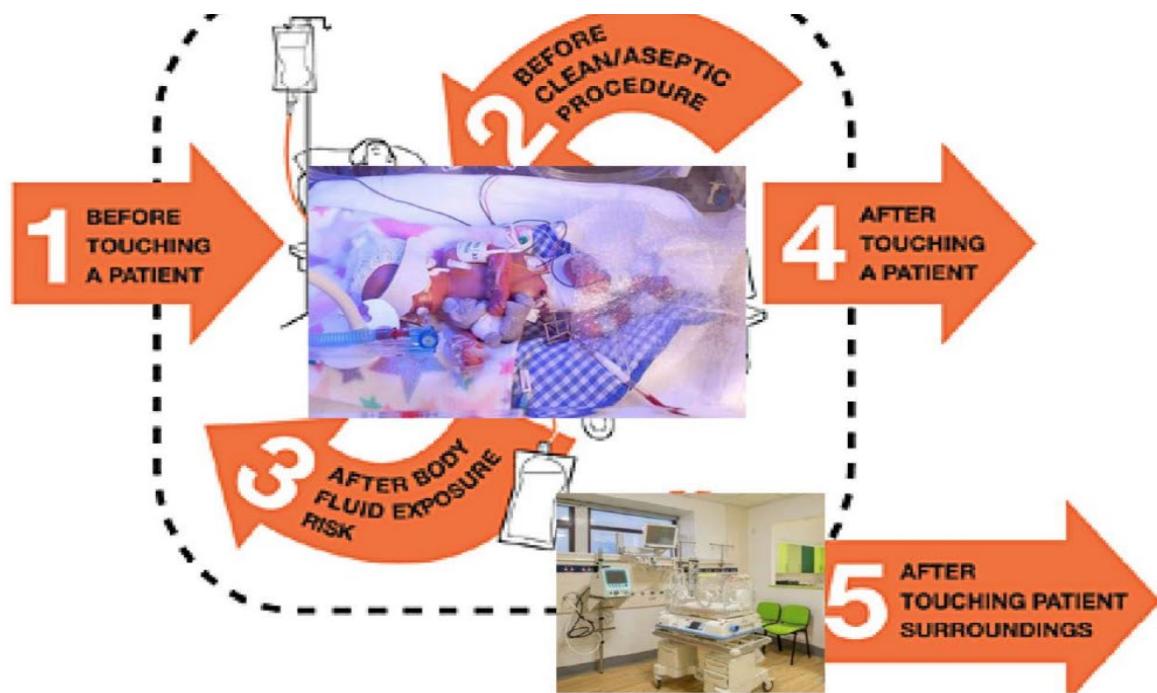


Figure: - Five moments of hand hygiene approach

Other opportunities for hand hygiene

- Immediately on arrival and before departure from work (the health facility).
- Immediately after touching contaminated instruments or articles
- Before putting on gloves and after removing, touching the face (eyes, nose or mouth), before and after cleaning the environment, before and after breastfeeding or preparing or feeding formula milk and after visiting the toilet.
- Whenever the hands become visibly soiled after nasal blowing or following a covered sneeze.

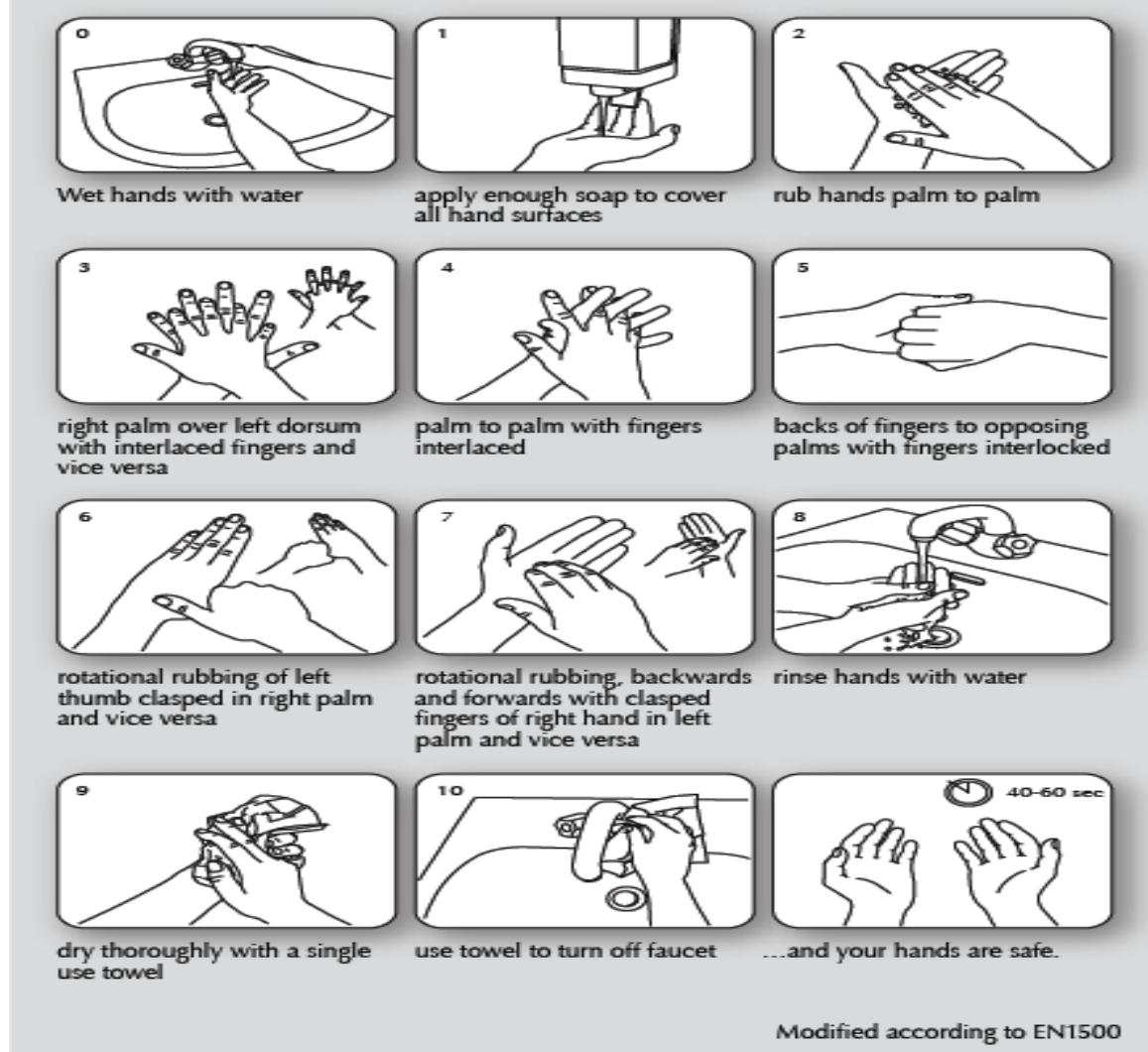
Alcohol based Hand rub

Purpose: to inhibit or kill transient and resident flora.

- More effective than antimicrobial hand washing agents or plain soap and water, but it should not be used when the hands are visibly soiled.
- It is quicker and easier to perform, do not rinse hands after applying hand rub
- An alcohol-based hand rub, Mix alcohol and glycerin solution: 2ml of glycerin + 100 ml of alcohol 70-90%; clean hands with 3 to 5 ml of solution. Cover the entire surface of hands and fingers; rub the solution into hands until they are dry.
- Alcohol-based hand rubbing: 20–30 seconds

NB: - Techniques of alcohol-based hand rub is the same of hand washing.

Handwashing Technique with Soap and Water



Modified according to EN1500

Figure: - Handwashing Technique with soap and water

4. Protective clothing and gloves

- It is not necessary to wear special gowns or masks when providing routine care for newborn babies.
- Wear protective clothing (e.g. aprons, gowns) when contact with blood or body fluids is anticipated.
- Wear closed-toe shoes
- Wrap or cover NICU linens & towels during transport from the laundry & store it in closed cabinets/containers.

Use different gloves for different situations:

- Wear sterile or high-level disinfected gloves for contact with broken skin or for invasive procedures (e.g. lumbar puncture, umbilical vein catheterization, taking a blood sample, caring for the umbilicus);
- Wear clean examination gloves for examination, caring newborns, contact with mucous membranes or body fluids.

- Wear heavy rubber or latex utility gloves for handling contaminated items, cleaning instruments and equipment, and disposing of waste.

NB: -Gloves do not replace hand hygiene

5. Space management in NICU

- One bed for one baby

6. Use aseptic technique.

- Scrub hands for three to five minutes using an antiseptic soap, and rinse with running or poured water.
- Allow hands to air dry or dry them with a clean paper or personal towel.
- Put on clean examination gloves.
- Prepare the skin for procedures by washing with a swab or cotton-wool ball soaked in an antiseptic solution in an outward spiral motion. Repeat two more times, using a new swab or cotton-wool ball each time, and allow to dry. If polyvidone iodine is used, allow it to dry after applying or wait at least two minutes before continuing with the procedure.
- Remove examination gloves and put on high-level disinfected or sterile gloves.
- Use sterile or high-level disinfected instruments and equipment.
- If there is any question about whether an item is sterile or not, consider it contaminated.

Standard antiseptic and disinfectant solutions

Standard antiseptic solutions: for skin preparation or scrub, for taking blood sample or establishment of I. V line

- 2.5%polyiodine
- 4% chlorhexidine gluconate
- 60 to 90%ethyl or isopropyl alcohol

Standard disinfectant solutions

- 0.5% chloride bleach
- 2% glutaraldehyde2% glutaraldehyde: -

NB: - 2% glutaraldehyde is extremely dangerous and which causes carcinogenic effect, respiratory and skin infection, and it shouldn't be used if possible.

7. Judicious antibiotics use and prevention misuse & rational use of antibiotics.

8. Avoid contamination

- If possible: **Do not** keep opened glass ampules so that the drug can be used for multiple babies. The drug may not be stable, and taping ampules shut will not prevent contamination.
- Discard diluent solutions (e.g. sterile water or normal saline) after 24 hours.
- Change the IV infusion set and fluid bag every 24 hours; even if the bag still contains IV fluid (they can be a major source of infection).

9. Prevention of central line-associated blood stream infection/CLABSI).

10. Instruments and equipment safe handling of sharp instruments

- Immediately dispose sharps by placing them in a puncture-proof container. Do not leave them on the sterile surface were they may cause a needle stick injury.
- **Do not** recap, bend, or break the needle or remove it from the syringe.

Instrument Processing Guidelines (after each use)

Thermometers and stethoscopes –

- Wipe with a disinfectant solution after each use.
- Dedicate a single thermometer and stethoscope for each bed.

Resuscitation bag and mask –

- Wipe exposed surfaces with gauze pad soaked in disinfectant solution
- Wash with soap and water

Weighing machine-

- Shouldn't be shared with other pediatric wards
- Should be cleaned after every use.

Incubator or radiant warmer-

- Wipe with a disinfectant solution daily
- Wash radiant warmer with soap and water before using for a new baby
- Wash incubator weekly, if the same baby is still in the incubator, and before using for a new baby

Suction apparatus and tubes, nasal prongs, nasal Catheter

- Soak in disinfectant solution for 10 minutes and sterile with HLD for 20 minutes,
- Wash with soap, high-level disinfect or sterilize.
- Oxygen head box (if available): - wash with soap and water

Ensure that a fresh container containing disinfectant solution is available at all times

- Immediately clean up spills of blood or body fluids using disinfectant solution.
- After each use, wipe off beds, tables, and procedure trolleys using disinfectant solution.
- Clean and dry the bottle containing water for humidification of oxygen daily.

Instrument process review

Four steps of disinfection/sterilization for reusable plastic materials



Step 1

DECONTAMINATION



Step 2

CLEANING



Step 3

STERILIZATION/HIGH LEVEL DISINFECTION



Step 4

STORAGE

STEP 1:- Decontamination-> making it safer to handle for further processing, submerge in 0.5% bleach solution for 10 minutes then soap and water and wash with water, this process is to make it safer for person doing further processing.

STEP 2:- Cleaning-> crucial step in processing, involves brush and mechanical removal of dirt, organic material and foreign material that can affect further disinfection if not done properly, change solution if visible particles in the water afterwards.

Do not use hand soap, let dry completely before proceeding to the next step

STEP 3:- HLD-> boiling/steaming or chemical germicide- bleach for 20 minutes or other germicide – hexanious solution- personal favourite...

- glutaraldehyde-based formulations (2%);
- stabilized hydrogen peroxide (6%);
- peracetic acid (variable concentrations, but ≤ 1% is sporicidal);
- sodium hypochlorite (5.25%, diluted to 1000 ppm available chlorine – 1:50 dilution)

STEP 4- storage of dry equipment- for further use

NB:- you must change prepared decontamination chlorine solutions after 24 hours.

Effectiveness of Methods of Processing Instruments

METHOD	Effectiveness (kill or remove microorganisms)	END POINT
Cleaning (soap and rinsing with water)	Up to 80%	Until visibly clean
High-Level Disinfection	95% (does not inactivate endospores)	Boiling or chemical for 20 minutes
Sterilization	100%	High-pressure steam, dry heat or chemical for the recommended time

Steps of manual cleaning:

- Put on personal protective equipment (PPE) including a water resistant gown, gloves, face mask and head cover. .
- Fill sink or appropriate basin with sufficient warm water for complete immersion of the devices being cleaned.
- Add the appropriate quantity of detergent following the manufacturer's instructions for dosage.
- Clean the device under the surface of the water so that aerosols are not produced.
- All devices be disassembled so that all surfaces may be cleaned and disinfected, irrespective of the cleaning method chose.
- Use appropriate brushes to properly clean box locks, lumens and other hard-to-clean areas
 - **Use soft (nylon) bristle brushes so that the surface of the instrument is not damaged.**
- In another sink or basin, completely immerse the device in clean purified water and rinse the device thoroughly.
- Air-dry or hand-dry using a disposable clean, non-linting cloth.

- Items that cannot be cleaned thoroughly should not be reused, but be discarded after use.

High-level disinfection

Destroys all microorganisms including HBV, HCV, and HIV; does not reliably kill all bacterial endospores

High-level disinfection can be achieved by:

- Pasteurization/ Boiling in water,
- Steaming
- Soaking instruments in chemical disinfectants
 - (OPA, Glutaraldehydes, Formaldehyde and Peroxide-are routinely used as high- level disinfectants).

Key steps in chemical high-level disinfection

STEP 1:- Thoroughly Clean instruments and other items that may have been contaminated with blood and body fluids and thoroughly clean and dry them before placing them in the disinfectant solution.

STEP 2:- Completely immerse all items in the high-level disinfectant.

STEP 3:- Soak them for 20 minutes.

STEP 4:- Remove items using high-level disinfected or sterile forceps or gloves.

STEP 5:- Rinse well with boiled and filtered (if necessary) water three times and air dry.

STEP 6:- Use promptly or store in a dry, high-level disinfected and covered container

Soaking of instruments in disinfectant prior to cleaning

According to the WHO and PHAO, soaking of instruments in 0.5% chlorine solution or any other disinfectant prior to cleaning is not recommended for the following reasons:

- It may damage/corrode the instruments
- The disinfectant may be inactivated by blood and body fluids, which could become a source of microbial contamination and formation of biofilm
- Transportation of contaminated items soaked in chemical disinfectant to the decontamination area may pose a risk to health care workers and result in inappropriate handling and accidental damage May contribute to the development of antimicrobial resistance to disinfectants.

How to Prepare Chlorine Solution

- For liquid bleach

$$\text{Total parts (TP) (H}_2\text{O}) = \left[\frac{\% \text{ Concentrate}}{\% \text{ Dilute}} \right] - 1$$

$$\text{Total parts (TP) (H}_2\text{O}) = \left[\frac{5\% \text{ Concentrate}}{.5\% \text{ Dilute}} \right] - 1 = 9 \text{ Total parts (TP) (H}_2\text{O})$$

- To make a 0.5% chlorine solution from 5% bleach, mix 1 part bleach to 9 parts water.

How to Prepare Chlorine Solution cont'd...

- For powder chlorine form

$$\text{Gram/Liter} = \left[\frac{\% \text{ Dilute}}{\% \text{ Concentrate}} \right] \times 1000$$

$$\text{Gram/Liter} = \left[\frac{.5\% \text{ Dilute}}{35\% \text{ Concentrate}} \right] \times 1000 = 14.2 \text{ Gram/Liter}$$

- To make a 0.5% chlorine solution form a 35% chlorine powder, mix 14.2 grams of powder chlorine to 1 liter of water

11. Routinely clean the newborn special care unit.

- Have a housekeeping schedule and post the cleaning schedule in a visible area. Clean the floor twice a day and more if needed. And clean the room once a week.

12. Care of Health Care Workers

- Exposure to human immunodeficiency:* The risk of a health care worker acquiring HIV after a needle stick or other “sharps” injury is less than 0.5%. Risk reduction must be undertaken for all blood borne pathogens, including: adherence to standard precautions using personal protective equipment and appropriate use of safety devices and a needle disposal system to limit sharps exposure.
- Sharp injuries:* Needle stick injuries are the most common of sharps injuries, although other contaminated sharp instruments may also cause injuries. All health care workers with potential

exposure should be vaccinated. For other personnel, the risk of hepatitis B, hepatitis C and HIV infection should be assessed and appropriate immunization or chemoprophylactic steps taken. Immediate treatment of such injuries should encourage washing thoroughly with running water and an antiseptic solution. An incident reporting system should be in place. It should not be seen as penalizing. And post exposure prophylaxis should be given as per the national guideline.

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Chapter 27: Common Neonatal Procedures

Learning objectives:

At the end of this session, the trainees will be able to:

- Explain principles behind common neonatal procedures
- Practice common neonatal procedure

GENERAL PRINCIPLES OF INFECTION PREVENTION

Observing the infection prevention practices below will protect the baby, mother, and health care provider from infections. They also will help prevent the spread of infections.

- Provide routine care of the newborn baby.
- Consider every person (including the baby and staff) as potentially infectious.
- Wash hands or use an alcohol-based handrub.
- Wear protective clothing and gloves.
- Use aseptic technique.
- Handle sharp instruments carefully, and clean and, if necessary, sterilize or disinfect instruments and equipment.
- Routinely clean the newborn special care unit, and dispose of waste.
- Isolate babies with infections to prevent nosocomial infections.

21.1 Administering oxygen

- Ensure that the baby does not receive too little or too much oxygen:
 - Giving too little oxygen may cause organ damage and eventual death;
- Giving too much oxygen may damage the baby's lungs and retinas. This damage, however, occurs after days (rather than minutes or hours) of excess oxygen therapy **Source of oxygen**
- Ensure that a source of oxygen is available at all times. Oxygen is expensive, so use it only in situations where it is necessary, and discontinue as soon as possible. There are three main sources of oxygen, oxygen cylinder, Oxygen concentrator, compressed air, and central oxygen source with pipeline. The oxygen is carried from the source to the baby by means of non-crush, plastic oxygen delivery tubing. A face mask, which can give a high concentration of oxygen, should always be available in case of rapid deterioration of the baby's condition.
-

Nasal Prongs

- Use 1-mm prongs for a small baby (less than 2.5 kg at birth or born before 37 weeks gestation) and use 2-mm prongs for a term baby.
- Place the prongs just within the baby's nostrils.
- Secure the prongs in place using elastic or a piece of adhesive tape.
- Adjust the flow of oxygen to achieve the desired concentration.
- Change the nasal prongs twice daily. Give oxygen using a face mask while cleaning and disinfecting the prongs, if necessary.

Nasal Catheter

- Use an 8-F catheter. If the **8-F catheter is too large**, use a 6-F catheter.
- Determine the distance the tube should be passed by measuring the distance from the nostril to the inner margin of the eyebrow.

- Gently insert the catheter into the nostril. If a **gastric tube is already in place in one nostril**, insert the catheter into the same nostril that the gastric tube is in, if possible.
- Ensure that the catheter is correctly positioned:
 - Look into the baby's mouth;
 - The catheter should not be visible at the back of the mouth;
 - If the **catheter is visible at the back of the mouth**, pull the catheter out slowly until it is no longer visible.
- Adjust the flow of oxygen to achieve the desired concentration.
- Change the nasal catheter twice daily. Give oxygen using a face mask while cleaning and disinfecting the catheter, if necessary.

Head Box

- Place a head box over the baby's head.
- Ensure that the baby's head stays within the head box, even when the baby moves.
- Adjust the flow of oxygen to achieve the desired concentration.



FIGURE 21:1 - Baby receiving oxygen via a head box

Face Mask

- Place the mask over the baby's mouth and nose.
- Secure the mask in place using elastic or a piece of adhesive tape.
- Adjust the flow of oxygen to achieve the desired concentration.

Incubator

- Use a head box, following the instructions for a head box, or connect the oxygen directly to the incubator according to the manufacturer's instructions.
- Adjust the flow of oxygen to achieve the desired concentration.

Table 21: 1 Methods for administering oxygen

Method	Flow and Concentration	Advantages	Disadvantages
Nasal Prongs	0.5-1 L per minute	<ul style="list-style-type: none"> - Low flow of oxygen required - Constant concentration of oxygen if applied correctly 	<ul style="list-style-type: none"> - Requires special prongs for use on newborn babies - Requires flow control device that allows low flow

			<ul style="list-style-type: none"> - Directs cold oxygen into baby's lungs
Nasal Catheter	- 0.5-1 L per minute	<ul style="list-style-type: none"> - Low flow of oxygen required - Constant concentration of oxygen if applied correctly 	<ul style="list-style-type: none"> - Requires flow control device that allows low flow - Directs cold oxygen into baby's lungs
Head box	3 to 5 L per minute	<ul style="list-style-type: none"> - Warms the oxygen - Can give a high Concentration 	<ul style="list-style-type: none"> - High flow of oxygen required to achieve desired concentration
Face mask	1 to 2 L per minute	<ul style="list-style-type: none"> - Oxygen can be administered quickly - Convenient for administering oxygen for short periods of time 	<ul style="list-style-type: none"> - Carbon dioxide can accumulate if flow rate is low or mask is small - Difficult to feed baby while mask is in place - Difficult to keep mask in place
CPAP	5-8 L per minute	<ul style="list-style-type: none"> - Prevent lung collapse - 	<ul style="list-style-type: none"> - Co2 retention - Air leak - Nasal damage - Abdominal distention
Incubator	<ul style="list-style-type: none"> - If using a head box inside the incubator, see above - If connecting oxygen directly to the incubator, follow the manufacturer's instructions 	<ul style="list-style-type: none"> - Warms the oxygen 	<ul style="list-style-type: none"> - Disadvantages of giving oxygen directly into the incubator: - High flow of oxygen required to achieve desired concentration - Difficult to maintain oxygen concentration when incubator portholes are open for care and procedures

Continuous positive airway pressure (CPAP)

In premature infants with respiratory distress CPAP expands collapsed alveoli, splints the airway, reduces work of breathing and improves the pattern and regularity of respiration.

Atelecto-trauma (repeated opening and collapse of the alveoli), biotrauma (intubation of the airway) and volutrauma (overstretching of the alveoli), the key determinants of VILI (ventilator induced lung injury) are minimal or absent with CPAP.

Indications:

- To put the neonate on CPAP the presence of good respiratory effort is the prime requirement.
- Recently delivered preterm infant with minimal respiratory distress and low supplemental oxygen requirement (to prevent atelectasis)
- Respiratory distress and requirement of FiO₂ above 0.30
- Recurrent apneas not responding to medical management
- Post extubation from mechanical ventilation
- Term neonates with respiratory distress and saturations less than 88% on hood oxygen

- Initial stabilization in the delivery room for spontaneously breathing, extremely preterm infants (25 to 28 weeks' gestation)
- Initial management of premature infants with moderate respiratory distress

NB: Preterm infants with RDS who require FiO₂ above 0.4 on CPAP should be intubated, ventilated, and given surfactant replacement therapy.

Contraindications :

- Poor respiratory efforts,
- Congenital diaphragmatic hernia, tracheo-esophageal fistula, choanal atresia and cleft palate
- Severe cardio-vascular instability better to put on ventilator
- ABG = pH is less than 7.25 and PaCO₂ >60 mm of Hg.

Methods and machines to deliver CPAP:

- CPAP can be delivered using variable flow or continuous flow method. Variable flow uses the mechanical ventilator as a gas source not commonly used, Continuous flow uses standalone CPAP device is a where a blended gas flow to the baby after it is heated and humidified via bi-nasal prongs and the expiratory limb is emerged under water seal or water bubble
- The bubble CPAP method is used with different modification in Ethiopia there is also locally made CPAP which was used for almost a decade its detail is available in the national guideline. Currently there is a concentrator device which has incorporated CPAP system in it called Diamedica CPAP which is available in most of the level 3 hospitals the details of it is described below

CPAP delivery interfaces :

- Can be delivered using binasal prongs and nasal mask different devices may have different methods of CPAP delivery
- Starting and weaning a patient on CPAP, the details available on Dimedica CPAP follow that for other CPAP devices

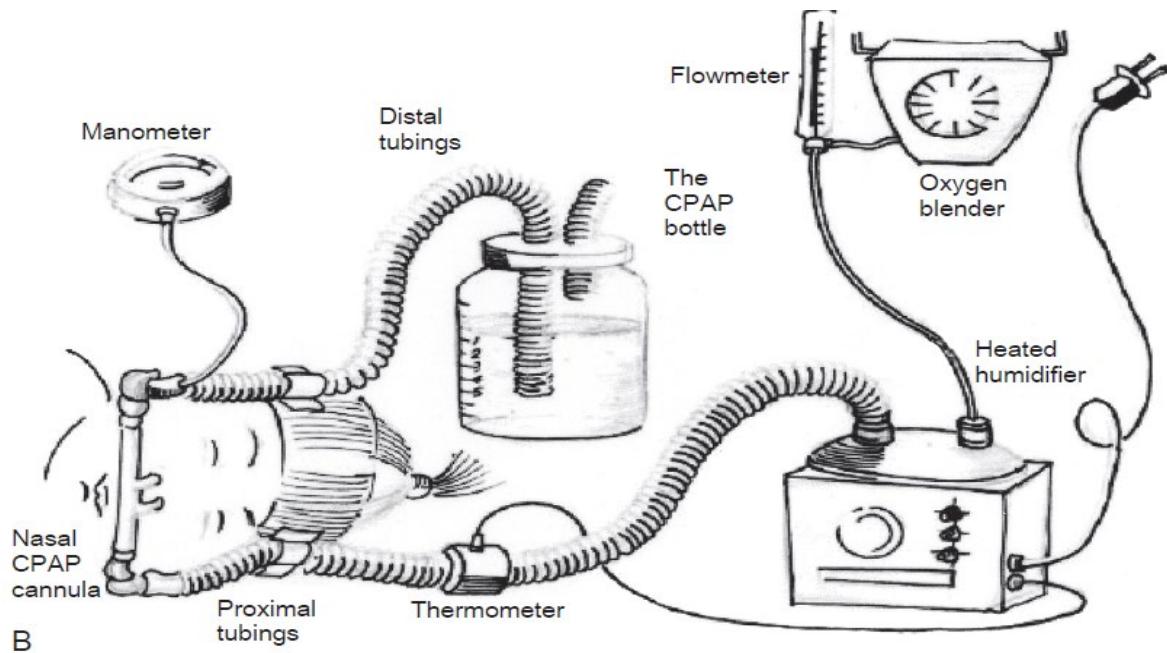


Fig :21:2 Bubble CPAP used in the current era

Diamedica Baby CPAP

Diamedica CPAP delivers gas by the concentrator mechanism no need to attach it to oxygen and compressed air. It needs electric source for operation. In centers where there is high power interruption better to put a reserve cylinder in case of power interruption to use the local CPAP

The Diamedica CPAP contains

- Two flowmeters for up to 10 l/min oxygen and 10 l/min medical air
- Self-contained unit generates 95% oxygen and its own medical air
- Voltage protector is fitted to all CPAP machines, protecting the machine from unstable power surges
- Humidifier ensures warmth and moisture for the air and oxygen delivered to the patient
- Clear oxygen/air mixing chart allows for easy setting of flow rates
- Inexpensive to run – no need for costly oxygen and air cylinders



Picture :21:3 Diamedica CPAP picture

Flow Oxygen/Air Mixing Chart

- Flowmeters allow for a variable gas mixture containing oxygen from 21% - 95%

- Recommended total flow of 10 liters a minute to start. Example if you give 5 liters of oxygen and 5 liters of air $\text{FIO}_2 = 57.5\%$
- Adjust flows to achieve desired FIO_2 levels

The CPAP system

- The concentrator has also been modified so that warm waste air from the concentrator's compressor is directed towards the humidifier bottle.
- This increases the temperature of the inspired gases, raising the dew point of the water and thus providing enhanced humidification to the device.
- Pressure is maintained throughout the respiratory cycle by directing the gas flow to a container of water at the distal end of the circuit via a tube with an open end at an adjustable depth beneath the surface

Air filter

- This is available at the back of the machine with a sponge cover of the air trap part
- Remove dust from the air filter daily
- Keep the machine 30 cm away from wall or curtains
- In between patients wash it with water and soap and let it adequately dry

Power on

Once power is turned on the yellow light will stay illuminated until concentrator has reaches and exceeds 85%, then the light will turn off. Approximately 10 minutes.

Table : 21:2 Oxygen/Air mixing Chart available on the machine

		Oxygen/air mixing chart								
		Air Flowmeter (l/min)								
		0	1	2	3	4	5	6	7	8
Oxygen Flowmeter (l/min)	1	95.0	57.5	45.0	38.8	35.0	32.5	30.7	29.4	28.3
	2	95.0	70.0	57.5	50.0	45.0	41.4	38.8	36.7	35.0
	3	95.0	76.3	65.0	57.5	52.1	48.1	45.0	42.5	40.5
	4	95.0	80.0	70.0	62.9	57.5	53.3	50.0	47.3	45.0
	5	95.0	82.5	73.6	66.9	61.7	57.5	54.1	51.3	48.8
	6	95.0	84.3	76.3	70.0	65.0	60.9	57.5	54.6	52.1
	7	95.0	85.6	78.3	72.5	67.7	63.8	60.4	57.5	55.0
	8	95.0	86.7	80.0	74.5	70.0	66.2	62.9	60.0	57.5

Assuming an oxygen concentrator output of 95% oxygen

CPAP application

- Position the patient- neutral supine position to maintain an open airway
- Elevate the shoulders using a towel or blanket
- Ensure clear airway-suction the nares with a catheter or bulb syringe if needed.
- Apply interface/ nasal prong Hudson prongs are supplied with the machine if available RAM cannulas can also be used

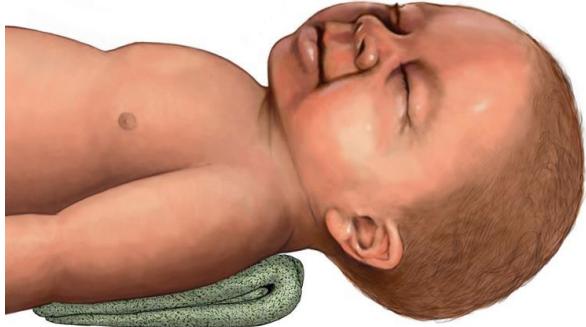


Figure :21:4 Positioning of newborn for CPAP application

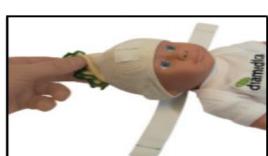
Applying Hudson Prongs

- In order to create CPAP Hudson prongs require full occlusion of the nares
- The machine is supplied with 8 different size prongs
- 0= the smallest to 7= the largest
- Each prong has size stamped on it
- Select the appropriate size for your patient
- There are also 4 sizes bonnets supplied with the prong select the appropriate size that will help to fix the tubing's
- May need to lubricate prongs with water or saline.
- Place the prongs curved side down and direct into nasal cavities.
- May need to lubricate prongs with water or saline.
- Place the prongs curved side down and direct into nasal cavities.
- Be careful on selection of the appropriate size prong
- Large prongs to size of nares cause nasal irritation
- Small prongs to the size of nares cause air leak, losses pressure and decrease the CPAP effect

Figure : 21:5 Steps of attaching the Hadson prong and bonnet



- a) Place the bonnet on patients head, centering the "securement line indicator"
- b) With the bonnet centered at nape of neck, place remaining bonnet on infant



- c) Close the top of bonnet by twisting bonnet until tightly secure to head crown.
- d) Secure with ribbon provided



- e) Cut self-adhesive Velcro in half and secure to the bonnet



- f) Attach chin strap to the infant and secure to Velcro



- g) Place the nasal prong into the infants nostril



- h) Secure tubing by placing elastic strap over tubing and secure to Velcro. Elastic strap is correctly positioned when strap is in line within the securement line indicator

Initiating CPAP

- In the NICU CPAP should be initiated based the presence of respiratory distress.
- Respiratory distress is assessed using clinical parameters of respiratory rate, intercostal and subcostal retraction, grunting, cyanosis, nasal flaring and air entry
- Downe score can be used for clinical assessment of respiratory distress see table below.

When to start

- If the preterm newborn has respiratory distress with Downe score (see table) is more than or equal to 4 CPAP must be started, earliest initiation is recommended in preterm infants with signs of RDS
- In preterm newborns who were initiated on CPAP at delivery room CPAP must be continued in the NICU till baby had Downe score less than 4
- In late preterm and term newborns oxygen requirement greater than 30 % or 0.5 L/min to maintain SpO₂ more than 90%

How to start CPAP

- Initial flow 10L/min = FIO₂ of 57.5 %
 - 5 L/min air
 - 5 L/min oxygen
- Increase or decrease FIO₂ based on patient saturation
- Initial CPAP depth

- RAM cannula is available start at 6 cm H₂O and increase to 10
- Hudson prongs start at 5 cm of H₂O and increase to 10
- Put orogastric tube attach open syringe at the end leave it open to re

Monitoring on CPAP

- Continuously monitor SPO₂ and heart rate if possible RR
- Every 2-4 hour monitor and document
 - Vital signs (temp, RR, HR)
 - Downes' score
 - Securing and position of nasal prongs
 - Condition of nares, nasal septum and skin – check for pressure points

Signs of improvement

- Oxygen saturations increasing – oxygen requirement decreasing
- Signs of respiratory distress improving
- Downes' score decreasing
- Baby appears more comfortable

Weaning from CPAP

- Reduce FIO₂ to minimum level FIO₂ <30%
- Reduce pressures by 1cm slowly until 5cm
- When baby is maintaining SPO₂ 90-95% at minimum FIO₂ and CPAP 5cm for several hours change to nasal cannula oxygen
- After CPAP discontinuation monitor continuously for respiratory deterioration

Table :21:3 Downes' score for assessment of Respiratory Distress

Downes' score	0	1	2
Reparatory rate	<60Breaths per min	60-80	>80
Retractions	None	Mild	Severe
Cyanosis	None	Cyanosis relieved by oxygen	Cyanosis not relieved by oxygen
Grunting	None	Audible with stethoscope	Audible with ear
Air entry	Good bilaterally	Mildly decreased	Markedly decreased

Guideline for initiation of CPAP

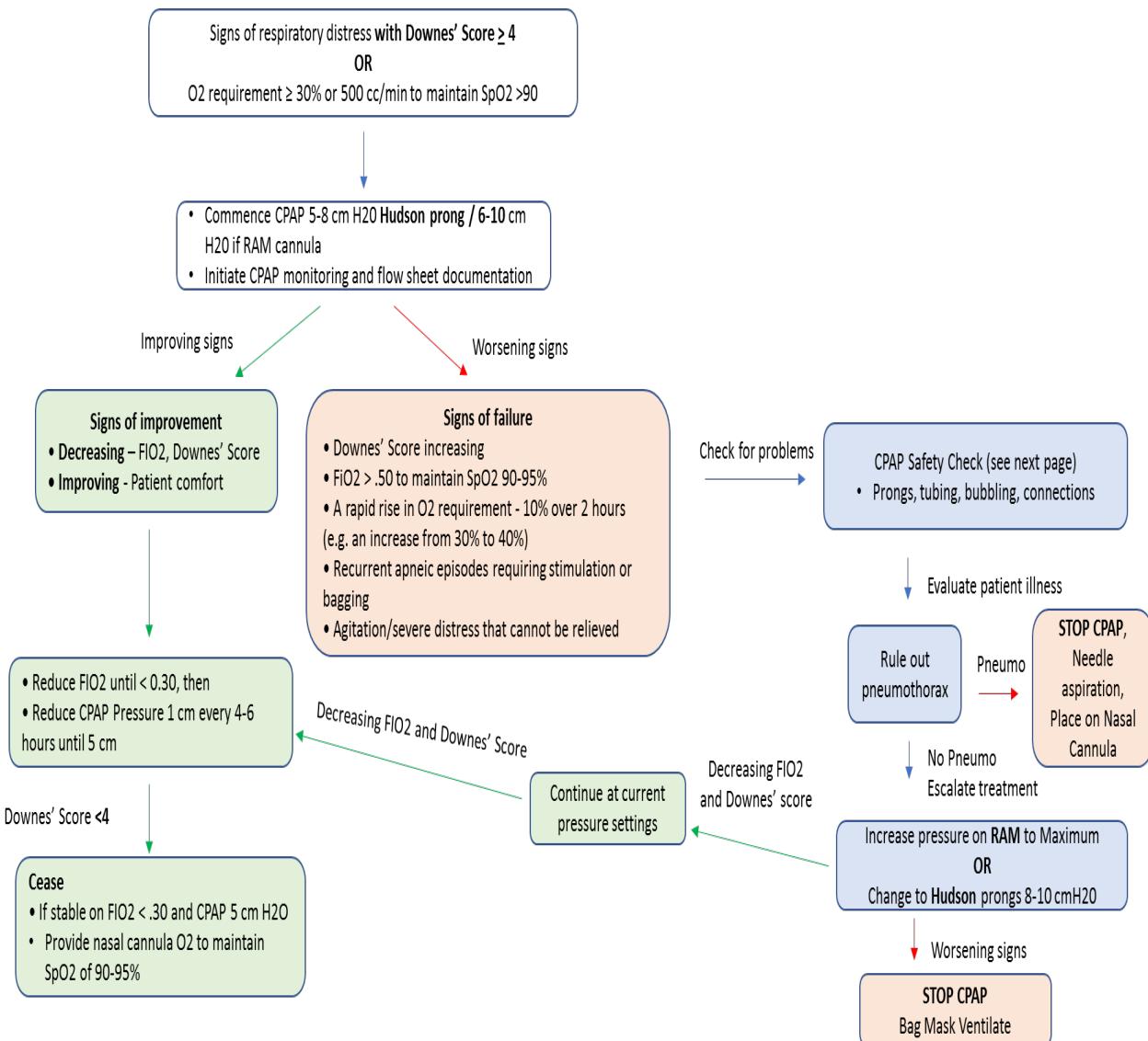


Figure :21:6 CPAP initiation and monitoring algorithm for preterm and term newborns with respiratory distress

(Fig Modified from FMOH, UNICEF and VON training material)

- Monitoring of infants on CPAP
 - Monitor and record every 2-4 hours:
 - Vital signs
 - SpO₂ (preferably right hand)
 - Downes' Score
 - FIO₂
 - CPAP pressure, Gas flow
 - Humidifier and circuit
 - Water level in humidifier

- CPAP interface positioned correctly, septal integrity, Securing devices not causing indentation, pitting or periorbital edema
- Performing CPAP safety check
- Assess nares for blockage, need for suction and injury to nares – put saline nasal drops every 3-4 hours
- Verify nasal prong size
- Check for water in CPAP tubing's, empty if water is present
- Check corrugated CPAP tubing are connected and fixed in place
- Verify water level in CPAP chamber is filled to the zero, remove water if needed
- Verify CPAP level is correctly dialed
- Check for water bubbling in the CPAP chamber
- Check the water level of the bubbling chamber daily, to check water level dial to 0 cm H₂O CPAP, there is tendency of water to evaporate

If no bubbling

1. Check CPAP prongs for occlusion
2. Check for leaks in tubing or disconnection or occluded tubing
3. Large air leak from the mouth
 - Chinstrap or pacifier may help
4. Increase CPAP level
5. Increase flow

Monitoring the Baby's response to Oxygen

- Use an oximeter according to the manufacturer's instructions to ensure that the baby receives an adequate concentration of oxygen.
- If an **oximeter is not available**, monitor the baby for signs of oxygenation by assessing whether the baby has signs of breathing difficulty or central cyanosis (blue tongue and lips) (note that these observations cannot differentiate between normal and excessive concentrations of oxygen in the blood):

Central cyanosis is a late sign that the baby is not receiving enough oxygen. If the baby shows signs of central cyanosis, increase the concentration of oxygen immediately and continue until cyanosis is eliminated.

- If the **breathing difficulty is moderate to severe**, give oxygen at a moderate flow rate;
- When the baby's breathing begins to improve (e.g. respiratory rate begins to move towards the normal range, grunting or chest indrawing decreases), decrease the oxygen flow;
- When the baby's respiratory rate is within the normal range and there are no other signs of breathing difficulty (e.g. chest indrawing or grunting on expiration), remove oxygen and observe the baby for 15 minutes;
- If the **baby's tongue and lips remain pink**, do not give any more oxygen. Observe for central cyanosis every 15 minutes for the next hour;
- If **central cyanosis reappears at any time**, give oxygen again at the last rate given;
- Continue to observe the baby for 24 hours after oxygen is discontinued.

Taking Blood Samples

- Determine how much blood will be needed to perform all necessary laboratory investigations
- Take enough blood at one time for all the tests, if possible
- Use venipuncture when more than 1 ml of blood is needed for several laboratory investigations or for blood culture and sensitivity
- Use a capillary blood sample (heel prick) If only a small volume of blood is needed

Venipuncture

- Use veins in the hands and feet first.
- Do not use brachial, jugular or femoral veins for routine sampling.
- when a sterile blood sample for bacterial culture and sensitivity is needed, use a closed system using a butterfly set and syringe

Procedure

- Identify the vein to be used
- Prepare the skin over the vein using a swab or cotton-wool ball soaked in antiseptic solution, and allow to dry
- Have an assistant use her/his forefinger and thumb to gently encircle the limb above the site selected for puncture.

Needle with a syringe or butterfly set

- Attach the syringe to the needle or butterfly set tubing.
- Insert the needle through the skin at an angle of about 15 degrees, with the bevel of the needle facing upward.
- Pull gently on the syringe plunger as the needle is advanced. Once blood flows easily into the syringe or the tubing of the butterfly set, do not advance the needle any further.
- After blood is collected:
 - Have the assistant remove her/his finger and thumb from around the baby's limb;
 - Withdraw the needle from the vein, and have the assistant apply gentle pressure to the puncture site with a dry cotton-wool ball for several minutes to prevent bruising.
- If an **open collection tube is used**, carefully recap the needle and remove it from the syringe before transferring the blood into the tube.

Needle without syringe

- This can be messy and is unsterile, making this method unsuitable for culture and sensitivity.
- Insert the needle through the skin at an angle of about 15 degrees, with the bevel of the needle facing upward, until blood flows out quickly:
- If the **blood comes out very slowly**, gently adjust the needle slightly by pulling it back or pushing it in;
- Hold the collection tubes under the needle to collect the blood, being careful not to touch the tubes or the end of the needle.

Capillary Blood Sample (Heel Prick)

- Use sterile lancet (if a lancet is not available, use a 24-gauge needle) to prick

Procedure

- Flex the foot up towards the leg and hold it in this position with one hand.

- Squeeze the heel firmly enough to make it flush red (but not so much that it turns white).
- Puncture the skin (about 1 to 2 mm deep) firmly with a lancet;
- Aim towards the lateral or medial side of the heel;
- Avoid the heel pad because of the risk of infection;
- Avoid using previously used sites, if possible.

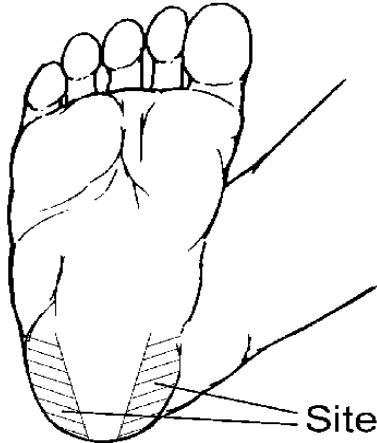


FIGURE 21:7 - Site for heel prick

- Squeeze the heel gently and intermittently to enhance blood flow.
- Avoid excessive squeezing and rubbing of the heel, as this will cause bruising and dilution of blood with tissue fluid, giving an inaccurate result.
- After blood is collected, have an assistant apply gentle pressure to the puncture site with a dry cotton-wool ball for several minutes to prevent bruising.

Giving Injections

A. Intramuscular injections:

General Principles:

The sites for IM injections include the:

- Quadriceps muscle group of the upper, outer thigh. This site is preferred because of the small risk of giving the injection intravenously, hitting the femur with the needle, or injuring the sciatic nerve;
- Gluteus muscle group in the buttock - use only the upper, outer quadrant of the muscle, and always aspirate before injecting to avoid injury to the Sciatic nerve and major blood vessels
- Deltoid muscle group. This site can be used for giving immunizations but should not be used for giving other injections.
- Minimize pain with injection by using a sharp needle of the smallest diameter that will allow fluid to flow freely (e.g. 22- to 24-gauge);
- Avoiding rapid injection of material;

Potential complications of IM injections include:

- Inadvertent intra-arterial or intravenous injection;
- Infection from contaminated injection material;
- Neural injury (typically the sciatic nerve after injections in the buttock);
- Local tissue damage due to injection of irritants

Procedure

- Grasp the centre of the target muscle between the thumb and forefinger, if possible.

- Insert the needle at a 90-degree angle through the skin with a single quick motion

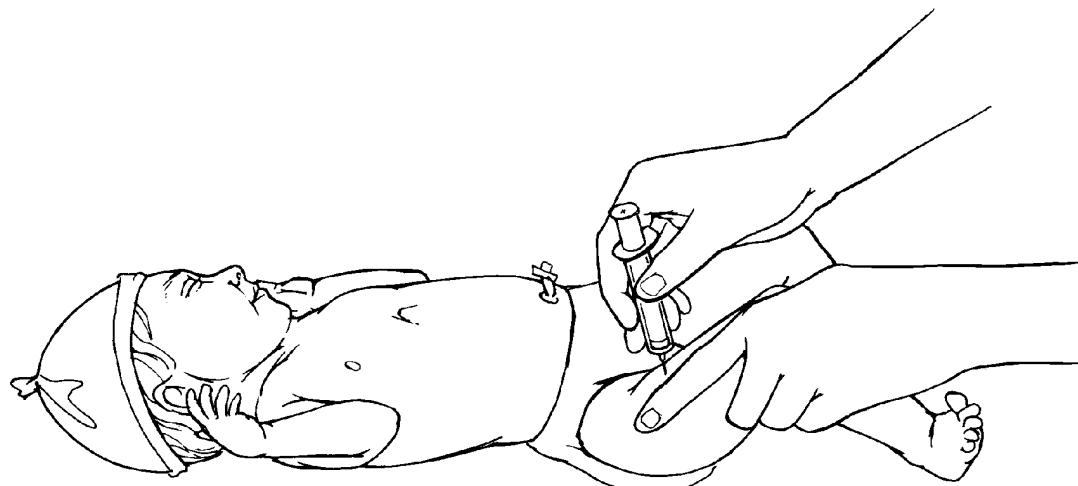


FIGURE 21:8 – IM injection into quadriceps muscle group

- Withdraw the plunger of the syringe slightly to ensure that the tip of the needle is not in a vein (i.e. no blood should enter the needle);
- If the **needle is in a vein** - Withdraw the needle without injecting the material; and apply gentle pressure to the site with a dry cotton-wool ball to prevent bruising; Place a new, sterile needle on the syringe; Choose a new site for injection;
- If the **needle is in the muscle**, inject the material with steady pressure for three to five seconds.
- Upon completion of the injection, withdraw the needle and apply gentle pressure with a dry cotton-wool ball.
- Record the site of the injection, and rotate the site of subsequent injections.

B. Intravenous (IV) Injections

The directions in this section are for giving an IV push injection to a baby with an IV line in place; these directions do not apply if the drug is mixed with IV fluid in a bag and then infused.

Procedure

- Choose the place in the IV line where an IV injection can be given closest to the insertion site of the cannula (e.g. a valve or a soft rubber connector)
- Clean the port with the swab or cotton-wool ball soaked in antiseptic solution, and allow to dry
- Draw the material for injection into the syringe
- Ensure that the drug and dose are correct
- If the **IV fluid was infusing without problem** - Stop the IV infusion;
- Insert the needle into the IV line, and inject the material slowly over two minutes, carefully observing the area around the cannula for swelling

If there is any question as to whether the cannula is properly positioned in the vein:

- Stop the IV infusion;
- Flush the IV line first with 2 ml of IV fluid, observing the area around the cannula carefully for swelling that indicates that the cannula has come out of the vein;
- If the **cannula is still in the vein**, inject the material slowly over two minutes, carefully observing the area around the cannula for swelling.
- Upon completion of the injection, withdraw the needle and restart the IV infusion.

C. Intradermal Injections

Only use intradermal injection for the BCG vaccine and when first administering local anesthetic for draining an abscess

Procedure

- Sterile 25- or 27-gauge, 5/8-inch needle
- Sterile 21-gauge, 1-inch needle
- Sterile tuberculin syringe (1-ml)
- Draw the material for injection into the syringe using the 21-gauge needle.
- Replace the 21-gauge needle with a 25- or 27-gauge needle.
- Hold the syringe and needle almost parallel with the skin, with the bevel of the needle facing up.
- Pull the skin taut with one hand, and insert the tip of the needle barely under the skin. Advance the needle slowly until the bevel of the needle has fully entered the skin.
- Gently point the needle upward, without re-piercing the skin.
- Inject the material with steady pressure for three to five seconds (there will be significant resistance) and look for a blanching of the skin. The baby will probably cry during the injection; a true intradermal injection often burns slightly and should raise a small "bleb" under the skin that causes the skin to pucker like the skin of an orange (peau d'orange).
- Upon completion of the injection, withdraw the needle and apply gentle pressure with a dry cotton-wool ball.

Establishing an Intravenous Line

Common sites used for a baby are:

- Peripheral veins on the back of the hand or top of the foot (the most common and preferred sites);
- Veins on the forearm, the front of the elbow, or around the ankle or knee (minimize use of the veins around the knee because there is a greater risk of the needle coming in contact with the bone);
- Scalp veins.

If a **peripheral IV line cannot be established quickly in an emergency situation**, use an umbilical vein catheter or intraosseous line

A. Peripheral IV Line

Procedure

- Prepare the solution to be infused, ensuring that the entire infusion set is filled with fluid and that there is no air in the infusion set. If a **butterfly set is used**, ensure that the set is filled with IV fluid.

Air embolism can occur easily in babies. It is essential to ensure that all components of the IV infusion set are filled with fluid and that there are no air bubbles in the set before beginning the infusion.

- Have an assistant press on the skin near the vein to act as a tourniquet: If **using a vein on the hand, foot, arm, or leg**, have the assistant use her/his forefinger and thumb to gently encircle the limb above the chosen site of insertion; If **using a scalp vein**, have an assistant press over the vein below the chosen site of insertion, or place a rubber band (as a tourniquet) around the baby's head

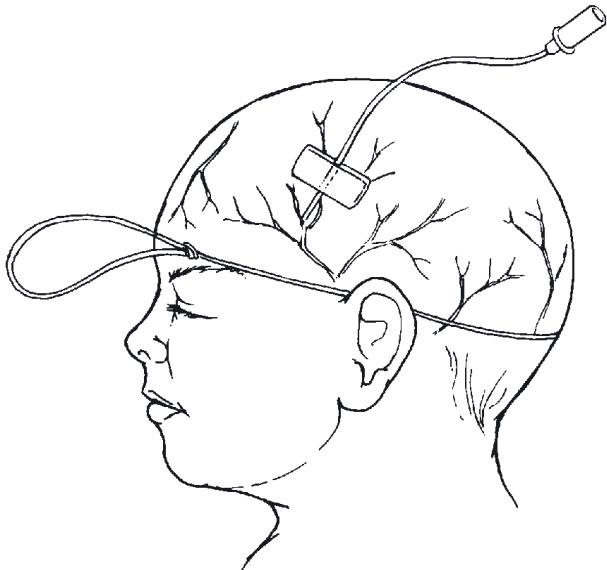


FIGURE 21:9- Using a rubber band as a tourniquet for scalp vein

- Insert the needle at a 15-degree angle through the skin, with the bevel of the needle facing upward;
- If **using a butterfly set**, a small amount of blood will flush back into the tubing when the vein is punctured. Do not push the needle in any further;
- If **using a cannula**: Once blood fills the hub of the cannula, withdraw the needle partially while continuing to push the cannula in;
- When the hub of the cannula reaches the skin at the puncture site, withdraw the needle completely;
- Have the assistant remove her/his finger and thumb from around the baby's limb (or remove the rubber band if a scalp vein was used).
- Connect the infusion set to the cannula or butterfly set;
- Ensure that there are no air bubbles in the infusion set;
- Infuse fluid into the vein for a few seconds to make sure that the vein has been successfully cannulated. The fluid should run freely, and there should be no swelling around the site of the cannula;
- If **swelling develops around the site of infusion**, withdraw the needle from the vein and repeat the procedure using a different vein.
- If **using a vein in the hand, arm, foot, or leg**, immobilize the limb (e.g. using an arm board [or splint] and adhesive strapping or thin paper tape) to minimize movement

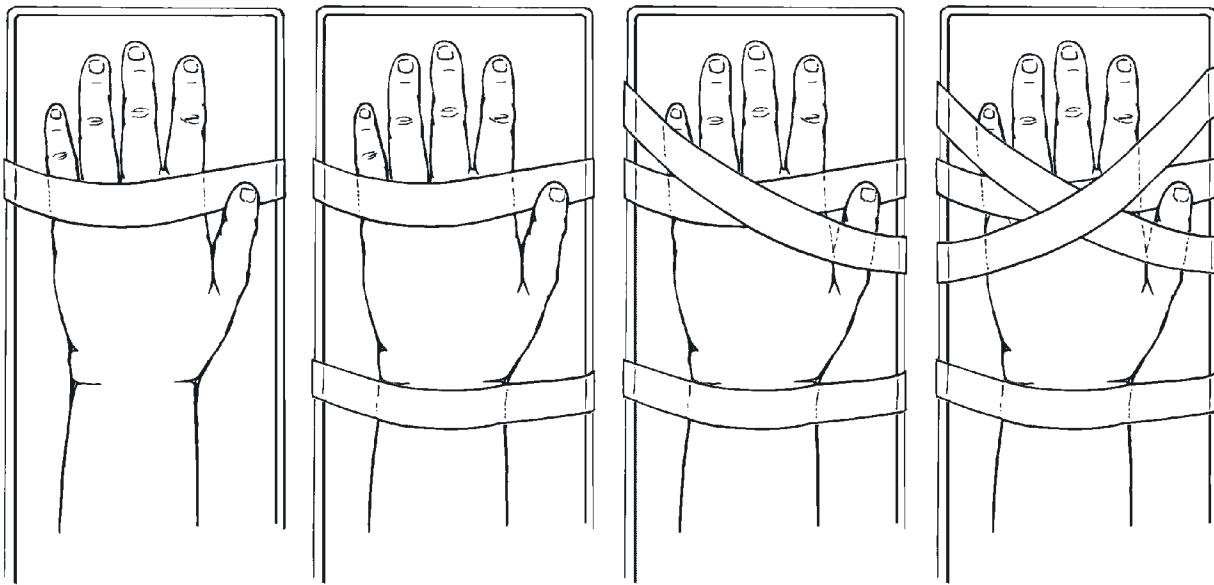


Figure 21:10: Immobilizing the hand

- Secure the cannula or butterfly set in position using strips of adhesive strapping or thin paper tape (e.g. **Fig. 10**). If **tincture of benzoin is available**, apply this to the skin before applying the adhesive strapping.

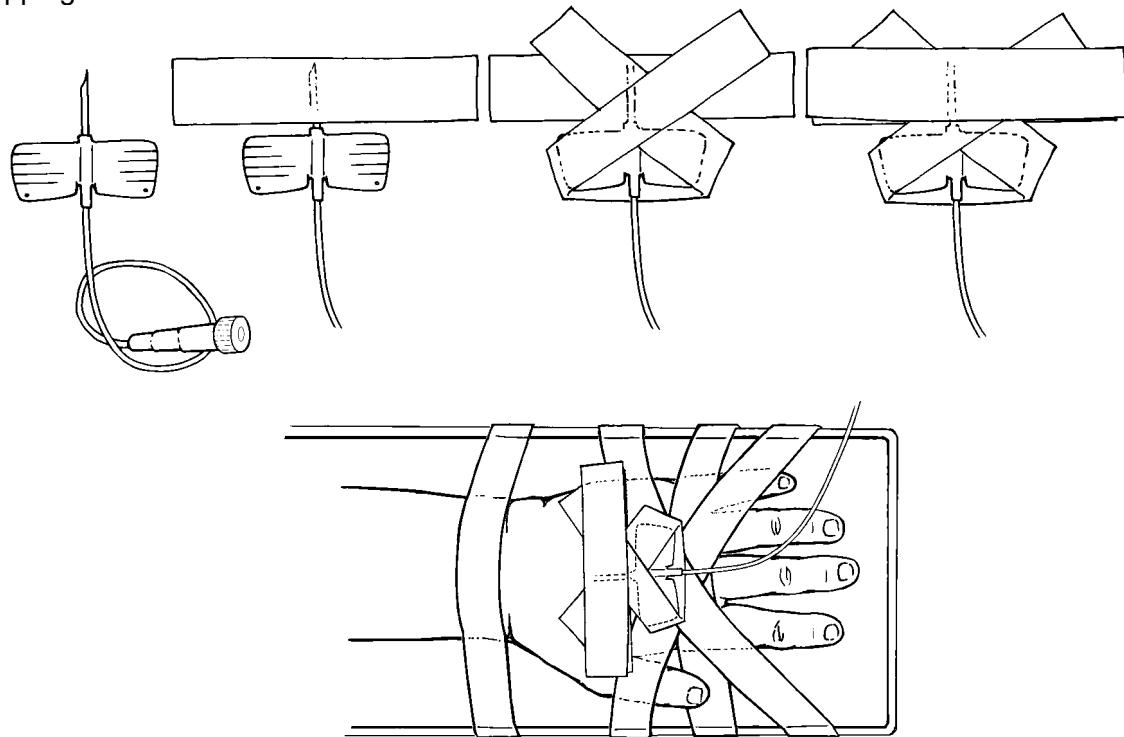


FIGURE 21:11 - Securing butterfly set in place

- Inspect the infusion site every hour:
- Look for redness and swelling around the insertion site of the cannula, which indicate that the cannula is not in the vein and fluid is leaking into the subcutaneous tissue. If **redness or swelling is seen at any time**, stop the infusion, remove the needle, and establish a new IV line in a different vein
- Check the volume of fluid infused and compare to the prescribed volume;

Solutions containing glucose can cause tissue to die and should not be allowed to leak into subcutaneous tissue.

- Change the IV infusion set and fluid bag every 24 hours; even if the bag still contains IV fluid, (they can be a major source of infection).

B. Umbilical Vein Catheter

An umbilical vein catheter is indicated only when the need for IV access is urgent but a peripheral IV line cannot be established quickly.

Equipment and supplies

- High-level disinfected or sterile umbilical catheter or ordinary gastric tube:
- If the baby weighs less than 1.5 kg, use a 3.5-F catheter
- If the baby weighs 1.5 kg or more, use a 5-F catheter
- Sterile infusion set with IV fluid (use a microdropper if one is available)
- Sterile 5- or 10-ml syringe
- Sterile drapes
- Sterile blade
- Cord tie or suture (to control bleeding)
- Sterile forceps
- Sterile suture, adhesive strapping, or thin paper tape (to secure catheter)

Procedure

- Prepare the solution to be infused.
- Prepare the umbilicus and surrounding skin by washing in an outward spiral motion with a swab or cotton-wool ball soaked in antiseptic solution. Repeat two more times, using a new swab or cotton-wool ball each time, and allow to dry.
- Remove examination gloves and put on high-level disinfected or sterile gloves.
- Fill the umbilical catheter with IV fluid using a closed syringe (i.e. with the plunger completely inside the barrel of the syringe) attached to the end of the catheter.

Ensure that air is not in the catheter and that a closed syringe is attached to the end of the catheter; a sudden deep breath by the baby just after the catheter has been inserted may result in an air embolus if air is inside the catheter.

- Place sterile drapes over the baby's body so that only the umbilical area is exposed.
- Place a cord tie or suture around the base of the umbilicus to control bleeding, and using a sterile blade, cut the cord to a length of 1 to 2 cm
- Identify the two umbilical arteries, which are thicker-walled and usually contracted, and the single umbilical vein, which usually has a wider opening and is found above the arteries (closer to the baby's head)

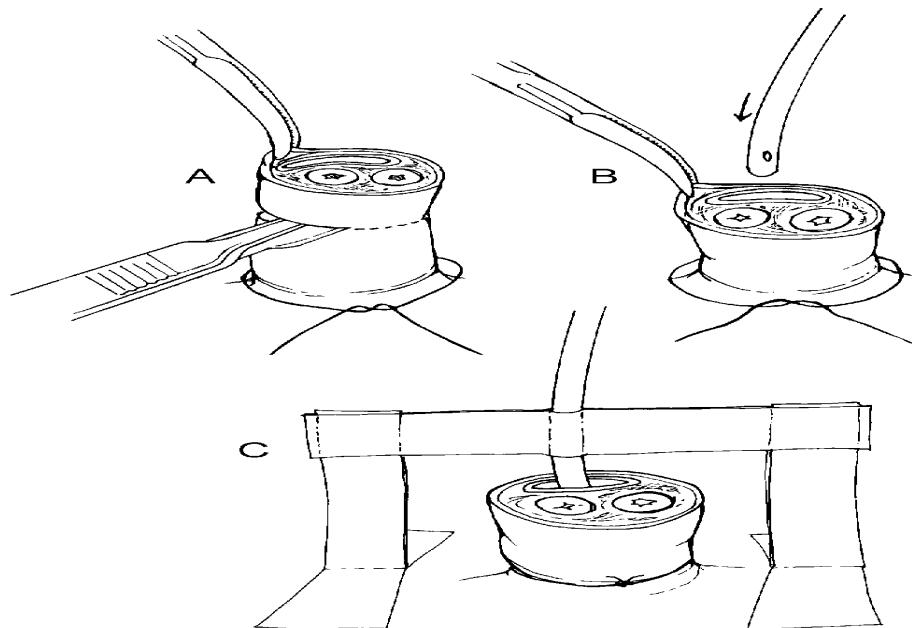


FIGURE 21:12 - Inserting an umbilical vein catheter

- Hold the catheter in one hand (applying gentle traction to the cord with forceps in the other hand, if necessary) and insert the catheter into the umbilical vein, guiding the catheter towards the head of the baby and to the baby's right side
- As the catheter is advanced, periodically apply gentle suction with the syringe until blood flows back. Once blood flows back freely through the catheter (usually after the catheter is inserted 4- 6 cm), do not advance the catheter any further.
- If **resistance is encountered while advancing the catheter**, especially in the first 2 to 3 cm, do not continue. Remove the catheter and try again.

Never force the umbilical catheter if resistance is encountered.

- Tie the cord tie or suture around the stump of the umbilicus to hold the catheter in place and prevent bleeding around the catheter or from one of the arteries.
- Remove the syringe and connect the infusion set to the catheter, ensuring that there are no air bubbles in the set.
- Secure the catheter with suture material or adhesive tape to prevent it from being dislodged.
- Inspect the infusion every hour:
- Look for redness and swelling around the umbilicus, which may indicate infection. If **redness or swelling is seen at any time**, stop the infusion and remove the umbilical vein catheter. Attempt to establish a peripheral IV line again, and treat for infection of the umbilicus
- Check the volume of fluid infused and compare to the prescribed volume;

Intraosseous Infusion

Establishing intravenous access in a newborn baby can be difficult. In an emergency, a good temporary alternative is the intraosseous route using the bone marrow cavity. Fluid and drugs can be given by this route.

Remove the intraosseous line as soon as other IV access is established (within eight hours, if possible). Do not place an intraosseous line if there is infection at the intended insertion site or if the bone is fractured. Because this procedure is only performed in an emergency, no anaesthetic is required.

Supplies

- Sterile intraosseous needle, bone marrow needle, or 22-gauge needle
- Sterile infusion set with IV fluid (use a microdropper if one is available)
- Adhesive strapping or thin paper tape
- Sterile 5-ml syringe
- Elastic bandage
- Padded splint

Procedure

- Prepare the solution to be infused, ensuring that the entire infusion set is filled with fluid and that there is no air in the infusion set.
- If **using a regular hypodermic needle**, attach a 5-ml syringe filled with 3 ml of IV fluid, and flush the fluid through the needle.
- Identify the insertion site (proximal end of tibia or distal end of femur): The site at the proximal end of the tibia is 1 cm below and 1 cm medial to the tibial tuberosity; the site at the distal end of the femur is 2 cm above the lateral condyle.
- Prepare the skin over the insertion site using a swab or cotton-wool ball soaked in antiseptic solution, and allow to dry.
- Position the baby's leg with the knee bent about 30 degrees and the heel resting on the table.
- Support the upper tibia with one hand, placed so that the hand is not directly behind the site of insertion.
- Hold the needle (with the attached syringe if using a hypodermic needle) in the other hand at a 90-degree angle to the selected insertion site, angled slightly towards the foot.
- Advance the needle using a firm, twisting motion and moderate, controlled force. Stop immediately when there is a sudden decrease in resistance to the needle, which indicates that the needle has entered the marrow cavity.
- Once the needle is properly positioned, remove the stylet (if a bone marrow or intraosseous needle was used) and attach the syringe.
- Aspirate using the syringe to confirm that the needle is correctly positioned. The aspirate should look like blood.
- Slowly inject 3 ml of IV fluid to check for proper placement of needle
- Look for swelling (indicating leaking of fluid under the skin) at the front of the leg or in the calf muscle at the back of the leg. If swelling is seen, remove the needle and try again;
- If it is **difficult to infuse the fluid but there is no swelling in the calf muscle**, the needle may have entered the posterior bone cortex. Withdraw the needle approximately 0.5 cm and cautiously inject IV fluid again.
- If **no problems are detected**, attach the infusion set to the needle

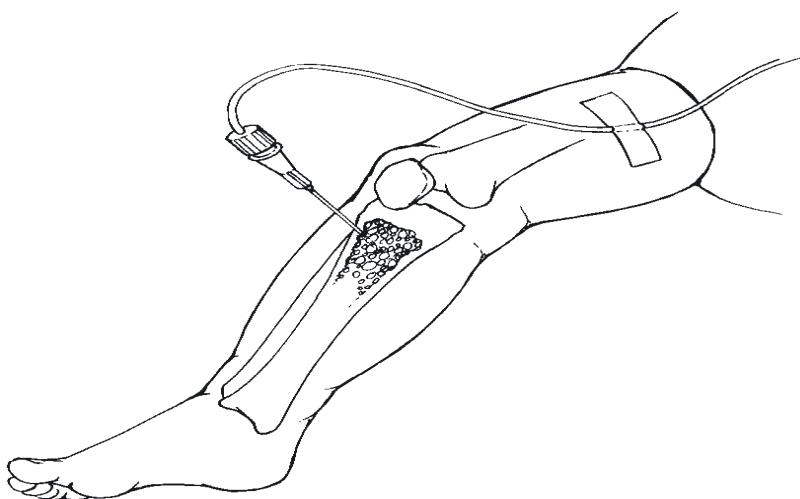


FIGURE 21:13- Intraosseous infusion

- Secure the needle in place using tape, and splint the leg as for a fractured femur, ensuring that the elastic bandage does not interfere with the needle or infusion set.
- Inspect the infusion site every hour:
- Look for redness and swelling around the insertion site of the cannula and in the baby's calf muscle, which indicate that the cannula is not in the vein and fluid is leaking into the subcutaneous tissue. If redness or swelling is seen at any time, stop the infusion, remove the needle, and attempt to establish a peripheral IV line again or establish a new intraosseous line at a different site;
- Check the volume of fluid infused and compare to the prescribed volume; flow rates may alter dramatically with changes in the position of the leg;
- Remove the intraosseous needle as soon as alternative IV access is available, and within eight hours, if possible.

Inserting Nasogastric Tube

A gastric tube may be inserted via one nostril or the mouth. Insert the tube via the nostril if the baby is breathing regularly, using the smallest (narrowest) tube available. Insert the tube via the mouth if the tube is needed for drainage of the stomach, for feeding a baby with breathing difficulty, or if only a relatively large tube is available.

Supplies

- Clean plastic tube or catheter appropriate for baby's weight:
 - o If the baby weighs less than 2 kg, use a 6-F tube
 - o If the baby weighs 2 kg or more, use an 8-F tube
- Writing pen or flexible tape measure
- 3- to 5-ml syringe (for aspiration)

Procedure

- Estimate the required length of tube:
 - o Hold the tube so that it mimics the route that it will follow once inserted (i.e. from the mouth or the tip of the nostril to the lower tip of the ear lobe and then to the stomach, half way between xiphoid sternum and umbilicus; and place a mark on the tube with a pen or a piece of strapping;
 - o Alternatively, estimate the distance using a flexible tape measure, and mark the distance on the tube with a pen or a piece of strapping.

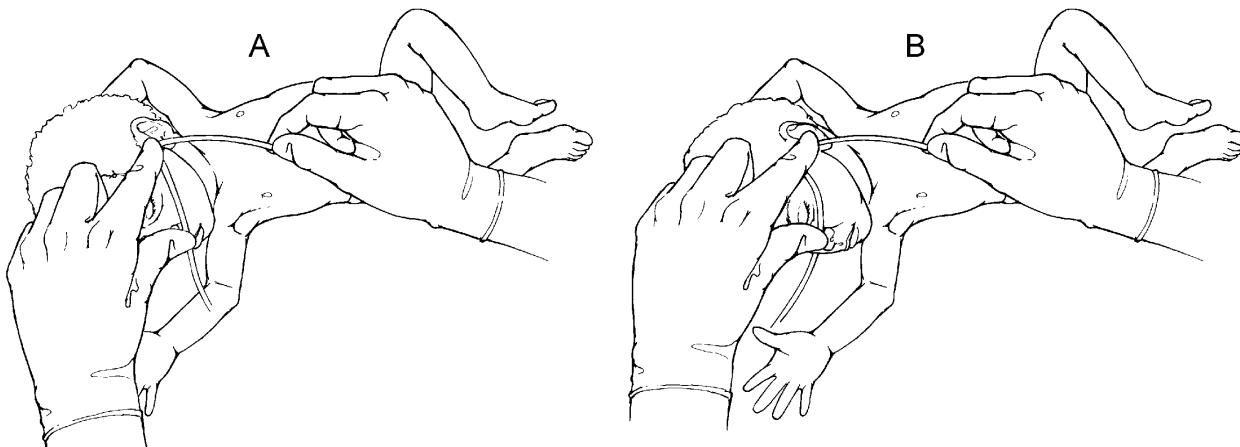


FIGURE 21:14- Measuring gastric tube for oral (A) and nasal (B) routes

- Flex the baby's neck slightly and gently pass the tube through the mouth or through one nostril to the required distance. If **using the nasal route**:

- If a patient is on oxygen, insert orogastric tube instead of nasogastric tube
- If the tube still does not slide easily into the nostril, use the oral route.

Never force the gastric tube into the nostril if resistance is encountered.



FIGURE 21:15- Inserting oral gastric tube

- Secure the tube in position with adhesive strapping:
 - If **tincture of benzoin is available**, apply this to the skin first before applying the adhesive strapping;
 - If a **nasogastric tube is used**, avoid pulling the tube taut against the nostril, as this may injure the skin.

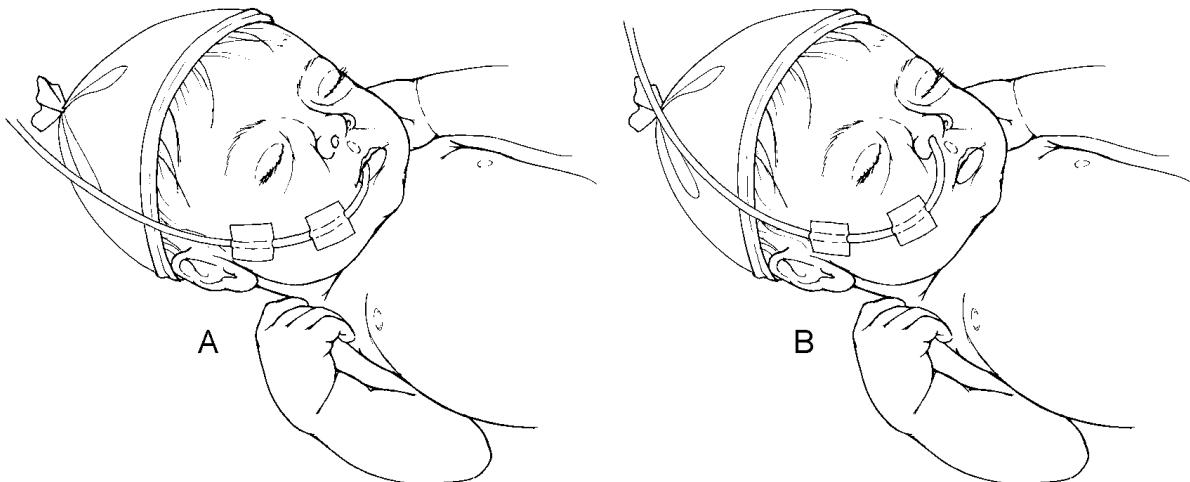


FIGURE 21:16- Securing oral (A) and nasal (B) gastric tube in place

Confirm proper placement of the tube:

- Fill a syringe with 1 to 2 ml of air and connect it to the end of the tube. Use a stethoscope to listen over the stomach as air is quickly injected into the tube:
 - If a **whistling sound is heard through the stethoscope as the air is injected**, the end of the tube is correctly positioned in the stomach;

- If a **whistling sound is not heard**, the tube is not properly positioned. Remove the tube and repeat the procedure.
- Alternatively, test the acidity of the aspirate:
 - Note that this method is only suitable for babies more than 24 hours old or small babies (less than 2.5 kg at birth or born before 37 weeks gestation) who are more than 48 hours old;
 - Use a syringe to aspirate some fluid, and place a drop of fluid onto a strip of blue litmus paper:
- Replace the tube with another clean gastric tube after three days, or earlier if it is pulled out or becomes blocked

Using A Gastric Tube For Feeding Or Drainage

- If the **gastric tube is inserted for the purpose of giving expressed breast milk**, see instructions for feeding
- If the **gastric tube is inserted for drainage**, leave the tube uncapped and wrap clean gauze around the end, fastened with tape, to keep the tube clean and to absorb the drainage from the stomach.

Performing a Lumbar Puncture

Lumbar puncture is used to confirm the diagnosis when the baby has signs suggestive of meningitis. Do not perform a lumbar puncture if the baby has spina bifida/meningomyocele

Supplies

- Spinal needle or intravenous needle (22- to 24-gauge)
- Appropriate collection tubes

Procedure

- Be prepared to resuscitate the baby using a bag and mask, if necessary.
- Place the baby under a radiant warmer, if possible, and undress the baby only when ready to perform the procedure.
- Position the baby:

place the baby on her/his side facing the assistant (most right-handed health care providers find it easiest if the baby is on her/his left side;

- Position the baby so that the baby's back is closest to the side of the table from which the lumbar puncture will be performed;
 - Have the assistant place one hand behind the baby's head and neck, and place the other hand behind the baby's thighs to hold the spine in a flexed position;
 - Ensure that the baby's neck is partially extended and not flexed towards the chest, which could obstruct the baby's airway.



FIGURE 21:17- Lying position for lumbar puncture

- Prepare the skin over the area of the lumbar spine and then the remainder of the back by washing in an outward spiral motion with a swab or cotton-wool ball soaked in antiseptic solution. Repeat two more times, using a new swab or cotton-wool ball each time, and allow to dry.
- Identify the site of the puncture between the third and fourth lumbar processes (i.e. on a line joining the iliac crests);



FIGURE 21:18 - Site of lumbar puncture

- Remove examination gloves and put on high-level disinfected or sterile gloves.
- Place sterile drapes over the baby's body so that only the puncture site is exposed.
- Insert the needle to the midline of the vertebrae, angled towards the baby's umbilicus.
- Slowly advance the needle to a depth of about 1 cm (or less if the baby is small [less than 2.5 kg at birth or born before 37 weeks gestation]). A slight "pop" may be felt as the needle enters the subarachnoid space.
- If **using a spinal needle**, remove the stylet
- If **bone is encountered**, the needle cannot be redirected. Pull the needle back to just beneath the skin and reinser the needle, directing it slightly upward while aiming for the baby's umbilicus.
- Collect the cerebrospinal fluid (CSF):
 - o Collect about 0.5 to 1 ml (about 6 to 10 drops) of CSF in each collection tube;
 - o If **CSF does not come out**, rotate the needle slightly;

- If **CSF still does not come out**, remove the needle and reinsert it between the fourth and fifth lumbar processes;
 - If **blood is seen in the CSF**, the needle probably went through the spinal canal and caused bleeding. If the **CSF does not clear**, collect enough CSF for culture and sensitivity only.
- After the CSF is collected, remove the needle.
- Have an assistant apply gentle pressure to the puncture site with a cotton wool ball until bleeding or leakage of fluid stops.
- Apply an adhesive bandage to the site.

Reference

1. MacDonald's Atlas of procedures in Neonatology, 2019
2. Jone P. Cloherty, Eric C., Anne R. Stark Manual of Neonatal Care 8th edition
3. Ethiopian CPAP training guideline

Chapter 28: Admission, Discharge, Re-admission and Follow-up after discharge

This chapter discusses key criteria that should be followed when sick neonates are admitted, re-admitted or discharged and those who require follow up at high-risk infant clinics.

At the end of this session, all participants will:

- State admission and discharge criteria
- Recall discharge recommendations
- Identify follow up needed for newborns

Admission Criteria

- Birth weight less than 1500g
- Gestational age less than 34 wks
- Hematologic problems: Hyperbilirubinemia, Blood group and RH incompatibility, anemia, polycythemia, bleeding disorders
- **Infection** - suspected or confirmed serious infection.
- **Respiratory problems**
 - (a) Apnea or cyanotic episodes
 - (b) Any respiratory distress.
 - (c) Requirement for ventilation
- **Gastrointestinal problems**
 - (a) Feeding problems severe enough to cause clinical concern
 - (b) Bile stained vomiting, or other signs suggesting bowel obstruction
- **Metabolic problems:**
 - a) Hypo/hyperglycemia
 - b) Hypocalcaemia/hypercalcemia
 - c) Hypo/hypernatremia
- **CNS problems**
 - (a) Convulsion
 - (b) Birth asphyxia
 - (c) Altered mentation
- **Malformations:** Congenital anomalies that may require immediate intervention
- **Cardiovascular:** Problems requiring monitoring or intervention
- Birth trauma: Subgaleal hemorrhage, cephalohematoma, bone fracture, etc.
- **Miscellaneous:** Any baby that is causing concern to such a degree that the attending doctor or nurse feels that the baby requires **observation or treatment**.
- **Social issues/terminal care:** Such babies ideally should be nursed in the ward. On occasions (after multidisciplinary consultation), circumstances dictate that these babies require a period of care.

Criteria for isolation

- All infants with neonatal tetanus, diarrhea, and infectious skin lesion.

Discharge Criteria

- They have no **danger** signs or signs of serious infection
- **Low birth weight infants** has to be **gaining weight (average weight gain of 15-20gm/kg/d)**
- Ability to take all feeding by cup or breast without respiratory compromise
- Baby should complete inpatient treatment
- The baby must be able to maintain his or her **temperature in the normal range (36 – 37°C) in an open cot.**
- The mother is confident and able to care for the infant
- **Parents must be willing and comfortable** to take the baby home and to have demonstrated that they have adequate skills to provide care at home
- Some basic information should be known about the **home environment**, if they are living in a remote area

Recommendations at discharge

- Hearing screening at discharge from the ward
- Eye examinations at 34 -37 weeks of gestational age.
- If possible, cranial ultrasonography (look for intraventricular hemorrhage for those <32 wk GA and <1500 g at 7-14 wks then repeat at 36-40 wks of postnatal age).
- Make sure the baby got the first immunization and subsequent vaccinations.
- Arrange an infant follow-up program and give a short appointment.
- Counsel parents before discharge about basic care, nutrition/exclusive breastfeeding, keeping the infant warm, sunlight exposure, recurrence rate of congenital anomalies, avoidance of malpractices and any danger sign for care seeking.

Neonatal Follow-up for neonates discharged from the NICU

The objective of neonatal follow-up program is to provide continuum of specialized medical management for neonates admitted, treated, and discharged from NICU. These includes-

- Very low birth weight babies
- Gastro esophageal Reflux disease
- Asphyxia (Hypoxic ischemic insult stage II and III)
- NEC – look for nutritional status, short bowel syndrome and intestinal stricture.
- Bronchopulmonary Dysplasia (BPD) [Oxygen required at 28 postnatal age].
- Neurologic abnormalities (Hydrocephalus, Hyperbilirubinemia, bilirubin encephalopathy, Microcephaly, Neonatal seizure, Meningitis, Intraventricular hemorrhage)
- Infant requiring special equipments (Oxygen, NG- tube feeding).
- Patient who had surgical intervention needs follow up by NICU team too.

Table 2: Follow-up schedule for neonates discharged from the NICU

Age	Type of evaluation
1st visit 7 – 10 days after discharge	To see how the child is adopting to the home environment
4 - 6 month of corrected age	Look for adequate catch-up growth and sever neurologic abnormalities
8 – 9 months of corrected age	Is the earliest and good time to confirm CP or other neurologic abnormalities
18 – 24 months	Most transient neurologic findings will resolve

	If not, refer them to specialty clinic Catch-up growth for head circumference is 12 months Catch-up growth for weight is 24 months
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During follow up, evaluate the following:-

- Growth and Nutrition need
- Neurologic assessment
- Evaluation of normal and atypical developmental pattern

Babies should be on exclusive breastfeeding for 6 months. When mother goes to work, she can express her breast milk and keep it in room temperature for 6 – 8 hrs, in refrigerator for 48 hrs but encourage the mother to keep the baby with her as much as possible.

Follow up for Preterm Newborns

- Measure growth rate for corrected age
 - o Weight, Head Circumference according to growth monitoring chart
- Consider cranial ultrasonography if possible for those less than 32 Wk of GA at 7 – 14 days of postnatal age. Repeat at 36 – 40 weeks of Post Menstrual Age (PMA) to see IVH.
- Start Iron, Vitamin and other micronutrients supplementation when full enteral feeds are established and follow hematocrit as indicated (for the dosage refer to the guideline on nutrition)
 - o 2 - 4 mg/kg if infant is feeding human milk.
 - o 2 mg /kg if infant feeding on formula milk
- Bronchopulmonary Dysplasia (BPD) Infant requiring supplemental oxygen at 28 days of life
- Retinopathy of prematurity
 - o Ophthalmologic examination to all infants < 1500gr or < 32 Wk GA
 - o Low-birth-weight infants should be followed up weekly for weighing and assessment of feeding and general health, until they have reached 3 kg

Look for Major Neurologic Sequelae

- CP (Spastic diplegia, quadriplegia, and Hemiplegia)
- Blindness, visual impairment or other oculomotor problems
- Deafness or hearing impairment
- Neonatal Seizure , Hydrocephalus, Craniosynostosis

Frequency of Follow up as follows unless there is an exceptional case

- Every two weeks for the 1st 4 weeks of life
- Every one month for the 1st 3 months of life
- Every two month for 3-6months
- Every 3 month till 12 months of age

References

- 1- Betty R. Voher Neonatal Follow up program in the new Millennium. American Academy of Pediatrics. September 29 2009.
- 2- Avory A. Fanaroff , Richard J. Martin . Neonatal Perinatal Medicine. 9th edition

Chapter 29: Parental counseling in neonatal intensive care unit

At the end of this session, the participants will:

- Demonstrate how to counsel parents of neonates in the ICU

Introduction

In neonatology, the patient is the infant, but the parent is the recipient of information. Most parents desire as much information as possible about their children's diseases and the concept of patient-centered care.

Unfortunately, the NICU is a complex clinical setting in which information and predictions vary and change rapidly: decisions are complex, and parents find the uncertainty difficult to cope with.

It is a good practice for parents to be present at the bedside during NICU rounds. This allows them to be updated daily and to become familiar with all team members. Ideally, delivery of 'bad-news' or discussion of complicated diagnoses and treatment options should be done in a quiet, private setting with suitable social support for the parents.

Providing family-centered end-of-life care to infants and their families in the NICU should be a component of optimal neonatal palliative care. If a child dies the family needs intense and long-term psychosocial support as well as cultural and spiritual comfort.

Personnel

- Most senior health professional taking care of the baby can be involved
- Involve the primary decision makers (Eg. Father/grandmother) along with the mother
- Involve the senior nurses whenever possible
- Involve social workers when required

When communicating with the family, remember the following

- 1- Introduce yourself and the team members at the first contact and imply anyone from the team could be doing the counseling.
- 2- Be respectful and understanding
- 3- Listen to the family's concern and reply their questions and express their emotions
- 4- Use simple and clear language when giving them information about the baby's condition, progress, and treatment.
- 5- Follow the best practices of counseling like ALPAC. Ask- what is already understood, Listen- to the family's thoughts , Praise- the family/ mother wherever possible, Advice –inform regarding the current status and instruct what the family could do, Check- for understanding
- 6- Respect the family's right to privacy and confidentiality during delivery of 'bad-news' or discussion of complicated diagnoses and treatment options with suitable social support for the parents.
- 7- Respect their cultural beliefs and customs and accommodate the family's needs as far as possible.
- 8- Ensure the family understands any instructions, and give written information to family members if possible. Some situations may require repeated discussion for a better understanding.
- 9- Obtain informed/written consent before performing procedures if possible.
- 10- Remember that health care providers may feel anger, guilt, sorrow, pain and frustration. Showing emotion is not a weakness.
- 11- Focus on positives but be realistic and honest
- 12- Avoid giving medical jargon Eg.drugs, Lab values etc unless specifically asked for
 - For babies with multi departmental problems, arrange for combined counseling.
- 13- Document the counseling for all the difficult cases with date and time. Trace families that DO NOT come for counseling

Parents of a baby who is dying or died

- 1- Allow the mother and the family to be with the baby even during the procedure, explain what is being done to the baby and why.
- 2- If the baby's death is an inevitable, focus on providing emotional support to the family. Provide compassionate and family-centered end-of-life care to infants and their families.
- 3- Involve 2 or more people and whenever feasible the primary doctor who has been earlier involved in counseling. Include a security person in aggressive cases especially during off duty hours
- 4- Must be done in counseling room with adequate privacy
- 5- The communication should be with plain language gently and empathically
- 6- Avoid apologetic statements and emphasize on efforts done to save the baby
- 7- Give enough time to internalize the information and stay with the family for some time

- 8- Encourage the mother and family to see and hold the baby after death and for as long as they desire, and ask the family how they will bury the baby.
- 9- It is also crucial that complete documentation be taken during end-of-life care.
- 10- Arrange to see the family after the death.
- 11- Counsel on autopsy when it is required

Discuss the further plan for the body based on family preferences involve in bereavement even after death.

Request for Left against medical advice (LAMA) counselling

- Understand the reason/s behind the decision- monetary/social/attitude/previous abnormal outcome/family issues/ perceived deterioration etc and counsel accordingly
- Emphasize the baby's point of view simultaneously offering help to the family
- Give examples of babies who have done well and try to involve supportive parents of those babies whenever possible.

References

1. C Samsel, BE Lechner. End-of-life care in a regional level IV neonatal intensive care unit after implementation of a palliative care initiative. Journal of perinatology, 2015
2. WHO, Managing Newborn Problems: a guide for doctors, nurses, and midwives

Chapter 30: Other patient monitoring formats and checklists

Normal values chart

When managing a neonate with a problem in the NICU you are expected to use the normal value charts annexed with this manual. It is critical that you stick to the figures and the recommended values to closely follow the prognosis of the sick neonate and avoid unwanted outcomes of the treatment and management applied on the newborn under care. There may be slightly different values presented in other documents and guideline. For use in Ethiopian facilities we advise you to stick to the annexed values.

For your quick reference you are advised that you print the normal value charts and posted them on the visible area on the wall in the NICU.

Patient care follow-up card

It is critical that sick neonates are closely followed up 24 hours a day, seven days a week and throughout their stay in the health facilities. Based on the specific diagnosis they have and their general conditions the level of follow up they may need may vary. Annexed with this manual there are some cards and checklists that you need to use for the daily and hourly monitoring of the sick neonates. The charts and checklists require that you regularly fill in patient information to ensure that the progress of the problem and the condition of the sick neonate at each point of contact is well recorded and there is complete information for the NICU care providers when they switch patients under care. It is important to understand that the next care provided to the sick neonate under care, and hence the outcome of the management is largely based on the recorded information on the card and checklists and all checklists and monitoring card should be completed and completed with accurate information.

Chapter 31: NICU Information Management System

The NICU service information will be collected and used to improve the quality of care provided and monitor program performance. At the initial phase NICU registration book will be provided to each health facility with NICU and service providers will be orientated on appropriate use of the registration book to ensure the service data are captured. Effort will be made to include selected critical NICU indicators in the national HMIS to ensure that NICU performance and quality are continuously tracked in the health facilities around the country.

NICU service and program data will be collected through routine supportive supervision of the health facilities with NICU and review meetings with NICU facilities and program managers. In addition, quality of the in-service training provided to NICU service providers will be tracked through pre-post training knowledge and skills texts. In the long run NICU indicators will be included in the national HMIS and routine reported by the health facilities.

List of NICU quality and performance indicators will be identified and database will be developed to continuously track the status of the indicators and provide feedback to the health facilities to improve quality and coverage of the NICU services. Service data will be collected during supportive supervision and through other mechanisms.

Evaluation of the NICU program performance, using qualitative and quantitative methods, in selected health facilities may be done by independent evaluators. The evaluation may focus on quality and effectiveness of the NICUs in terms of improving the survival and health of neonates in the NICU implementing health facilities.

The FMOH is committed to scale up NICU services in all hospitals in the country (Level I, II or III depending on the status of the hospital). There is also growing interest from health development partners to support health interventions that aim at improving the survival of newborns. It is critical that the initial phase of NICU implementation generate sound evidence on the program quality and effectiveness and capture real-life implementation challenges and measures taken to address them. The primary beneficiary of these evidences will be NICU facilities, FMOH/RHBs and NICU program partners. The evidence can also be shared with health development partners who have interest to improve the health and survival of newborns. Furthermore, from the evidence messages can be developed to communicate to mothers and caretakers/communities to ensure that newborns with problems are brought to the health facilities and receive appropriate care.

Chapter 32: Linkage of NICUs

NICU implementing hospitals in the country are at different status. Some of them are teaching hospitals with relatively better infrastructure, management and expertise. Others are less organized and may need intensive support to be able to provide standard care for neonates with problems. Creating a learning forum which enables poorly performing NICU facilities to share experiences from best performing facilities is one of the mechanisms that will be used to improve the quality of NICU services provided in health facilities. To realize this linkage will be created among NICU facilities with different capacities.

Some of the purposes of linking NICUs across the country include:

- Create experience sharing forum for the weakly performing NICU facilities to learn from the best performing NICUs
- Ensure senior pediatricians and neonatologists provide clinical mentorship and on the job training for NICU facilities with technical assistance and support need
- Ensure that best performing NICU providers are recognized and motivated

The strategies that will be followed to realize strong linkage among the NICU facilities will be through organizing regular review meetings, conducting regular need based clinical mentoring visit to NICU facilities and establishing NICU providers' association.

NICU facilities will meet at least once every quarter to review their performance, discuss the challenges they faced and the measures they have taken to address them. In the review meetings, in addition to the experiences shared among the NICU facilities in Ethiopia, new evidences and experiences form other countries with better NICU implementation experiences will be communicated.

Chapter 33: Principles of quality Improvement in the care of the neonates

Introduction

This chapter introduces the principles of quality improvement in the NICUs using the quality improvement principles. It has six steps and each step has its own objectives. The steps in the chapter includes :-

- 1. Step one Create quality improvement teams**
- 2. Step two Decide what to improve**
- 3. Step three Choose the barriers to overcome**
- 4. Step four Plan and test the change**
- 5. Step five determine of the change resulted in improvement**
- 6. Step six make the improvement the norm**

Health care providers want to give the best care possible to babies. Knowing the right thing to do is the first step. Having the skills to do the right thing is the next step. But, even when there is knowledge and skills, the care may not be the best it can be. By working together as a team, in the health facility and with families to make important changes that improve the care of babies.

Step one Create an improvement team

OBJECTIVES

- *Understand the advantages of working in a team to improve care***
- *Create an improvement team***

A team has greater power than a single person to make change.

- Team members add to the knowledge and experience of a single person.
- A team of people with different roles in the care of mothers and babies will more easily understand problems and develop solutions that work.
- Team members share the work needed to improve care.
- Teams also create the enthusiasm necessary to encourage others to change.
- A team can lead the rest of a facility's personnel in the improvement process.

Action	Tips & Techniques
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<p>Create an improvement team:</p> <ul style="list-style-type: none"> • Get support from facility leaders to create an improvement team. • Invite interested people who are involved with care of mothers and babies. • Consider inviting mothers or other family members. 	<p>A team can be any size, but:</p> <ul style="list-style-type: none"> • A team that is too small (less than 3 people) may not have enough creative ideas or time To get the work done. • A team that is too large (more than 10 or 12 people) may have trouble listening to all perspectives and making decisions.
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Team member	Role(i.e. leader, recorder, data analyzer)

Schedule for improvement team meetings:

Date	Time	Place

1. Step two Decide what to improve

OBJECTIVES

- Understand where gaps in quality can occur
- Identify gaps in quality
- Choose what to improve
- Perform a baseline assessment
- Write an aim statement

A good outcome depends upon **processes** of care being performed correctly and consistently. The processes of care depend upon **inputs**. Inputs are the resources necessary for delivery of health care. Lack of an essential input creates a **barrier** to the process of care. Inputs and barriers are further described in Step 3.

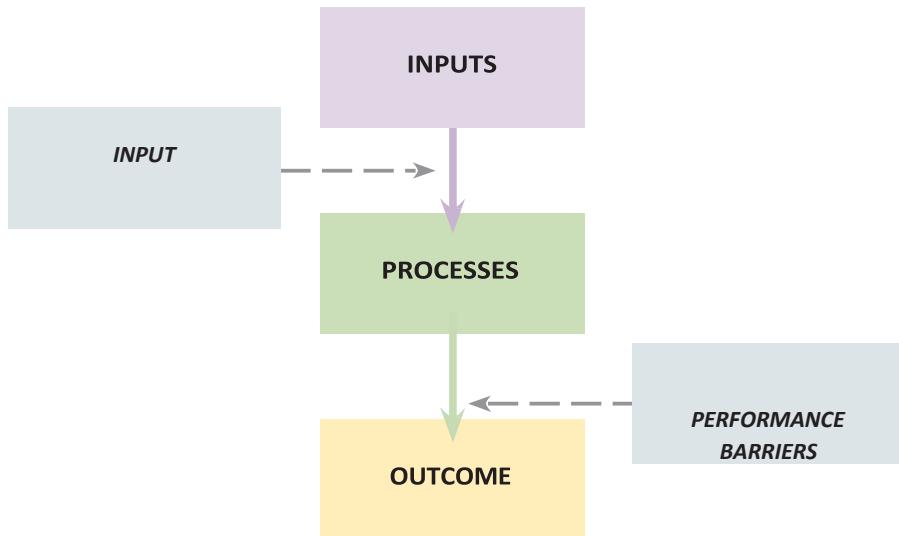


Figure 23:1

This figure illustrates how an outcome is affected by inputs, processes of care, and processes depend upon inputs. Inputs will be discussed in step 3.

Way to identify gaps in quality: Aim statements answer the questions:

- What? -the process or outcome to improve
- Who? -the patients affected

Choose what to improve

There may be a gap in the quality of more than one outcome. Even when only one outcome needs improvement, there may be many processes that affect that outcome. It is usually best to improve only one outcome or one process at a time, and the team will need away to choose one.

Several factors influence the choice of what to improve, including:

- The **importance** of the outcome or process
 - How important is the outcome or process to families or the health authority?
- The **expected amount** of improvement
 - How much improvement is expected from a change in care?
- The **impact** of the improvement
 - How many mothers or babies experience the outcome or receive the process of care?

Priority setting

Once the assessment is conducted, the unmet score of the standard performance are identified as gaps.

Priorities are set by selecting prioritization criteria. Common criteria for this type of priority setting are listed in Table below

Table: 23:2Priority setting

CRITERIA	CRITERIA DESCRIPTION
<i>Urgency of solving the problem</i>	<i>Is it one of the ten interventions that will decrease morbidity or mortality of mothers and newborns? Or does it pose a high risk for creating a negative impact on the woman or newborn?</i>
<i>Effectiveness</i>	<i>How sure are we that the intervention will work?</i>
<i>Cost</i>	<i>Is it affordable within existing resources?</i>
<i>Feasibility</i>	<i>Are systems in place to support this intervention? Is it realistic?</i>
<i>Cultural acceptability</i>	<i>Will community and clients respond favorably?</i>
<i>Within control</i>	<i>Does this group have the authority to implement this solution? (Often teams identify staff shortages and propose that the MOH obtain more staff — this is an example of a solution that is not within the control of the team.)</i>

Source: EMEN quality improvement Guide for Health facility Staff, UNICEF

Perform a baseline assessment

A baseline assessment describes the gap in quality, including the size of the gap before the team begins activities to improve care. A baseline assessment count show often the outcome occurs or how often the process is being performed correctly and consistently.

To define how often the outcome occurs:

- Review facility statistics.

- Review medical records.

Write an aim statement

An improvement team defines its goals by writing an aim statement. An aim statement describes the improvement goal clearly and in a way that can be measured. The aim statement is the first step in planning changes for improvement.

An aim statement answers the questions *what, who, how much and by when*.

- **What**—identifies the outcome or process that needs improvement.
- **Who**—identifies the persons who will be affected.
- **How much**—describes the change from baseline to the desired result.
- **By when**—indicates a time frame for change.

Guiding Quality Improvement: Using the 5-S quality method for change in working environment
In implementing changes, give priority for quick fix. Start with approaches that bring fast change.

Sorting through the contents of the workplace and removing unnecessary items. This is an action to identify and eliminate all unnecessary items from the workplace.

Systematize by putting every necessary item in good order, and focuses on efficient and effective storage methods. When items are not put in the same place, time is wasted searching for them, and errors can be made, e.g. medications.

Sweep, involves keeping everything clean and using cleaning to inspect the workplace and equipment for defects. This is an action to clean the workplace daily. “Cleanliness is next to Godliness.”

Standardize, involves keeping the workplace organized, orderly and clean. Standardizing in a health facility includes standardizing sets of equipment, e.g., medication and emergency trolleys, so that staff can easily access items regardless of which unit they are working in.

Self-Discipline, involves training and discipline to ensure that everyone follows the 5-S steps. Through periodic involvement of facility management to check that the first four S's are being implemented and leaders encourage staff to keep it up by recognizing improvements

Sample of register

DELIVERY REGISTER

Name	Date of Birth	Time of Birth	Delivery Route	Oxytocin	Post-partum Blood Loss	Apgars 1,5 min	Wt	Temp	Vit K	Discharge Date	Baby Disposition	Notes
M.Saidou	15-06	00:45	Vag	✓	250	8,9	3400	35.4	✓	15-06	Home	
C.Bidi	15-06	06:30	C/S	✓	450	7,8	2400	34.5	✓	17-06	Home	
A.Bacar	15-06	14:30	Vag	✓	200	8,9	2350	35.2		16-06	Home	
S.Rashad	16-06	09:20	Vag	✓	200	6,8	3310	36.8	✓	17-06	Home	
Z.Saloy	16-06	17:50	Vag		350	6,8	2670	37.1	✓	17-06	Home	
H.Alai	17-06	02:42	Vag		750	5,7	2740	37.9	✓	19-06	Referred	
C.Sidi	18-06	08:16	Vag	✓	150	8,9	2851	36.8		19-06	Home	
R.Abow	18-06	12:25	Vag		400	8,9	2780	37.1	✓	19-06	Home	
B.Resava	18-06	13:11	Vag	✓	300	7,8	3500	34.4	✓	20-06	Referred	
Z.Halifa	19-06	11:13	Vag	✓	200	9,9	3215	35.2	✓	20-06	Home	
B.Bayau	20-06	04:07	Vag		750	7,8	2720	37.8		20-06	Home	
M.Sedah	20-06	11:48	Vag		150	7,8	1900	34.2		20-06	Died	mother died
D.Djibril	21-06	07:38	Vag		350	8,9	2995	36.8		21-06	Home	
S.Bintou	21-06	14:26	Vag		1000	7,8	3620	36.4		22-06	Home	
S.Beraca	21-06	21:15	C/S	✓	250	8,9	2780	36.7	✓	22-06	Home	
M.Banou	22-06	18:20	Vag	✓	200	8,9	2618	35.8	✓	23-06	Home	
R.Yaayou	22-06	22:10	Vag	✓	250	8,9	2651	37.8	✓	24-06	Home	

Step three Choose the barriers to over come

OBJECTIVES

- **Understand common reasons for gaps in the quality of care**
- **Identify barriers to the process or outcome chosen for improvement**
- **Select the barrier(s)to over come**

IN PUTBARRIERS:

The following are the in put barriers that needed to be fixed

- **Lack of knowledgeand skills**
- **Staffing shortage**
- **Insufficient supplies**
- **Un favourable infrastructure**
- **Inadequate financial resources**
- **Traditions and cultural beliefs that interfere with recommended care**

Even when essential inputs are available, a gap may occur because of barriers to the correct and consistent performance of the process.

Performance barriers

- ***Poorly organized processes***
- ***Misaligned incentives***
- ***Challenges with leadership and management***
- ***Providers' convenience***

2. Step four Plan and test change

OBJECTIVES

- ***Identify and select changes that may improve care***
- ***Develop a plan for change***
- ***Test the changes in the plan***

Table-23:3 Consider the following to over come input barriers:

INPUTBARRIERS	EXAMPLES OF CHANGES
Lack of knowledge and skills	Ensure that correct guidelines for practice exist and educate staff about these guidelines. Develop a system for frequent real or simulated practice of the skill by all providers.
Staffing shortage	It may not be possible to hire additional personnel. The change may involve redistributing tasks or combining responsibilities so that processes of care can be performed correctly and consistently.
Insufficient supplies	If a lack of supplies is due to improper purchases or poor distribution, the change may involve working with the persons responsible for managing the supplies to: <ul style="list-style-type: none"> • Seek out fairly priced equipment and supplies • Explore collaborative large-volume purchasing • Educate persons who purchase supplies about the type and number of items needed
Un favourable infrastructure	Large changes, such as new buildings, may be beyond the resources of the facility. Smaller changes and routine maintenance of equipment and structures..
Inadequate financial resources	Finding new funds can be difficult, but gathering data describing the need may be the first step to get new funds or redistribute the existing funds.
Traditions and cultural beliefs that interfere with recommended care	Overcoming barriers from traditions and cultural beliefs may mean involving persons in the community who influence community beliefs (e.g. a village elder or experienced mothers in the community).

When developing a plan for change to improve care, consider the following five points

/

- **What actions** to take
- **Who** is responsible for completing each of the actions
- **Where** the action stake place
- **When** the plan begins and ends
- **What resources** are necessary to execute the change

Develop plan for change

Quality Improvement (QI) teams at their respective facilities shall bring change and collecting real time data for improvement and using data for decision making.

Collecting real time data and using data for decision making case helps to improve service quality on time. When monitoring data in real time, it's also quicker and more convenient for administrators to detect shady activity as it happens and put a stop to it before any real damage is done. Dash Board helps to rapidly monitor what's going on. It is very important to have a dashboard of agreed quality improvement indicators that can be accessed and active measures can be taken base on time

3. Step 5 Determine if the change resulted in improvement

OBJECTIVES

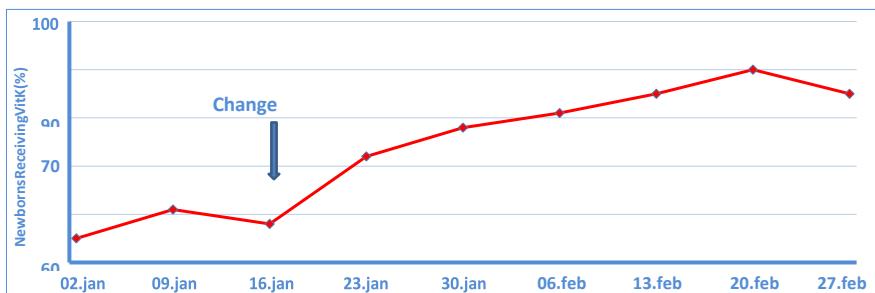
- **Determine if the actions in the change have occurred**
- **Determine if the change produced improvement**
- **Decide on next steps**
- **Start the next cycle of improvement**

Determine if the change produced improvement

To determine if improvement occurred, consider the following:

- 1) ***Determine if there is an improvement in the performance of the process or outcome after the change.***

2) Display the data in a chart or graph to determine if change has occurred.



EXAMPLE:

This run chart shows the percentage of babies treated with vitamin K on the vertical axis and weeks on the horizontal axis (Figure 5.1).

Figure 23.2: Percentage of newborns receiving vitamin K during January and February (the blue arrow indicates when the change for improvement occurred).

Analyze the run chart.

- First, examine the chart to determine if there is a difference after the large-scale test of change started.
 - Compare points on the chart before and after the change started. Marking the time of the change on the chart helps.
- If there appears to be improvement, examine the chart to determine if the improvement is real or random variability.
 - Random variability means that movements of the line up or down are the result of random chance and not the result of changes made by the team.
 - Statistical methods can be used to determine whether there has been real improvement or random variability.
 - There are also easy ways to confirm if the change resulted in real improvement, such as by identifying shifts and trends.

Shift(Figure23:3):

- Improvement can be demonstrated by a shift in the line on the run chart. A shift occurs when a line consists of 6 or more consecutive data points that are all located above or below the median.
- The median is the number separating the higher half and the lower half of a set of data points.
- The blue arrow indicates the time that the change occurred.
- Before the change, 55, 61 and 58 percent of newborns received vitamin K. The team arranges the numbers from low to high and find that the median is 58. They show the median by drawing black dashes on the run chart.
- After the change, there are 6 consecutive data points above the median, representing a shift in the percentage of infants receiving vitamin K.
- This indicates that the improvement was real, and not random variability.

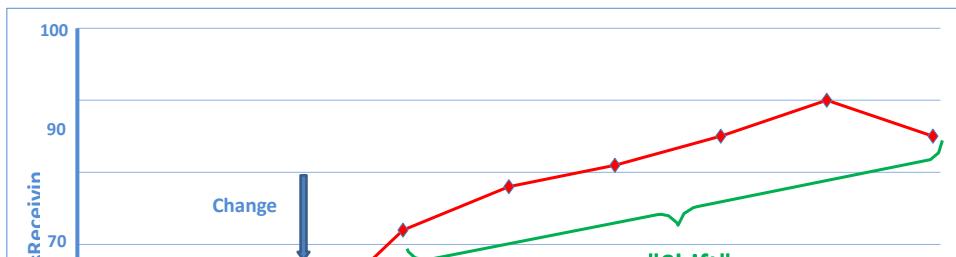


Figure 23.3 Improvement in the percentage of newborns receiving vitamin K demonstrated by shift.

Trend (Figure 23.4):

- A trend on the run chart is when five or more consecutive points all go up. A trend shows real improvement.
- In Figure 5.3, there are 5 consecutive data points all going up compared to the previous point.
- This indicates a trend and confirms that improvement has occurred.

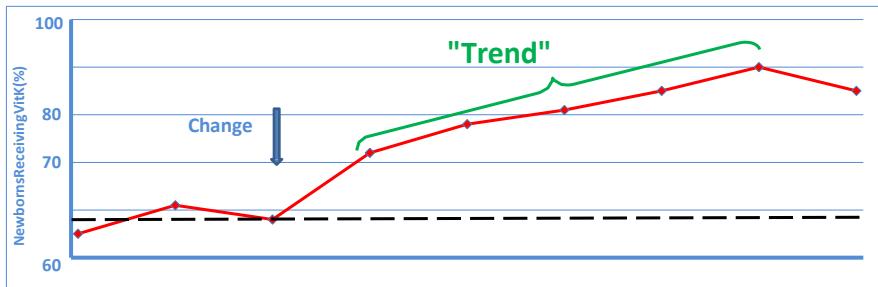


Figure 23.4: Improvement in the percentage of newborns receiving vitamin K demonstrated by trend.

Decide on next steps

Consider whether to adopt, adapt or abandon the change.

- If the change resulted in improvement, the team may **adopt** the change, and implement the change on an even larger scale. For example, the team may include more health providers, more units in the hospital, or more days of the week.
- If the change did not result in improvement, the team may decide to **adapt** the change. Adapting the change may be necessary if the actions in the plan did not occur as expected, or the improvement was small.
- **Abandon** the change if no improvement or an undesirable result occurred. Sometimes changes in one practice may have negative effects on other processes or outcomes, and the change may need to be abandoned.

Start the next cycle of improvement

The desired improvement in a process or outcome might be achieved with a single change, but it is more likely that improvement will not reach the goal of the aim statement with only one change. This is true more often when an outcome is chosen for improvement.

Reasons for less than desired improvement include:

- The process or outcome is affected by more than one barrier, and only one barrier has been overcome.
- Change is adopted by some, but not all providers.

The activities related to each change (planning, testing, determining the effect of change and deciding on next steps) are often called a “cycle of change”(Figure 5.4) or PDSA cycle (Plan Do Study Act cycle).

- After each cycle, decide whether the change should be adopted, adapted or abandoned.
- If a small change results in improvement, consider scaling up this change.
- If the team decides to adapt a change, begin a new cycle with the adapted change.
- If the change is abandoned, consider new ideas for change and begin the new cycle with a new change. Follow the steps outlined in Step 4 (plan and test change) for each cycle.

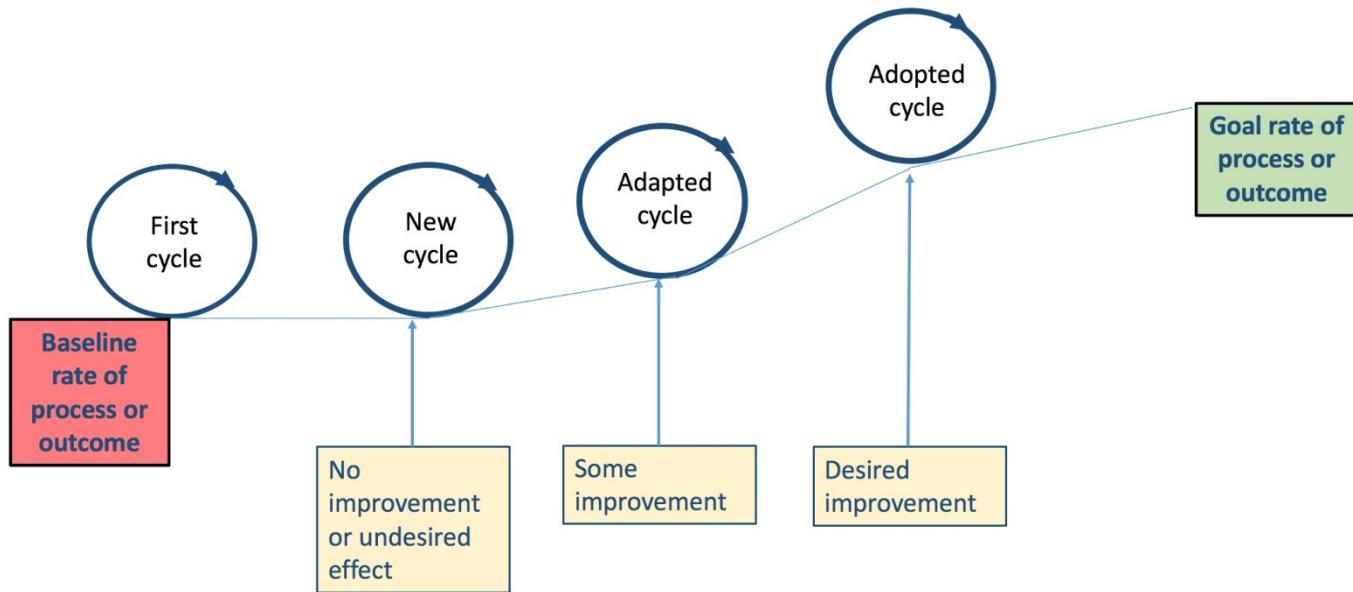


Figure 23.5: The figure illustrates how a team might use four cycles of change to achieve the goal of their aim statement

4. Step 6 Make improvement the norm

OBJECTIVES

- Communicate changes that resulted in improvement
- Facilitate practice of changes
- Overcome objection to change
- Make an improvement a permanent part of a facility's routine

Communicate changes that resulted in improvement

Share what has been learned about changes that resulted in improvement with all providers, clinical leadership, administrators and the community.

- Providers need to understand what is changing and how the change benefits their patients and themselves.
- Display run charts where they can be viewed by all providers to show the progress being made.
- Sharing positive results can help future change.
- Discuss the results and describe how change will be expanded at staff meetings and in written messages.
- Share the results with mothers, families and the community.
- Members of the improvement team from the community can help design posters for clinics and wards, and carry the message to groups outside the facility.

Summary

Health care providers want to give the best care possible to babies. Knowing the right thing to do is the first step. Having the skills to do the right thing is the next step. But, even when there is knowledge and skills, the care may not be the best it can be. Sometimes this happens when resources are lacking, but even then, care can be improved by using available resources creatively. By working together as a team, in the health facility and with families to make important changes that improve the care of babies.

Reference

1. The Quality Improvement Workbook, ©2016 by American Academy of Pediatrics and University Research Co., LLC

Annexes

APPENDIX 1. Normal Hematologic Values: First Two Weeks of Life in the Term Infant.

Value	Cord Blood	Day 1	Day 3	Day 7	Day 14
Hb (gm/100ml)	16.8	18.4	17.8	17.0	16.8
Hematocrit (%)	53.0	58.0	55.0	54.0	52.0
Red cells (cu.mm. x 10 ⁶)	5.25	5.8	5.6	5.2	5.1
MCV (m ³)	107	108	99.0	98.0	96.0
MCH (yy)	34	35	33	32.5	31.5
MCHC (%)	31.7	32.5	33	33	33
Reticulocytes (%)	3-7	3-7	1-3	0-1	0-1
RBC (cu.mm.)	500	200	0-5	0	0
Platelets (1000's/cu.mm.)	290	192	213	248	252

APPENDIX 2. The White Blood Cell and the Differential Count: First Two Weeks of Life

Age	Leukocytes	Neutrophil			Eosinophils	Basophiles	Lymphocytes	Monocytes
		Total	Seg	Band				
Birth								
Mean	18.100	11,000	9,400	1,600	400	100	5,500	1,050
Range	9.0-30.0	6.0-26			20-850	0-640	2.0-11.0	0.4-3.1
Mean %	-	61	52	9	2.2	0.6	31	5.8
7 Days								
Mean	12,200	5,500	4,700	830	500	50	5,000	1,100
Range	5.0-21.0	1.5-10.0			70-1100	0-250	2.0-17.0	0.3-2.7
Mean %	-	45	39	6	4.1	0.4	41	9.1
14 Days								
Mean	11,400	4,500	3,900	630	350	50	5,500	1,000
Range	5.0-20.0	1.0-0.5			70-1000	0-230	2.0-17.0	0.2-2.4
Mean %	-	40	34	5.5	3.1	0.4	48	8.8

APPENDIX 3. Hematologic Values in Low Birth weight Neonates

Determination	1-3 Days	4-7 Days	2 Weeks	4 Weeks	6 Weeks	8 Weeks
Birth weight less than 1200g						
Hemoglobin	15.6	16.4	15.5	11.3	8.5	7.8
Reticulocytes as % of RBC	8.4	3.9	1.9	4.1	5.4	6.1
Platelets	148,000 ± 61,000	163,000 ± 69,000	162,000	158,000	210,000	212,000
Leukocytes	14,800 ± 10,200	12,200 ± 7,000	15,800	13,200	10,800	9,900

Segmented Neutrophils	46	32	41	28	23	23
Band Neutrophils	10.7	9.7	8.0	5.9	5.8	4.4
Juvenile Neutrophils	2.0	3.9	5.3	3.6	2.6	2.0
Lymphocytes	32	43	39	55	61	65
Monocytes	5	7	5	4	6	3
Eosinophils	0.4	6.2	1.0	3.7	2.0	3.8
Nucleated RBC as % of total RBC	16.7	1.1	0.1	1.0	2.7	2.0
Birth weight 1200-1500g						
Hemoglobin	20.0	18.0	17.1	12.0	9.1	8.3
Reticulocytes as % of RBC	2.7	1.2	0.9	1.0	2.2	2.7
Platelets	151,000 ± 35,000	134,000 ± 49,000	153,000	189,000	212,000	244,000
Leukocytes	10,800 ± 4,000	8,900 ± 2,900	14,300	11,000	10,500	9,100
Segmented Neutrophils	47	31	33	26	20	25
Band Neutrophils	11.9	10.5	5.9	3.0	1.4	2.1
Juvenile Neutrophils	5.1	2.4	2.7	1.8	1.7	1.6
Lymphocytes	34	48	52	59	69	64
Monocytes	3	6	3	4	5	5
Eosinophils	1.3	2.2	2.5	5.1	2.6	2.3
Nucleated RBC as % of total RBC	19.8	0.8	0	0.4	1.4	1.0
Hemoglobin	20.0	18.0	17.1	12.0	9.1	8.3
Reticulocytes as % of RBC	2.7	1.2	0.9	1.0	2.2	2.7

APPENDIX 4. SILVERMAN ANDERSON ASSESSMENT OF RESPIRATORY DISTRESS

Signs	0	1	2
Thoraco-abdominal movement	Rhythmic and regular	Immobile thorax movement in abdomen	Thorax and abdomen in up and down
Intercostals retraction	Absent	Discrete	Accentuated and constant
Xiphoid retraction	Absent	Discrete	Very marked
Flaring of alanasi	Absent	With closed mouth	Very marked with open mouth
Grunting	Absent	Mild and inconstant	Constant and accentuated

Scoring:

- 0 – 3 ----- Mild , 4 – 6 -----Moderate , >6 -----Sever

APPENDIX 5. PARKIN METHOD OF CLINICAL ASSESSMENT OF GA

External sign	0	1	2	3	4
Skin color	Dark red	Uniform red	Pink pale variable over the body	Pale only pink over the ear palms and sole	
Skin texture	Very fine gelatinous	Fine and smooth	Smooth medium thickness skin rash peeling	Mild thickness skin with peeling hand and feet	Thick like parchment

Breast	No breast tissue	Breast tissue in one or both sides <0.5 cm of the diameter	Breast tissue in one or both sides 0.5-1cm of the diameter	Breast tissue in one or both sides >1 cm of the diameter	
ear	Smooth early folded doesn't turn back	Smooth easily folded returns back slowly	Cartilage over the top smooth returns fast	Firm ear returns very fast	

Point	1	2	3	4	5	6	7	8	9	10	11	12
GA	30.6	31.7	32.8	33.9	35.1	36.2	37.3	38.4	39.4	40.6	41.7	42.8

APPENDIX 6. BLOOD PRESSURE MEASUREMENT TABLE

Weight in Kg		Gestational Age				
		28	30	32	34	36
1		35-45	36-46	37-47	38-48	39-49
1-2		37-47	38-48	39-49	40-50	41-51
1-4		39-49	40-50	41-51	42-52	43-53
1-6		41-50	41-51	42-52	43-53	44-54
1-8		42-52	43-53	44-54	45-55	46-56
2		43-53	44-54	46-56	47-57	48-58
2-2		45-55	46-56	47-57	48-58	49-59
2-4		47-57	48-58	49-59	50-60	51-61
2-6		48-58	49-59	50-60	51-65	52-62
2-8		50-60	51-61	52-62	53-63	54-64
		8-18hs	19-32hs	33-54hs	55-96hs	97-124hs
		+2	+4	+6	+8	+10

APPENDIX 7. APGAR SCORE ASSESSMENT

Apgar score		If at 1 st minute <6 assess at 5 th minute			1 st minute	5 th minute	10 th minute	20 th minute
		0	1	2				
Heart rate	Absent	<100/min	>100/min					
Respiratory effort	Absent	Slow, irregular	Good, crying					
Muscle tone	flaccid	some flexion of extremities	active motion					
Reflex irritability	no response	Grimace (slight response)	vigorous cry, cough, sneezing etc					
Color	Blue, pale	Pink body, extremities blue	Completely pink					
Score:			Total					

<ul style="list-style-type: none"> • 0-3: Severely depressed (URGENT RESUSCITATION) • 4-6 : Moderately depressed • -10: Good condition 					
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APPENDIX 8. COMPOSITION OF BREAST MILK AND DAILY REQUIREMENT

Status at delivery	Composition	Post delivery days				
		3	7	14	21	28
Pre term	Calorie	0.51kcal/ml	0.67	0.72	0.65	0.70
	Protein	0.032gm/ml	0.024	0.021	0.018	0.018
Term	Calorie	0.48	0.60	0.64	0.68	0.69
	Protein	0.022	0.18	0.015	0.015	0.014

PROTEIN requirement /24 hrs

- In the first week → 1-3 gm/dl/24hrs
- After 7 days → up to 6 gm/dl/24hrs preterm every 2 hrs- Time of feeding

CALORIES requirement/24 hrs

- In the first week → 120kcal/24hrs
- After 7 days → up to 160kcal/24hrs

Time of feeding

- Preterm every 2 hrs
- Term every 3 hrs

Example of daily requirement for 28 days old and 4.2Kg

- CALORIE = TBM X 0.7 X 8 x 4.2 kg
60ml x 0.7 x 8 x 4.2 = 80kcal/day; which is low. So we have to increase it by 10 to 20ml/day/kg according to their GA and post natal age
- PROTEIN = TBM X 0.018 X 8 x 4.2kgm.
60ml x 0.018 x 8 x 4.2 = 2gms /dl/day. This is also low and we have to increase the amount.

APPENDIX 9. NORMAL ECG PARAMETERS

Age in days		Rate	QRS axis	PR (ms)	PII (mV)	R V1 (mV)	R V5 (mV)	R V6 (mV)	S V1 (mV)
0-1	95%	150	+185	140	0.25	2.35	1.8	1.0	1.8
	50%	120	+135	105	0.16	1.3	1.0	0.4	0.8
	5%	100	+90	82	0.07	0.7	0.3	0.1	0.1
1-3	95%	150	+185	132	0.25	2.4	1.9	1.0	1.8
	50%	120	+135	105	0.16	1.5	1.1	0.4	0.8
	5%	100	+90	85	0.05	0.7	0.4	0.1	0.1
3-7	95%	160	+180	130	0.27	2.1	1.9	1.1	1.5
	50%	125	+135	103	0.17	1.25	1.3	0.5	0.7
	5%	100	+90	80	0.08	0.5	0.5	0.15	0.1
7-30	95%	175	+150	128	0.28	1.7	2.1	1.3	1.0
	50%	145	+110	100	0.18	1.0	1.4	0.5	0.4
	5%	110	+75	75	0.08	0.4	0.6	0.25	0.1

- Values relate to term neonates.
- At a paper speed of 25 mm/sec, 1 mm=0.04 sec (one small square)

5 mm=0.2 sec (one large square)

- Rate ----Divide 300 by the number of big squares between 2 R-R complexes

APPENDIX 10. GUIDELINE TO START ORAL FEEDING

Weight (gm)	INTERVAL	STARTING (ml/kg/d)	INCREMENT (ml/kg/d)	MAXIMUM (ml/kg/d)
<750	Every 2 hrs	10	15	150
750 – 1000	Every 2 hrs	10	15 - 20	150
1001 – 1250	Every 2 hrs	10	20	150
1251 – 1500	Every 3 hrs	30	20	150
1501 – 1800	Every 3 hrs	30	30	150
1801 – 2500	Every 3 hrs	40	40	165
>2500	Every 3 hrs	50	50	180

Neonatal daily Progress Monitoring Sheet

Name of the Neonate _____ Age in Weeks _____
 Diagnosis _____ Card Number _____ Date _____

D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	
D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	
D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	
D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	
D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	
D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	
D	V/Sign	Condition	I/V Therapy	Feeding	Output	Air Way	Lab	Remark
D	T	Imp.	F	NPO	Urine	N	BGF	
	RR	N/imp.	AB	EBF	stool	DO2	HCT	
	AHB	D/charge	B/P	FF	G/con	CPAP	RBS	
	Kg	Dead	O	O	O	O	BIL	

	T				Imp.		F				NPO				Urine			N		BGF		
RR					N/imp.		AB				EBF				stool			DO2		HCT		
AHB					D/charge		B/P				FF				G/con			CPAP		RBS		
Kg					Dead		O				O				O			O		BIL		

University of Gondar INFANT FEEDING CHART

NEONATOLOGY UNIT PRETERM BABY FEEDING CHART

Name of the Neonate _____ Age in Weeks _____

Diagnosis _____ Card Number _____ Date _____

Date	Daily weight	Mode & Quantity of feeding	Feeding every 2/hrs/24hrs												Remark
			Morning			Afternoon			Evening			Night			
			6am	8am	10am	12pm	2pm	4pm	6pm	8pm	10pm	12md	2am	4am	
1															
2															
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