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The Standards of Practical Skills in Neonatology

Study Guide

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Recommended by the Academic Council of Sumy State University



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This study guide covers information about basic principles of care for newborn babies, transitory conditions and feeding infants, main principles of neonatal resuscitation.

For English-speaking students of higher educational institutions of III–IV levels of accreditation, postgraduates, neonatologists, family physicians, pediatricians, internists, obstetricians and gynecologists.

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Introduction

The materials in the study guide may be used for teaching students, interns, future doctors – specialists in such specialties as neonatology, pediatrics, children’s anesthesiology, obstetrics and gynecology, children's surgery, general practice – family medicine, and for raising the level of practical skills of the doctors to improve the organization of medical care of newborns.

According to modern concepts there are three levels of knowledge mastering:

The first – when the doctor can make a procedure after reading about it and studying it theoretically or under control of other doctor (it meets the requirements of graduate’s level after the higher medical educational establishment).

The second – when a young specialist learned the order of actions after studying it and during the procedure recollects the next steps and makes them (it meets the requirements of the internship level and specialization of 1–2 years of practice).

The third – when a specialist makes all the actions automatically almost without thinking of what he is doing.

The concepts of practical skills presented in this study guide may be useful for all the specialists on any level of knowledge mastering.

I. Using the materials of the study guide for teaching future specialists you should follow such rules:

1. Read the following standard for the practical skill revealing incomprehensible questions and talk them out with a teacher or colleague.

2. Find additional information from other sources which explains the material.

3. It is necessary to work out the techniques presented in theory, almost on a mannequin or a conventional doll or other equipment.

4. Talk with a teacher and colleagues about the information from section “mistakes and complications” and actions of their prophylaxis and treatment.

5. Look for the procedure being made by the experienced person in a clinic on a working place.

6. Make the procedure on a patient under control of a teacher or an experienced specialist.

7. Analyse mistakes in the manipulation and their reason with a teacher (it may be excitement the lack of knowledge, etc).

8. During the further manipulations you should remember about the possible mistakes, study your own findings in your conditions (convenient position near the patient, the location of equipment and assistant’s place, etc.).

II. Within the general concepts of medical education, which provides continuing professional development of physicians, a great role is given to the preparation of doctors at their places.

The presented material can also be useful to review and optimize existing practice of newborn care, especially when medical care for neonates in hospital is provided by pediatricians, children’s surgeons and anesthesiologists without special neonatal training and deep knowledge about the features of physiology and pathology of the newborns.

At the beginning of practice most doctors improve their skills with a method of “trials and mistakes” and, having reached a certain level that satisfies them, consider their practice correct and useful. Meanwhile, there is a difference in providing medical care to newborns and children of early age.

For those physicians who constantly improve their clinical skills, this guide would serve as an assistant for self-knowledge and the basis for “work on the mistakes”. Elaboration of theoretical material presented in this guide can help experienced doctors to better understand the causes of some failures and complications observed in their practice, and reduce the total

number of “automatic” errors (those that have emerged in the primary skill false formation, which then moved to the rank of routine use).

While working with a study guide for self-knowledge and increasing the effectiveness of treatment of newborns you should follow such recommendations:

1. Don't change everything at once. Take into consideration several skills which are similar.

2. After reading the material, work it out theoretically and make up incomprehensible questions.

3. Discuss the questions with colleagues without any sources and get them interested with the problem.

4. Search for other sources of information (manuals, scientific articles, Internet, randomized investigations, bases and meta-analysis). Remember that neonatology is a young high technological science which is developing very quickly so choose a new material for your investigations. Physiological bases of fetus evolution and neonatal period are described in details in manuals written by our teachers – founders of pediatrics, obstetrics, and neonatology.

5. On the basis of found material make a dispute with colleagues concerning existing practice and necessity of its changing because truth is born from arguments.

6. On the basis of considering the data you got, formulate the best practice for the whole hospital which will be followed by your colleagues and young doctors who will study and work at the hospital.

7. Make sure that the changes in practical procedures fulfillment are useful and secure the practice by organizing an internal algorithm of making a procedure.

III. Foreign practice adapted to the realities of insurance medicine is based on medical standards, local protocols and algorithms.

Nowadays in Ukraine there is a process of standardization of medical care. The process is difficult, because different national science schools have different approaches. However, for serious research there are not enough adequate resources and time, and foreign practices can't be immediately applied because of a limited capacity and resources (problems with the presence of some modern technologies, medicines, timely transportation, staff, etc.). We are sure that in some time, all these issues will be successfully solved, but our patients need qualified help right now.

There are recommendations to create internal (local) algorithms – protocols in the health care set on the basis of national guidelines and standardized clinical protocols approved by the Ministry of Health of Ukraine. However, most of our experienced colleagues, neonatologists, passing training at the department ask questions and need help on creating such algorithms. We hope that this guide can be the first help in the preparation of internal clinical protocols and algorithms.

To create algorithms of procedures and manipulations (medical and nursing) it is recommended:

1. Study the existing practice of the performing manipulation.

2. Record it and mark “Who?” (doctor, nurse, how many people). “Where?” (operating room, manipulation room, the ward). “To whom?” (indications and contraindications). “When?” (indications, time, connection with other manipulations). “What is the goal?” (what we want to achieve whether the investigation changes, a treatment scheme) “With the help of what?” (instruments, equipment). “How?” (describe the algorithm of making the procedure in details).

3. Give it to some other person for checking (colleague, nurse, doctor) who knows how to make the procedure. Get his/her

commentaries, questions, instructions concerning mistakes and inaccuracies.

Search for sources of information (manuals, including this one, scientific articles, Internet, randomized investigations bases and meta-analysis).

5. On the bases of found material and considering the data formulate a new practice that will be followed by everybody who works at the department.

6. Check the algorithms of its epidemiological safety, convenience and availability of making.

7. Apply the algorithms in practice and make sure they are effective. Make changes and supplements if needed.

8. Use the algorithms for teaching new doctors and young specialists and for periodical repetition of the main moments of procedures making with staff.

9. Get the data of new experiments based on evidences-based medicine that explain the changes of existing practice, reconsider the application of clinical practice and the algorithms to improve the results of neonatal care.

The general rules of any procedures and manipulations that are not described in a text for every skill

1. Foresee the necessity of making the procedure.

2. Answer the questions: “Why is it necessary for a patient? Will it change the scheme of treatment or recovery chances? Can we avoid it? What are the consequences of making or not making the procedure for a child?” (consider indications and contraindications).

3. Search for the alternatives – more safe and less invasive method.

4. Explain the aim of the procedure to parents. Get the informed agreement if needed.

5. Make a note in a case history with indications and aim of the manipulation.

6. Make sure there are necessary conditions, assistants, materials, medicines, etc.

7. Re-read the algorithm and remember the main details and actions order if necessary.

8. Prepare the room, light, clothes, and protective measures.

9. Remember about infectious control and follow prophylaxis measures for patients and staff.

10. Consider anesthesiology method and use it.

11. Before the procedure make sure that it is the real patient (collate with a tag, ask mother a surname or presence of patients with the same surname at the department).

12. During the procedure check the state of a child with pulse oximeter, auscultate the heart and lungs or check them visually.

13. Do not worry and do not hurry, explain your actions to the parents, give commands to assistants for coordination of actions.

14. Estimate the child's conditions and presence of complications after the procedure.

15. Make a note in a case history about time, taken actions and child's condition.

16. Evaluate the manipulation, assistants' and your actions, analyse mistakes, remember and note them for further work.

17. Foresee the next actions.

1. The estimation of child's adaptation after birth and elaboration algorithm of doctor's actions

Indications: For all newborns. Objective: To carry out the estimation of newborn adaptation.

Contraindications: None.

Required instruments: a warm room, warmed diapers, sterile gloves, phonendoscope, equipment to provide primary resuscitation if necessary.

Methods of making:

Immediately after birth the midwife or doctor evaluates the condition of the newborn for making a decision on how to proceed. They make:

1. Fast estimation.
2. Estimation according to Apgar scale at the end of 1st and 5th minutes of life.
3. Look for the child during the whole time in a labour room (about 2 hours), estimate risks, and make primary doctor's examination.
4. Appoints examinations and treatment of a child.

Making every step doctor analyzes the data he gets and makes decisions about further child's actions. He should communicate with the mother and explain his actions and results of examinations.

Fast primary estimation is to make a decision about the necessity of reanimation; exclude congenital defects and other pathological states that require immediate examination and interference:

Index	Norma	Requires reanimation
Gestation age	> 37 weeks	< 32–34 weeks
Amniotic fluid	Clean	Meconial
Pulse*	> 100/min	< 100/min
Breathing	Breathing or crying	Not breathing, gasping
Muscle tone	Satisfactory	

** If a child is breathing or crying, has a satisfactory muscular tone, pulse is not measured*

If indicators of the newborn state are normal, the child remains on the mother's abdomen. In case of any indicator declination doctor makes **a decision about reanimation**. Reanimation is not carried out in the absence signs of life signs.

In case of revealing congenital malformations or birth trauma doctor informs the mother, appoints appropriate analyses, care and treatment.

Estimation of a child's state according to Apgar scale is made at the end of 1st and 5th minutes of life and then every 5 minutes until it reaches point 7 or establishes life support procedures (AVL etc.).

Index	Point		
	0	1	2
Pulse*	Absent	Less than 100/min	100/min and more
Breathing	Absent	Not regular breathing	Rhythmical breathing, crying
Skin colour	Pale or cyanotic	Acrocyanosis with pink trunk	Pink (local cyanosis may occur)
Muscle tone	Atonic	Weak extremities bending	Physiological position of a newborn
Reflexes	Absent	Grimace	Crying or coughing, sneezing

** If a child is breathing or crying, has a satisfactory muscular tone, pulse is not measured*

Points of the table are summarized. A healthy child in the 1st minute after birth has 7–10 points at the Apgar scale. Assessment between the 1st and 5th minutes must have a positive dynamics. Evaluation can be done simultaneously with reanimation.



Figure 1 – An active child was born by cesarean section

The newborn is crying, tone is enough, it does not require intensive care.



Figure 2 – Rapid assessment of newborn during drying



Figure 3 – Observation of the child during 2 hours after delivery (cesarean section) during skin-to-skin contact with his father

Assessment of the child's condition according to Apgar scale is not used to determine the need of reanimation, moment of its implementation or volume of reanimation. This assessment describes the overall status and effectiveness of the newborn resuscitation. Low Apgar score on the 5th minute shows the distress and the need of examination of the child. In case of low evaluation 5 minutes after birth examination it is repeated every 5 minutes until it reaches a mark 7 or providing life support procedures (AVL etc.).

Assessment of adaptation of the child is held while newborn is staying in skin-to-skin contact in the delivery room – a midwife or doctor examines breathing, colour, movements of a child every 15 minutes (more often if necessary), measures body temperature (30 minutes, 1st and 2nd hours after birth) or touches hands and legs (other intervals – every 15 minutes), notes the presence of cyanosis, moaning, sleep apnea, defines heart rate if necessary.

If the child is breathing or crying and has a satisfactory muscle tone, heart rate is not measured.

For a premature newborn moderate muscle hypotony (semiflexion pose and reduced motor activity) is the norm, and it depends on the degree of maturity (gestational age).

If midwife is supervising a child, she should immediately call the doctor if any of the following parameters go beyond the norm:

Signs	Normal value	Physiological peculiarities of a child with a low birth weight
Pulse	100–160 /min	
Breathing rate and character	35–60 /min	Expiratory moaning and chest retraction are absent
Movements	Active	Active or moderately decreased (moderate hypotony and hypodynamy)
Muscle tone	Satisfactory	Present (moderate hypotony)
Child's pose	Flexory	Flexory or semiflexed: head is adducted, extremities are moderately bent in joints
Temperature	36.5–37.5 °C, extremities are warm	
Apnoe	Absent	
Expiratory	Absent	
Central cyanosis	Absent	

If you find any pathological signs initial medical examination of the child is carried out by pediatrician-neonatologist immediately. If a child needs emergency care, doctor conducts a quick review before transferring, using the simplified scheme (for exclusion congenital defects and

estimation of necessary care). Complete review of systems is carried out only in the department after stabilization of the child's condition and setting respiratory support and intravenous infusion.

Risk assessment and prevention of pathological conditions

To determine presence or to exclude respiratory disorders you should observe the newborn during the skin-to-skin contact in incubator or under a radiant heat source to avoid cooling. Estimate 5 signs on Downes or Silverman scales. Evaluation is carried out after birth at least every 3 hours, and after getting 0 points – twice for the next 2 hours.

If there are signs of respiratory distress you should immediately evaluate a child according to Downes or Silverman scales and classify the severity of respiratory distress. In case of respiratory distress of moderate and severe degree you should provide medical assistance (according to protocol) and transfer the child to the neonatology department. If signs of respiratory distress are absent (0 points) for 3 hours, it is necessary to stop the evaluation, provide a joint residence with mother, breastfeeding, and then carefully observe the child.

Determination of blood glucose is compulsory in newborns with the birth weight of 1500 g or less in the first 4–6 hours of life at once, and also in children with clinical signs of hypoglycemia. Repeated determination of blood glucose is carried out in accordance with the child's clinical condition and results of previous examinations. The normal blood glucose level is 2.6–5.5 mmol/l. The control of the level of blood glucose must be done in every healthcare institution with glucometer to reduce the risk of complications of invasive procedures.

Laboratory research of cord blood for group, Rh-factor and bilirubin level is made to babies who were born by women with 0 (I) blood group and/or Rh-negative blood type.

Also, cord blood rapid tests check for the presence of antigens to HIV infection if the women have not been examined during pregnancy and refused from the examination in labours.

If there are indications the patency of the esophagus is examined (previously to the first application to the chest/breastfeeding).

If the adaptation of the newborn with gestational age more than 32 weeks during the skin-to-skin contact runs smoothly, complete initial medical examination carried out on a warm table under radiant heat for 2 hours after birth before the child is taken to the ward for joint residence with mother.

Basing on monitoring the early period of acute cardio-respiratory adaptation and initial examinations the doctor makes a note in the development history of the newborn: full-term healthy baby or prematurely born (specify gestational age), and/or a child with low birth weight, child with birth defects, birth trauma (visible/suspicion), suspected infection, receiving neonatal intensive care, neonate with hypothermia, respiratory disorders, etc. If necessary, at any stage of observation laboratory tests may be carried out.

If disorders of early physiological adaptation or pathological conditions are revealed, further medical care is carried out according to protocols.

Complications and mistakes:

- underestimating the severity of the condition, respiratory disorders;
- late call of neonatologist (pediatrician) after the deterioration of the child's condition;
- hypothermia, failure in the warm chain;
- providing intensive care to children who do not require it;
- incorrect procedure of estimation of the child's condition and medical care provision;
- routine (without indications) performing the following procedures: sanitation of upper respiratory ways, oxygen therapy, checking patency of the esophagus and anus.

2. Primary examination of a newborn

Indications: all newborns. Contraindications: none.

Deferred primary examination is conducted in newborns in case of serious condition at the time of transferring from the labour room. In this case a short examination is conducted in order to eliminate congenital defects and estimate the amount of necessary care; a full review of systems and organs and anthropometry are carried out after stabilization of a child or adjustment of treatment (mechanical ventilation, infusion, etc.).

Required tools: a warm room, adequate lighting, phonendoscope, individual or sterilized measuring tape, flashlight, digital scales and gloves.

The aim of the doctor's examination according to the scheme of complete system review is to get answers to the following questions:

- whether there are any congenital anomalies that require medical intervention, or dysmorphic changes;
- if there is adequate cardiorespiratory adaptation;
- whether a newborn has clinical signs of infection;
- if there are other pathological conditions that require urgent examination and intervention;
- whether a baby is healthy.

The method of conducting doctor's examination:

1. Before making a full doctor's examination according to the scheme of complete system review of the newborn, physician who performs it should analyze the data of history, study the medical documentation and obtain information on maternal health, pregnancy and childbirth. The doctor gets additional information, which is absent in the medical documentation, by interviewing mother. If a woman has a 0 (I) group and/or Rh-negative blood type, a laboratory research on umbilical cord blood group and Rh-factor and bilirubin level is conducted.

2. The primary doctor's examination according to the scheme of complete system review of a newborn is carried out in

the delivery room by pediatrician-neonatologists, pediatrician (in his absence obstetrician-gynecologist, general practitioner – family medicine) before transferring the child to the ward of compatible stay of the mother and child. The examination of a newborn in the delivery room or ward of compatible stay should be done in the presence of mother. You should introduce yourself and explain the purpose of child's examination to mother.

3. The examination of a newborn child is made systematically avoiding hypothermia.

The scheme of systematic examination of a newborn:

Child's pose. Flexed or semiflexed (the head is slightly adducted to the chest, arms are moderately bent at the elbows, legs are moderately bent at the knees and hip joints). Hypotony, atony in severe condition or at immaturity of the newborn can be also observed. Normally a child at 28 weeks has only a minimal bending of limbs, at 32 weeks – bending of the legs, at 36 weeks – bending of legs, and less – hands, at 40 weeks – bending of arms and legs (flexion).

Crying. Loud, of average power, weak, emotional or absent.

Skin. Skin colour reflects the success of cardio-respiratory adaptation. In healthy warmed newborns all skin is pink (erythema of newborn) during the first few hours of life. During crying the skin can take a light cyanotic colour that may be normal, except the central cyanosis (cyanosis of the skin and mucous membranes, cyanotic tongue).

Children with polycythemia may also become cyanotic with no signs of respiratory or cardiac failure. Prematurely born children and children born by mothers with diabetes mellitus, look more pink than usual, and postterm – more pale. Skin is elastic, can be covered with labour grease. Full-term newborns have good soft tissue turgor, in postterm children the skin is dry and flaky (does not require treatment, only care and prevention of infection cracks). Pay attention to the presence of Mongolian spots, milia,

toxic erythema (no treatment is necessary, explain to mother the principles of general care and hygiene).

The appearance of jaundice in the first day is pathological. Pay attention to the presence of edema, palpable lymph nodes. White spot after pressing on the soft tissue disappears in 3 seconds. Longer retention suggests microcirculation disturbances.

Depending on the gestational age skin may be covered with grease, visible veins; in infants with a gestational age approaching 37 weeks there can be superficial peeling and/or rash and small veins; fluffy hair covers most of the back and extensor surfaces of the extremities; in infants with gestational age approaching 37 weeks there are areas without lanugo.

Subcutaneous fatty layer is thin or absent. The skin on the soles with the subtle red line or with only marked front transverse fold is in infants with gestational age approaching 37 weeks, folds occupy $2/3$ of the surface.



Figure 4 – Face “cyanosis” caused by petechial rash on the head and cephalhematoma in newborn with macrosomia.
Appoint a clinical blood test



Figure 5 – Primary medical examination in the delivery room in 2 hours after birth



Figure 6 – Cephalhematoma in a newborn with meconial aspiration

Head and skull. Head is brachiocephalic or dolichocephalic (depending on the position of the fetus during labours). The head circumference of a full-term newborn is 32–38 cm. Premature children have rounder head in contradistinction to mature ones. Bones of the skull are thin. Sutures and fontanels are open.

There can be **labour tumour** – pastry consistency extends beyond one bone. Treatment is not required.

Determine availability of cephalhematoma and determine its size.

A large fontanel and a **small one**, if present, are measured on the level of skull bones. We estimate the condition of cranial sutures: sagittal suture can be opened and its width is less than 3 mm. Other cranial sutures are palpated on the verge of bones.

Face. The general view is determined by the position of the eyes, nose, mouth, defining features of dysmorphia.

On the examination of the oral cavity the normal mucous is pink. Note symmetry corners of the mouth, whole palate and upper lip.

Eyes. Pay attention to the presence of hemorrhages in the sclera, jaundice, possible signs of conjunctivitis.

After viewing **ears examine** the external auditory canal, shape and position of ears, development of cartilage in them. Changing the shape of ears is observed at many dysmorphic syndromes.

Nose. Except of the form of the nose, pay attention to the possible involvement of the wings of the nose in breathing, this indicates respiratory failure.

Neck. Evaluate the shape and symmetry of the neck, the amount of movement.

The normal **thorax** is cylindrical (lower aperture is deployed, ribs position are close to horizontal and symmetrical). Pay attention to the respiratory rate (30–60/min.), absent retraction of jugular fossa, intercostal spaces and xiphoid process during breathing. At auscultation of the lungs the symmetrical puerile breathing is heard above all surface. In prematurely born children the lower aperture is more deployed, the ribs are oblique. Chest circumference varies from 21 cm to 30 cm depending on gestational age.

Heart. Percussion is used to determine the borders of cardiac dullness, auscultate the heart, determine the heart rate, tones characteristics, and the presence of additional murmur.

Abdomen is rounded, involved in breathing, soft, deep palpation is available. Determine the border of the liver and spleen. Normally the liver may be 1–2.5 cm from the edge of the costal arch. The spleen edge is palpable under the costal arch.

Review **genitals and anus**. Genitals are clearly formed by female or male type.

The boys' phimosis is physiological. The testes in full term newborns are palpable in scrotum, they shouldn't appear blue through the scrotum, because it is a sign of torsion of spermatic cord. In mature girls large labia cover small ones. During examination open big lips for possible vagina anomalies review. Examine anus and visually estimate its presence.

Inguinal region. The pulse on the femoral artery is palpated and checked for symmetry. Feeling of pulse decreases in case of coarctation of the aorta, and increases in case of an open ductus arteriosus.

The limbs, spine, joints. Pay attention to the shape of the limbs, presence of clubfoot, the number of fingers on both sides on hands and feet. Check the absence of dislocation and dysplasia of the hip joints, after pulling apart the hip joints fully and the "click" symptom is absent. During examination of the back pay attention to the possible presence of spina bifida, meningocele, dermal cysts.

Neurological examination. Determine muscle tone – flexed child's pose, at the ventral hanging head is in the line with the trunk; physiological reflexes are being examined: searching, sucking reflex (Babkin), grasping hands, Moro, automatic moves and resistance. Searching, sucking and swallowing reflexes can be evaluated during feeding. Prematurely born children usually have reduced muscle tone and spontaneous motor activity, small and intermittent tremor of the limbs and chin, small and intermittent horizontal nystagmus, reflexes moderately decrease in case of

satisfactory general condition of the child are transient and do not require special treatment.

Determination of gestational age. For healthy full-term newborns, whose weight is between 10th and 90th percentile, it is not necessary to determine gestational age. Indications for determination of gestational age by examination are a low birth weight and discrepancy between physical development and gestational age determined by obstetrician-gynecologist.

4. The physician must evaluate the physical development of children by anthropometric data according to the attached tables.

After primary examination the doctor concludes the child's condition in the following points:

Full-term healthy baby or child with low birth weight, prematurely born baby and/or possible congenital defects, birth trauma, suspected infection, child received neonatal reanimation, suffered from hypothermia, respiratory disorders and other.

In case of physiological adaptation of the newborn (loud crying, activity, pink skin, sufficient muscle tone), which occurs in conditions of unlimited early contact with mother and early initiation of breastfeeding, absence of birth defects, signs of intrauterine infection, based on the results of full systematic objective view, the child can be considered as healthy.

5. Explain the results of the examination to parents. You should ask the mother if she has questions concerning the child's condition. After the examination fill the case history of the newborn.

6. If necessary, appoint laboratory or other additional tests (high levels of bilirubin in cord blood, medical history data about placental blood loss, the child's condition, etc.).

7. Monitoring the general condition of the child and providing appropriate help in case of health impairment should not depend on conduction of medical examination or its volume.

Complications and mistakes:

- hypothermia of child, warm chain inobservance, prolonged examination;
- making examination and anthropometry immediately after birth;
- routine procedures without necessary indications (checking the patency of anus and esophagus, cleansing enema, etc.);
- the underestimation of the severity of the child, its needs and treatment requirements;
- incorrect assessment of the child's condition (especially prematurely born) assisting a help to a child who does not need it;
- the separation of a child from mother if necessary, supervision and temporary transfer to the intensive care unit to carry out laboratory tests.

3. General examination of a newborn

Indications: All newborns who are in the hospital or when visiting a doctor/physician. The amount of examination depends on the child's condition; the full review is carried out after admission to the neonatal department and before discharge/transfer of a newborn.

Contraindications: None. Measurement of body weight is made by special indications.

Required tools, conditions: In warm conditions under radiant heat source or incubator, sufficient daylight, clean gloves, phonendoscope, measuring tape, flashlight, digital scales.

The aim of a daily doctor's examination - to estimate the health of the child, the need, scope and type of medical interventions, eliminate unsafe conditions to ensure optimum mode of nursing, feeding, scheme of examination and treatment (if needed).



Figure 7 – Examination of healthy newborns before discharging from the hospital



Figure 8 – Daily examination of a sick child with low birth weight is carried out through the window of couveuse

A doctor should analyze medical history of a newborn before the full examination. General examination of a newborn must be as short as possible. It is necessary to limit, if possible, the extra turning, shifting, and avoid cooling. If a child is in couveuse, a review is carried out with the closed door, through the

window. If you need to change the couveuse or bedclothes, the child can be put under radiant heat source while the examination lasts and the other person (mother, nurse) changes couveuse or bedclothes. Weighing is made if necessary, preferring scales inbuilt in the couveuse. After examination the data is recorded into the case history of the newborn. The examination should be explained to parents and you should answer questions about the condition of their child.

Examination methodics:

1. There should be noted time of the examination, child's age at the time of examination and general condition (satisfactory, moderate, severe, very severe, and terminal).

2. Details of stay (compatible with mother, single bed, bed with additional warmers, reanimation table, couveuse, etc.).

3. Details of life support (breathes independently, oxygen tent, CPAP, its type and oxygen concentration in %, mechanical ventilation with indications of its parameters), body temperature, pulse, breathing rate, and oxygen saturation.

4. Details of feeding (breast, therapeutic or artificial enteral feeding, main method of food intake, volume, and assimilation, complete or partial parenteral feeding).

5. Infusion therapy: aim, volume, way and speed. Antibacterial and other drugs.

6. Child's pose, response to treatment, the need for sedation or anticonvulsant drugs.

7. Skin. Estimate colour: pink, pale, erythematous, cyanotic, the presence of grayish colour, marmoreal, icteric etc. Exclude central cyanosis, which has a sign – tongue cyanosis. Exclude pathological jaundice, estimating the degree of icterus according to Kramer scale. Estimate soft tissue turgor, dryness of skin, the presence of vascular spots, “moles”, rash and other violations of the integrity of the skin. Pay attention to the presence of edema, assess their prevalence, and exclude sklerema/skleredema. Palpate lymph node areas. Identify the symptom of “white spots” by pressing on the soft tissue (in

normal variance it is up to 3 seconds). Longer retention of spots shows microcirculation disorders.

8. Head and skull. Determine the circumference of the head, measure large fontanel, and if present – a small fontanel, check their bulging or retraction on the level of skull bones. Assess the state of cranial sutures, determine the width of the open seams, palpate bone and exclude craniotables areas, the presence of labour tumour, cephalhematoma, and edema.

9. Face. Describe the position of the eyes, nose, mouth. Define symmetry, signs of dysmorphism, grimaces, signs of pain, discomfort, response to external irritants.

10. On examination of the oral cavity examine symmetry of mouth corners, palate and upper lip integrity, the colour and condition of the mucosa, tongue, oral cavity contents.

11. Eyes. Pay attention to the presence of hemorrhages in the sclera, jaundice, possible signs of conjunctivitis. Evaluate the spontaneous movements of the eyeballs, reflexes, photoreaction of pupils, corneal reflex.

12. Pay attention to the possible involvement of the wings of the nose in breathing, which indicates the presence of respiratory disorders.

13. Evaluate the shape and symmetry of the neck.

14. The examination of thorax (shape, symmetry, ribs position). Pay attention to the character of breathing, presence of retraction of jugular fossa during breathing, intercostal spaces, xiphoid process. Auscultate breathing above the lungs, if necessary, make percussion in problematic areas. Breath rate should be counted no less than for 30 seconds, in case of arrhythmic breathing, presence of apnea in prematurely born – for 1 minute. Exclude apnea.

15. To determine the border of cardiac dullness one makes percussion, also it is necessary to provide auscultation of heart, determine heart rate, character of tones, and the presence of additional murmur.

16. Abdomen (normally rounded, involved in breathing, soft, deep palpation is available). Pay attention to the surface (swollen, contours of guts, waves, visual peristalsis, a symptom of “sand clock”, increased venous pattern on the skin of abdominal wall, a symptom of “jellyfish”). During palpation exclude umbilical hernia; define borders of the liver and spleen. Normally the liver exceeds the border of the costal arch for 1–2.5 cm. A spleen edge is palpable under the costal arch. Auscultate intestinal peristalsis.

17. Examination of the urinary organs and anus. It is necessary to exclude swelling, irritation, inguinal hernia. If the child is on infusion therapy or receives parenteral nutrition, provide control of diuresis by collecting urine or weighing diapers. When using a urinary catheter (in case of urinary retention and poor condition of a child to remove urine and for urinalysis), its use should be noted (increased risk of sepsis).

18. Inguinal area – the pulse of the femoral artery is palpated and checked for symmetry. The filling rate decreases in case of coarctation of the aorta, increasing when ductus arteriosus is opened.

19. The limbs, spine, joints. Pay attention to the form of the extremities, possible valgus or varus deformity, the number of fingers of arms and legs on both sides. Check the absence of dislocation and dysplasia of the hips in hip joints.

20. Neurological examination: define muscle tone – child’s pose in rest (flexed, “frog’s”, atony, opisthotonus etc.), in ventral hanging define symmetry (not used at serious condition); examine physiological reflexes: searching, sucking (Babkin), grasping hands, Moro, automatic gait and resistance. Sucking and swallowing reflexes are evaluated during feeding.

Estimate feeding and breast milk provision condition: ask mother to examine her breast areola, pumping skills, watch the feeding of the child, check the calorie content and protein provision in artificial, additional and parenteral (partial or complete) diet.



Figure 9 – Weighing of a newborn with very low birth weight at hospital conducted by a physician



Figure 10 – Examination of premature baby by doctor of a transport crew before transporting to hospital



Figure 11, 12 – Neurological examination in the delivery room before transferring to the ward of compatible stay of mother and child

Complications, mistakes:

- hypothermia of a child, failure of warm chain, long examination;
- the underestimation of the severity of the child's needs and scope of examination, treatment and nutrition of a newborn;
- incomplete informing of mothers about the health of her baby and dangerous conditions that require immediate help.

4. Neurological examination of a newborn baby

Indications: All newborns that are at the hospital or when visiting a doctor/physician. The amount of examination depends on the child's condition; the review must be maximal in case of entering the department and before discharging/transferring newborn.

Contraindications: None.

Required tools, conditions: In warm conditions under radiant heat source or couveuse, sufficient daylight, clean gloves, measuring tape, flashlight.

Objective daily examination – to estimate condition of a child, the need, scope and character of medical interventions, eliminate hazardous conditions, ensure optimum mode of nursing, feeding, scheme of laboratory investigations and treatment (if needed).

Before the neonatal neurological examination the doctor should examine medical history. After examination the data should be noted into the case history of the newborn. The examination results should be explained to parents and you should answer questions about the condition of their child.

Methods of examination:

1. Gestational age, matching the physical parameters of gestational age.
2. The general condition of the child (satisfactory, moderate, severe).

3. Visual examination (general condition, malformations, facial expression, dysembriogenesis stigma, trauma).

4. The level of activity and consciousness (preserved, sopor, stupor, coma).

5. Convulsions (minimal clonic, tonic, myoclonic).

6. Head:

a) the head circumference (cm);

b) the shape of the skull (head configuration, brachiocephalic, dolichocephalic, “tower form”, craniostenosis, microcephaly, macrocephaly, hydrocephalus);

c) large fontanel (dimensions and characteristics);

d) small fontanel (dimensions and characteristics);

e) cranial sutures (size and characteristics);

f) congenital tumour. Cephalhematoma, subaponeurotic hematoma (size and characteristics);

g) cerebral hernia (dimensions and characteristics).

7. “Mechanical” signs of head, spine or extremities trauma (scratches, bleeding, swelling, limitation of motion, pain during movement and/or risk factors for injury).

8. Cranial nerves:

1st pair (response to odor);

2nd pair (response to light);

3th, 4th, 6th pair (width of eye slits, ptosis, width and shape of the pupils, volume and common eye movements, exophthalmos, enoftalmos; strabismus, vision paresis, Graefe’s symptom, Horner symptom);

5th pair (corneal reflex), (conjunctival reflex), (mandibular reflex);

7th pair. Facial muscles (symmetry), taste;

8th pair. Nystagmus (horizontal, vertical, rotational) and hearing;

9th, 10th pair. The voice (loud, emotional, hoarse, snuffing), taste, choking, vomiting. Draining the milk through the nose, mouth ±. Characteristics of the soft palate and uvula.

Pharyngeal reflex, heart rate (HR), breath rate (BR).

11th pair (torticollis);

12th pair. Tongue (deviation, atrophy, fibrillation).

9. The motor and reflex activity:

a) pose:

In normal full-term baby the pose is flexed or semi-flexed (head is slightly tilted to the chest, arms are moderately bent at the elbows, legs are moderately bent at the knees and hip joints). Physiological for the baby at 28 weeks is characteristic the minimum bending limbs, at 32 weeks – bending legs, at 36 weeks – bending legs and a little – arms, at 40 weeks – bending arms and legs;

b) hands (in fist, claws, “seal paws”, 1st finger flexed);

c) feet (hanging, varus, valgus deformations, the heel foot);

d) volume of movements:

– active (saved, absent);

– passive (complete, incomplete).

Value of movements (asymmetry, inharmonious, sharp, reducing the number and amplitude, boxing, rowing, pedaling, tremors, spastic twitching of tongue or fingers, excessive irritability and generalized motor reaction (“shaking”) in response to touch or sound).

e) muscles tone (physiological, high, low, dystonic);

f) knee tendon reflexes (living, high, torpid, absent);

g) reflexes of oral automatism (search, sucking, proboscis, nasal and labial, hand-mouth);

h) reflexes of spinal automatism (safety, support, walk, crawl, Moro, upper grasping, below embracing reflex);

i) reflexes of suprasegmental automatism (neck symmetric tonic reflex, neck asymmetric tonic reflex, tonic labyrinthine reflex).

10. The autonomic nervous system.

Skin colour, breathing rate, heart rate, blood pressure, body temperature, sleep and breathing disorders, urinary

excretion, peristalsis, the quantity and structure of saliva or sputum, pupils width, sleep and oversleep correlation.

11. Sensitivity. The sense of touch, pain, vision, hearing, taste.

12. Meningeal syndrome +/- . (Tense, pulsating large fontanel, general hyperesthesia, opisthotonus, positive Lessage's (hanging) symptom).

Conclusion: Neurological syndrome or diagnosis.



Figure 13 – Newborn with very low birth weight (hypotonic muscles)



Figure 14 – Physiological pose of prematurely born baby with low birth weight (semiflexed)



Figure 15 – The normal physiological pose of healthy full term newborn (flexed)

Complications, mistakes:

- hypothermia of child, failure in warm chain;
- examination of the child during or immediately after painful manipulations that could affect the neurological condition (venipuncture, sanitation of trachea, mechanical ventilation). If exclusion the impact factor is not possible (prolonged AVL), its

influence during the inspection should be noted in case history;

- if during the examination a child is under the influence of sedatives/anticonvulsants, it should be taken into account when evaluating the condition and noting it in a case history;

- the interpretation of some conditions of prematurely born related to the immaturity of the nervous system and specific to their gestational/postconceptual age as pathological if the estimation is carried out without regard to their conceptual maturity.

Evaluation of general cerebral neurological symptoms begins with an examination of a newborn. Watch the response to medical examination or communication skills (this is the main measure of overall activity) for expression of discontent and discomfort (the child is hungry, lying in wet diapers, intentionally woken etc.), quick calming after removal of irritative factors, also the response to positive stimuli (smiling, saying kind words to a child, picking him up).

A healthy baby in the first weeks of life is mostly asleep, waking only to feed. Crying after waking up is one of the most important indicators of overall activity and is estimated by intensity and character.

For a healthy child noisy, modulated, emotional crying is typical. Weak cry is observed in case of neurological diseases (such as neuroinfections, intracranial hemorrhage, cerebral ischemia), and in somatic (sepsis, pneumonia, etc.), accompanied by CNS depression syndrome. Annoyed cry can be in case of neurological disorders (cerebral ischemia, intracranial hemorrhage), metabolic disorders (hypoglycemia, hypocalcemia, hypomagnesemia, etc.), accompanied by increased neuro-reflex excitability or increased intracranial pressure. The monotonous cry is observed in case of congenital hydrocephalus and bilirubin encephalopathy.

Nasal shade of cry appears in case of bulbar and pseudobulbar disorders, anomalies of the structure of the nasopharynx. Vocal newborn reactions also include coughing,

sneezing, sucking and yawning sounds. Various pathological conditions can lead to difficulty of these primitive vocal reactions or even the inability to express them. In newborns with weak respiratory muscles we often observe whimpering, cough is weakened or absent, poorly expressed sneezing reflex, absent guttural sounds. Due to the weakness of the respiratory and articulatory muscles such crying may be short, weak, high-pitched, and sometimes so quiet that only facial reactions show that the child is crying. Also there may be a piercing cry, reminding different animal sounds (bellowing, grunting, bleating, crowing, and mewling). This is not peculiar to healthy newborns.

As for emotions, till the end of the neonatal period in a fed and quiet newborn in response to a smile and addressed to it kind words, especially when they are repeated, so-called “oral attention” when the circular muscle of the mouth has barely perceptible wave of contractions and lips are slightly stretched forward as if a baby was “listening” with lips may appear. The child, who aged 1 month, in response to such treatment from adult, may give a smile. It occurs because a positive emotional reaction and oral attention appear on the 2nd week of life. There are no clearly defined rules concerning the expression of emotional reactions and timing of their appearance because they depend on many factors: genotype characteristics of the organism, the type of higher nervous activity, threshold of its excitability, individual biorhythms, physiological state of the organism (satiety, hunger, the level of bowel movements) and others.

Therefore, some babies cry reacting to the slightest unpleasant stimulus and positive emotional response is easily caused and in others occurrence of these reactions is difficult. If a newborn does not cry when he does not have defecation for a long time, when he is hungry, lying wet for a long time or not waking up during examination, it can be estimated as an expressive inhibition and apathy. This condition in the neonatal period is typical for, prematurely born and immature children.

In a hyperexcitable newborn negative emotions arise under any, even very weak stimulus. Such a child sleeps little, often cries without apparent reason, it is difficult to calm it in the usual way (rocking, feeding, holding in arms, etc.). Also, in hyperexcitable children it is often difficult to trigger positive emotions. The combination of low threshold of emotional reactions with advantage of negative emotions distinguishes hyperexcitement as a pathological state from physiological excitability. To avoid diagnostic mistakes all abovementioned must be considered on examination of a newborn.

Changes in consciousness. There are degrees of CNS depression: somnolence, stupefaction, stupor and coma.

Somnolence is characterized by permanent stay of the newborn in a state of sleep. On examination, he wakes up, but immediately falls asleep when he is left alone. The deeper somnolence is the fewer unconditioned reflexes can be caused in a child. There is a specific order for suppression of reflexes (inhibition according to increasing severity of state): searching, Moro reflex, protective, stepping, supporting reflex. The upper and lower grasping reflexes are present, sucking reflex is weakened or absent.

In a state of stupefaction child responds to tactile stimulation with a specific grimace, typical for crying; pupils have average size; pupillary reaction; oculocephalic, proboscis and corneal reflexes are present. The tendon reflexes are present, Babinski symptom is clear. The upper grasping reflex is present, but other unconditioned reflexes, including sucking are absent.

In stupor child responds only to painful irritation with a grimace and reacts on a bright light screwing up the eyes. Pupils have medium size or can be narrowed. Reflexes of brain stem level (pupillary, oculocephalic, corneal, proboscis) and tendon are present. The typical is a "frog pose". The response to lining irritation of foot is a flexion of the lower limb.

In a coma child does not respond to pain stimuli. Coma of I degree is characterized by the presence of brain stem level

reflexes, tendon reflexes, Babinski reflex; muscle tone may increase periodically with the formation of decortication tonic posture. Signs of II degree coma are partial inhibition of brain stem reflexes; possibility decerebration tonic posture. In III degree coma brain stem reflexes are suppressed completely, pupils are dilated; tendon reflexes, upper grasping reflex and Babinski symptom are depressed.

Intracranial hypertension syndrome is clinically characterized by hyperexcitability symptoms, rapid rate of increasing head circumference and size of large fontanel, its intensity (no protrusion and pulsation), cranial sutures differences, angry shouting, frequent delayed spitting up (more than 30–40 min after feeding), Graefe symptom, symptoms of autonomic dysfunction.

Evaluation of motor reflexes sphere

Spontaneous motor activity. Evaluation of spontaneous motor activity is subjective and depends on the experience of the doctor. Spontaneous movements made by the child – a periodic bending, straightening and crossing legs, pushing away from the support, bending hands in elbows and wrists with making a fist. Determine the volume and symmetry of spontaneous motor activity. Choreoathetoid component of movements, which is a physiological for newborns, shows the advantage of extrapyramidal (striatum) motility and is seen in spontaneous movements of tongue and fingers, their unclenching.

Tremor is a periodic fluctuation of limbs, jaw, tongue around a fixed axis with a certain frequency and amplitude. It is observed in almost half of newborns. Low amplitude high-frequency tremor while shouting, sizzling and some stages of sleep is a physiological phenomenon.

Muscle tone. The most important characteristic of motor activity of a newborn is muscle tone, the level of which is determined by the mobility of joints. Typical for healthy full termed newborns is embryonic posture as a result of increased muscle tone: arms are bent in all joints, pressed to trunk and chest,

hands clenched into fists, thumbs of both hands are under four other fingers, legs are bent in the joints in hips and pulled apart, dorsiflexion is dominating in feet. Characteristics of muscle tone depend on gestational age. Flexor muscle tone in the lower extremities is observed in premature children born on 30 week of gestation and later, in the upper extremities – in newborns with gestational age of 36 weeks or more.

Passive muscle tone is evaluated as normal by the following indicators:

- the head during movements toward the chin touches the acromial process;

- extension of arms in the elbows possible to 180° , flexion in radio-carpal joints – up to 150° , abduction of hips bent at 75° in each side;

- if hip is flexed at 90° , leg at the knee can straighten up to 150° ;

- foot dorsal flexion is 120° .

The test of the traction (pulling the newborn by wrists) is normally accompanied by a slight extension of the elbow (1st phase), and then again increased tone in flexors and the child is pulled to the doctor's hands (2nd phase).

The muscular dystonia is characterized by changing tone in the same group of muscles.

Increased muscle tone appears to strengthen flexor hypertony (during suspension of a child arms and legs are sharply bent, in traction the phase of extension is absent), abovementioned angle indicators are significantly reduced. There may be increased tone of extensor muscles, which manifests itself in the disappearance of signs of flexor hypertony, and in a state of hanging face down, the baby's head is thrown back, arms are straighten.

The most severe manifestation of extensor hypertension is opisthotonus, head is thrown back, legs are straightened and usually crossed. In case of nuclear jaundice a posture of the child with outstretched limbs and fists clenched in hands is typical.

Reduced muscle tone may be local and generalized. If there is a generalized, we see a “frog posture” (straightened limbs in all joints, hips withdrawn, rotated out, abdomen is wide and flattened). The amount of passive movements increased, while face is hanging upside down and limbs are hanging down, during traction phase of flexion is absent, head is thrown back. Generalized hypotonia is not nosological specific symptom and may occur in case of severe somatic diseases, metabolic disorders, and nervous system disorders of various etiologies. Do not forget about the possibility of inherited neuromuscular diseases with the beginning in the neonatal period (such as spinal amyotrophy of Verdnih–Hoffman). Local hypotonia may be caused by the relevant neural innervation (traumatic neuropathy, plexopathy) or segmental (congenital spinal injury) disorders.

Unconditional reflexes in newborns. This group includes oral reflexes and spinal automatism, suprasegmental posetonical, myelencephalic posetonical, suprasegmental automatism and mesencephalic grasping reflexes.

Reflexes of oral automatism:

- Hand-mouth (Babkin). Pressing the palm of a child – mouth opens, and head is flexed. It appears after birth and fades away in 3 months.

- Proboscis. When tap with a finger on lips there is contraction of m. orbicularis oris and lips are stretched like “proboscis”. The reflex appears after birth and fades away in 2–3 months.

- Searching (Kusmaul). Stroking with your finger corners of the mouth (without touching the lips) causes lowering this section and returning the head in the direction of the stimulus. Pressing with your finger on the middle of the lower lip causes mouth opening, lowering the lower jaw, bending head. It appears after birth and fades away in 3–4 months.

Sucking. In response to the irritation of oral cavity sucking movements arise. The reflex appears after birth, fades away in 12 months. It is occurred in infants of 27–28 weeks of

gestation, with increasing gestational age becomes more expressed and coordinated with swallowing up to 32–34 weeks when the baby can be fed per orally.

Reflexes of spinal automatism:

- Protection. If the baby lays down, it turns its head to a side. The reflex appears after birth.

- Support and automatic walking. If the child is kept so that the feet touch support, he straightens the trunk and stands with a half bent legs on full feet and in mild inclination takes a step forward. It is occurred from the 34th week of gestation, fades away the 2 month.

- Crawling (Bauer). If the baby lays down (head at the midline), it will do creep movements. If to put a hand to the soles of the feet – the baby pushes off with his feet. It appears after birth, fades away after 4 months.

- Grasping (Robinson). After pressing on a palm a child grabs doctor's fingers (grasping reflex) and can be lifted (Robinson reflex). It appears after birth, fades in 3–4 months. In infants with gestational age 27–28 weeks after pressing on the palm a weak flexion of fingers appears. With the increase of gestational age the contraction is spread to the muscles of the forearm and shoulder and in 37–38 weeks is strengthened so that the child can lift the shoulders.

- Grasping reflex of the lower limbs (Babinski). Pressing with your thumb on the plantar pad of the foot causes plantar flexion of fingers, lining irritation of the sole of the foot causes dorsiflexion and fan-shaped arrangement of fingers. Is formed at the 26th week of gestation, later becomes more expressed, appears birth, fades away in 3–4 months.

- Galant reflex. After skin irritation along the spine a baby bends its back, forms an arch, concave toward the stimulus, and a leg on the appropriate side usually straightens in hip and knee joints. It appears after birth, occurs well on a 5–6th day of life and fades after 3–4 months.

- **Perez reflex.** If you hold your fingers (slightly pressing) on the spinous processes of the vertebrae of the neck to the tailbone, the child cries, raises the head, folds upper and lower limbs, the trunk is unbent. The reflex is checked the last at examination because of its painfulness. It appears after birth, fades away in 3–4 months.

- **Moro reflex.** It is caused by various methods: a blow to the surface (on which the child is) at a distance of 15 cm from its head; rising of the straightened legs and pelvis; sudden passive extension of the lower extremities. The newborn moves hands apart and opens arms (1st phase), after a few seconds hands are put into the starting position (2nd phase). It appears after birth. At the 25–27th weeks of gestation only opening of hands occurs, on the 33–34th there develops adduction of hands and up to the 40th week – abduction and adduction of hands develop identically. Hands adduction of a premature baby less than 40 weeks of gestation appears less clearly than in a full-term one.

Suprasegmental pose tonic automatism (myelencephalic):

- **Asymmetrical tonic neck.** If you turn the head of the newborn, which lies on the back so that the lower jaw is on the level of shoulder, he unbends the limb to which the face is turned and bends the opposite limb. It appears after birth. In full-term infants it isn't expressed clearly. In preterm infants (< 36 weeks of gestation) expressed asymmetric tonic neck reflex is caused in the neonatal period as a result of the physiological benefits of extensor tone. It fades away in 4 months.

- **Symmetric tonic neck.** With bent head increases flexor tone in hands and extensor tone in feet. It appears after birth, fades away in 2 months.

- **Tonic labyrinth.** In the supine position there appears maximizing tone in the extensor muscle groups; in position on the stomach – a flexor muscle groups. It appears after birth, fades away in 2 months.

Suprasegmental pose tonic (mesencephalic constituent) reflexes:

- Neck straightening reaction. After active or passive head rotation the body turns in the same direction. It appears after birth, fades away in 5–6 months.
- Trunk straightening reaction. After touching by the child a support with the feet it straightens the head. It appears in the end of the 1st month, fades away in 5–6 months.
- Trunk straightening reflex. It occurs after head turning shoulder girdle and pelvis turning relative to the axis of the body. It is expressed in 6–8 months, modified in 10–15 months.
- Landau reflex. If the child is kept face down, it raises its head, the tonic extension of the back is observed. It appears in 4–5 months.

Reducing the hand-mouth, upper grasping and Robinson reflex may indicate lesions of corresponding cervical segments of the spinal cord. This applies to the Moro reflex, but its decline may also be caused by stem lesions. Expression of Moro reflex is one of the main criteria for general functional status of the newborn. Other important indicators are lower plantar reflex and Babinski reflex, the inhibition of which is possible in case of severe lesions of the nervous system. Stepping and support reflexes are often absent in children with a high body weight, Galant reflex sometimes appears on the 5th day of life. Renewal of this group of reflexes by the end of neonatal period suggests pseudobulbar affection.

The function of the autonomic nervous system in a newborn is evaluated by the balance of sympathetic and parasympathetic impact structures on such indicators as the condition of the pupils, skin, blood pressure, heart rate and breathing rate, breathing rhythm and independence, peristalsis, salivary and bronchial secretion.

Sympathetic tone is characterized by mydriasis, arterial hypertension, tachycardia, tachypnoe, and decreased bowel

motility, inhibition of salivary and bronchial secretions. Skin is pale, domination of white dermographism is observed.

Parasympathetic tone reveals in miosis, arterial hypotension, bradycardia and bradypnoe, arrhythmic breathing with apnoe attacks, excessive salivary and bronchial secretions, skin flushing, red dermographism.

In neonatal practice the instability of autonomic tone (vegetative dystonia syndrome or autonomic visceral dysfunction), is often observed, manifested in lability of pupil diameter, frequency and rhythm of the heartbeat and respiration, bronchial and salivary secretion variability. Skin acquire spotted (“marble”) look. A manifestation of autonomic dysfunction is also called Harlequin symptom (when the baby is turned to the side the lower half of the body is red, and the upper is pale).

The conclusion drawn from this examination shall include:

- a general estimation of the severity of the newborn’s condition according to neurological status;
- a list of pathological symptoms and syndromes that cause the severity of this condition;
- possible (at primary examination) etiology and nosological form of nervous system pathology (according IDC–10);
- evaluation of the child’s development and its correspondence to biological and chronological age;
- examination and treatment plan.

Transient physiological changes in neurological status are detected almost in half of healthy children. Therefore, the correct interpretation of a deviation in the neurological status of the newborn (physiological or pathological) should conduct dynamic monitoring compared to the clinical condition of the newborn in general, and in some cases there is a need for prompt additional research methods.

5. Methods of early child apply to the mother's abdomen, skin-to-skin contact

Indications:

- all healthy newborns;
- prematurely born children and children with low birth weight with gestational age more than 32 weeks in a stable condition.

Contraindications:

- severe condition of the mother (surgery, obstetric complications, physical illness);
- severe newborn's condition requiring reanimation;
- very and extremely low birth weight, gestational age less than 32 weeks.

Methodics:

1. Immediately after birth the midwife applies the child to the mother's abdomen, dries a child with a warm clean diaper. Neonatologists, obstetrician-gynecologist or midwife carry out primary estimation of the child's condition at birth (gestational age, purity of amniotic fluid, whether the baby is breathing or screaming and satisfactory muscle tone), and if the child does not need reanimation, the midwife finishes drying of head and the body of the child, puts a clean cap and socks on it and covers with a dry, clean, warm blanket and diaper.

2. After the cessation of pulsation of the umbilical cord, but not later than 1 min after birth, the midwife, changes sterile gloves, cuts the umbilical cord, the child is moved from the stomach to the mother's breast.

3. Pediatrician-neonatologist, or obstetrician-gynecologist during skin-to-skin contact estimates the condition of the newborn in case of activity and crying, by the reduced short scheme, and informs mother about the child's condition.

The midwife watches the condition of the child during the skin-to-skin contact, in case of violation of state she informs neonatologists and obstetrician-gynecologist. Every 15 minutes

she makes a note in the corresponding column of the case history of the newborn.

5. When searching and sucking reflexes appear (the child raises his head, opens mouth wide, seeks the mother's breast) the midwife helps to make first early application of the child to mother's breast. The mother is provided with information on the rules of child applying to breast and the benefits of breastfeeding for women's health are explained.

6. In 30 minutes after birth the midwife measures body temperature of a newborn in axillary area with electronic thermometer and makes notes of the thermometry results in the medical card of a newborn.

7. After eye-to-eye contact of the mother and child (within the first hour of life) the midwife makes disinfection of hands and carries out the newborn's ophthalmia prophylaxis according to current orders (using antiseptic eye drops, or 0.5 % erythromycin, or 1 % tetracycline eye ointment) according to the instruction for use.

8. "Skin-to-skin" contact is made for at least 2 hours in the delivery room when the state of mother and child remains satisfactory.



Figure 16 – Skin-to-skin contact after the birth lasts no less than 2 hours



Figure 17 – During the contact, in 30 minutes, 1 and 2 hours thermometry is carried out



Figure 18 – Measuring of tape length (length of diapers edge), which measured the length of the body of the child

9. In two hours after the birth a midwife puts a child to a warmed swaddle table, treats and clamps the cord, measures the height, circumference of head and chest, and weights it.

10. Doctor pediatrician-neonatologist, or obstetrician-gynecologist, before transferring the child to a joint stay ward provides primary medical examination of the newborn.

11. The midwife puts clean warm vests, sliders, hat, socks, and gloves on the baby. Clean home clothes are used.

12. A child and its mother are covered with a blanket and transferred to the joint stay ward.

Mistakes:

- inadequate evaluation of child’s condition;
- the absence of observation of the child during contact;
- failure in warm chain, hypothermia of child;
- lack of contact duration (less than 2 hours), dressing the child before/during contact;
- premature making of anthropometry and primary examination.

6. Method of attachment to the mother’s breast in the delivery room and early breastfeeding

Indications:

- all healthy full-term newborns.
- premature infants with gestational age > 32 weeks and newborns with perinatal pathology after stabilization of the child.

Contraindications:

- severe newborn’s condition requiring reanimation;
- prematurity (gestational age < 32 weeks or weight < 1500 g);
- severe condition of the mother (surgery, obstetric complications, somatic disease);
- the open form of tuberculosis in mother;
- HIV/AIDS of mother;
- admission of some medicines to mother;
- acute mental illness of mother.

Methodics:

In the first hour of life during the skin-to-skin contact in case of revealing signs of readiness for feeding the baby (lifts head, opens mouth, licks the skin, makes crawling movements toward the nipple, “targets” in the nipple) the present medical staff (midwife, neonatologist, pediatrician, obstetrician) helps to make the first putting of a baby to the breast.

1. The mother is in a comfortable position, calm and relaxed.
2. Baby’s whole body turned to its mother and pressed to her.
3. The baby’s head should be on the same line with the trunk and abdomen – in front of the mother’s abdomen. Baby’s whole body must be turned to mother so that during feeding there would be no need to rotate or tilt its head.
4. Child’s chin touches breasts.
5. You can touch the lips of the child with a nipple to stimulate grasping reflex. It’s better to touch the upper lip.
6. Wait until the baby opens the mouth wide in search of the nipple. Quickly attach the baby to the breast.
7. The child must cover the entire areola, not just the nipple. Do not squeeze the nipple or areola with fingers trying to push the nipple into the baby’s mouth.
8. Put the baby to the breast so that its lower lip would widely cover areola. The chin should touch breasts and the tongue must be located directly under the milk sinuses. In this position the nipple will be in the centre of its mouth and colostrums will pour down to the root of the tongue when the tongue muscle contraction will decant it by pressing the sinuses to the palate.



Figure 19 – The first feeding of a baby in the delivery room during skin-to-skin contact



Figure 20 – Improper breast application of a newborn



Figure 21 – Newborn baby correctly applied to the mother's breast

Signs of the correct application:

- baby's mouth is wide open;
- the lower lip of a baby is twisted out;
- the child takes mostly the lower part of the areola;
- the mother does not feel pain in the nipples;
- it is heard as a child swallows milk.

Early application to the mother's breast in the first hour of life, stimulation of the gastrointestinal tract with colostrums favours physiological microbial colonization of the newborn, forming a protective epithelial film involving breast milk that also favours colonization resistance and creates a biological barrier, prevents penetration of potential allergens and toxins inside the body and its sensitization.

Early initiation of breastfeeding contributes to the development and structuring of the intestine, its mucous, reticular and antigen enzyme-synthesizing structures and the acquisition of tolerance to enteral nutrition, prevention of necrotizing enterocolitis in preterm infants.

Early breastfeeding, as well as a joint stay, favour close emotional contact of a mother and a child; the newborn behaves calmly, eats often, sleeps more, develops better, mother has no worries about the child's condition, in its presence milk is better produced and secreted, biorhythms of mother and child are consistent faster.

Complications:

- milk aspiration;
- pneumophagia;
- the deterioration of the newborn's condition after suffering from asphyxia;
- cracked nipples after wrong technique of breastfeeding.

Mistakes:

- a healthy baby is not applied to the breast because of “lack of milk in the mother”;
- incorrect breast application;
- premature (before signs of child's readiness) application to breast and trying to feed the child by force;
- absence of psychological care for mother, her disbelief in the ability of feeding (following wrong application to breast).

7. Maintaining a stable body temperature in a newborn

Indications: To all newborns.

Contraindications: None.

Equipment needed:

- the warm draft-free room, locked doors and windows, central heating, additional heaters if necessary;
- source of radiant heat, mattress or cot (nest) with heating, transport couveuse;
- thermometers to measure air and body temperature (preferably electric);
- warmed clothing, hats, socks and blankets;
- transparent plastic food bag or food film;
- the presence of mother or other family members.

Methodics:

The following 10 Steps of warm chain, which are aimed to prevent hypothermia and hyperthermia of a newborn.

During the birth and in the first days after birth some steps are taken to reduce heat loss in all newborns, despite place of birth and residence – in hospital or at home. Non-compliance of at least one of these links breaks the warm chain and puts a newborn baby at risk of hypothermia. Normal body temperature of the newborn in the first days of life is 36.5–37.5 °C, the further 36.5–37.2 °C is measured in axillary area. Failure in warm chain increases the risk of neonatal hypoglycemia, metabolic acidosis, infection, respiratory disorders, central nervous system lesions (hemorrhage, seizures).

Ten steps of warm chain:

Warm delivery room (operating room)

The most important terms of the warm chain is to provide temperature not less than 25 °C in the delivery room (operating room). The room should be clean and warm, without drafts from open windows, doors and air conditioners (fans). The optimal ambient temperature for a mother and a child is considered to be 25-28 °C. Everything you need for warming a baby (diapers, hats, socks, vests, sliders, blanket) should be prepared and reheated.

Immediate drying of a child

Immediately after birth a full-term baby with clean amniotic fluid (before cutting the umbilical cord) the midwife dries the baby's body and head on mother's abdomen with warmed diapers.

If reanimation is required, it is necessary to cut the umbilical cord, to put the baby on a warm surface under radiant heat source, and after sanitation to finish drying; put off wet diapers, put on a baby a clean cap and socks, without stopping reanimation.

The child with gestational age < 28 weeks and weight less than 1500 g immediately after birth must be put into transparent

plastic food bag or wrapped in film package with a cut for baby's head, and one must put on it a cap. In 1 minute or after cessation of pulsation of the umbilical cord, one must transfer it to radiant heat source that warms the baby through the film. All reanimation is carried out without removing the film. If you need to establish venous access, the tape is cut in the abdomen area. Transportation of the child to intensive care unit is carried out in the film in the transport incubator, the film or package is taken away in the department only.

A healthy child before cutting the umbilical cord after the first drying is left on the abdomen of the mother and drying is finished. Wet diapers should be put away, one must put on a baby a clean hat and socks and cover it with a clean, dry, heated diaper.

Skin-to-skin contact

Skin-to-skin contact prevents heat loss and favours colonization of the child with microflora of the mother. The baby lies naked in socks and a cap on mother's abdomen covered with clean, heated diaper and a blanket shared with mother and is staying like this up to 2 hours, then they should be also transported to a joint stay ward.

In order to monitor the observance of warm chain every 15 minutes one must touch the baby's legs, normally they should be warm, and in 30 minutes, 1 and 2 hours after birth measurement of the body temperature is carried out in the axillary area of a newborn with electronic thermometer.



Figure 22 – Immediate drying and long lasting skin-to-skin contact with mother – safe and effective link of warm chain



Figure 23 – Skin-to-skin contact with father after birth by Caesarean section

During joint stay body temperature of a newborn is measured every 6 hours with thermometers, and tactile – after every change of diapers. If the limb is cool, one should measure temperature with thermometer. If the temperature is less than 36.5 °C, immediately warm the baby, feed it, check blood glucose levels, observe the child for at least 6 hours after restoration of normal temperature. In a child weighing <1500 g the temperature is measured every 3 hours. In case of hypothermia till its

elimination it is necessary control body temperature every 15–30 minutes.

Breast feeding, energy support

If the child's condition allows, one should begin breastfeeding as early as possible during the first hour after birth after the signs of readiness to start feeding. Do not force a child to start the first feeding, if he does not show specific signs.

If the child's condition is severe, it is transferred to the neonatal intensive care unit, where it should be possible to immediately establish venous access and start parenteral nutrition.



Figure 24 – Additional protection of a child with very low birth weight – a plastic transparent bag

Postpone the weighing and bathing

Bathing and weighing of the newborn immediately after birth leads to heat loss, so they should be postponed. Blood, meconium are partially removed from the skin newborn during drying after birth. Remains of generic lubrication are not removed. During the first days small contaminated areas of the newborn's body are gradually purified using warm water, liquid soap, and wet wipes with obligatory fast drying of damp areas and warming the baby. It is advisable to make the first bathing at home or after

prescription in case of prolonged hospital stay.

Weighing and child anthropometry are carried out after the skin-to-skin contact and the first application to mother's breast before transferring to the ward of compatible stay (2 hours after birth). Weighing and anthropometry after reanimation are carried out after stabilization of the child or establishing life-saving support in the department. It is optimal to use scales inbuilt into a couveuse.



Figure 25 – The child in the crib should be dressed so that clothes should not restrain freedom of movement



Figure 26 – Thermometry of sick child is carried out regularly despite the presence of servocontrol

Wrap and dress a child properly

Tight swaddling is harmful for newborn and reduces the effectiveness of keeping the child warm, restricts breathing and general movements of the child, worsens the microcirculation in areas of tight swaddling, reduces the child's activity and the frequency and number of feedings, which results in hypoglycemia, atony and increased weight loss.

That is why, the child should be dressed in clean warm sliders, shirt, socks, diaper, other clothing, depending on the mode of nursing. The child must be naked when staying under the source of radiant heat and in a modern couveuse. In the old couveuse, where there is air circulation, the child is dressed and covered with a blanket (except when supervision or phototherapy is necessary). To control body temperature use skin sensors. In the bed with heated place a baby must be dressed in warm vests, sliders and covered with a warm blanket. A healthy child is dressed in a clean warm shirt, romper, hat, socks and gloves, and if necessary, is covered with a light blanket.

Round-the-clock joint stay of mother and child (rooming-in)

If the condition allows, a child should stay during the whole day with its mother in one room, that providing conditions to keeping a body temperature of the child, breastfeeding on demand and prevention of nosocomial infections. If a child is treated in the neonatal intensive care unit, the mother helps to care, feed (after training) during the whole day. The newborn should be with its mother around the clock in the same room.

Joint mother and child stay creates the most optimal conditions for maintaining constant body temperature of the newborn because:

- *the baby is fed on demand, as often as it wants;*
- *the mother observes the child, measures the temperature more carefully, than the medical personnel;*

– nothing can warm up a baby better without the risk of overheating than a close skin-to-skin contact with the mother staying next to her in the same bed.

Transportation in warm conditions

The newborn should be transported to the ward of compatible stay together with its mother in skin-to-skin contact. When a child is born by cesarean section it is transported in a couveuse or baby cot covered with a warm blanket or in skin-to-skin contact with a family member.

If a child should be transported to another department or hospital to prevent the occurrence of hypothermia you should provide support and control of body temperature during transportation. Use transport couveuse or heated crib (with battery), covered with a warm blanket.

Reanimation in warm conditions

Newborn baby with asphyxia has an increased risk of hypothermia that is why reanimation should be done only in warm conditions, following all the links of the warm chain, especially in premature children with a low and extremely low birth weight.

Reanimation of newborn babies born with asphyxia who require intensive care to restore vital functions is carried out quickly and co-organized on a warm, preheated surface under radiant heat source in a warm draft-free room. The child should be dry as soon as possible, in case of clean amniotic fluid it can be done simultaneously with conducting rapid evaluation and subsequent cutting the umbilical cord.

Then the baby in a warm dry diaper or in a transparent plastic food bag or film (for newborns weighing less than 1500 g) is quickly transferred to the reanimation table with warm surface under a radiant heat source. Diapers are taken away because radiant heat warms only physical body, and thermal conductivity is better than in cotton. If the baby is covered with a diaper, it can cool more because diaper is a barrier to heat rays. Reanimation of newborns with very low and extremely low birth weight is carried out in plastic bags, the air access to which is maximally limited.

According to recent recommendations the primary reanimation with AVL starts with room air, if necessary use oxygen. It is desirable to use oxygen-air mixture, if possible, to warm and humidify oxygen.

Increasing the level of training and experience

All health care workers and people who take care of the newborn should have appropriate training and skills in compliance with the principles of thermal chain. The parents should understand well the importance of maintaining a normal body temperature of a newborn baby.

Further treatment of the sick child at all stages should be carried out in strict compliance with warm chain.

The temperature in the chamber/room where a child is dressed must be at least 22 °C, optimally – 25–27 °C.

For prematurely born children the couveuse should have double walls, and in case of transporting them to open intensive care systems use cling film to maintain constant moisture and prevent air movement. Being in a bag a newborn is transported under a radiant heat source, all reanimation and transportation to department are carried out in a bag that is taken off only in intensive care ward.

When using temperature sensors under a radiant heat source the active element of the sensor should be covered with special reflective stickers or pieces of foil, mirror film. If servocontrol is missing in the couveuse, the temperature or radiant heat lamp intensity is set according to the tables and the body temperature of a child is measured hourly for individual selection of the required parameters. Even if servocontrol is present, axillary temperature should be measured every 6 hours with electronic thermometer. For treatment of a newborn it is necessary to use warm (according to the body temperature) solution for infusion, enteral and parenteral administration. Diagnostic and therapeutic devices should be warmed before contact with the

child. Oxygen or oxygen-air mixture that is used for respiratory support of infants should be warmed and moistened.

Try to avoid excessive wetting of the child's body with fluid, oil. Despite the method of treatment the child must be dressed in hats, socks, if needed – gloves.

The movement of air in couveuse is inappropriate, do not open the door (unless you need to take out or put in the child), use windows, do not leave them open unnecessarily. Do not remove the child from couveuse unless it is necessary. Examination, most of manipulations, even changing diapers and rollers can be done through the window together (one person picks up the child, the other gently replaces diapers through the window on the other side). Couveuse/crib should not be closer than 80 cm from the wall (to prevent loss of heat by radiation), and so that access to the child was easy from both sides.

Clinical signs of hypothermia:

- the child is cold by touching;
- total cyanosis, acrocyanosis, marble skin;
- refusal or inactive sucking, poor digestion, vomiting, abdominal distension;
- tachypnea, shallow and irregular breathing, apnea;
- bradycardia;
- reduced motor activity, hypotension, hypersensitivity, hyporeflexia, areflexia;
- weak cry, atony;
- welts, swelling, sclerema;
- hypoglycemia.

The temperature 36–36.5 °C is considered as mild hypothermia (cold stress).

The temperature 32–36 °C is moderate hypothermia.

The temperature less than 32 °C – severe hypothermia.

Treatment of hypothermia

In *mild hypothermia* you should warm up the baby as soon as possible: to provide skin-to-skin contact, put on socks and a cap, cover mother and the child with extra blanket or place

under a radiant heat source, a warm couveuse/heated bed, or increase the temperature of the heating equipment, if the child is there. Warm up to 37 °C. Control body temperature every hour. Breastfeeding, warm breast milk or mixture for energy supply are usual.

In case of moderate hypothermia – warm up, as described in the previous paragraph, provide breast, tube or alternative feeding or parenteral administration of glucose. Warm up to 37 °C and control body temperature every hour. Watch the child's condition, as hypothermia can lead to severe disorders of respiration and circulation, cause acidosis and activate inflammation. Provide help if needed.

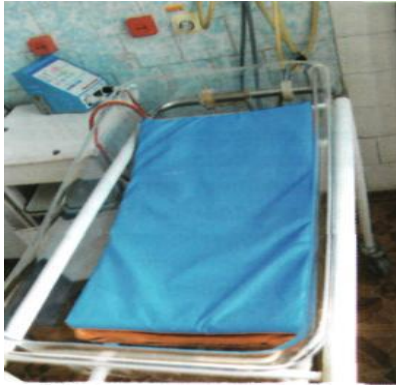


Figure 27 – Crib with electric mattress

In case of *severe hypothermia* the child needs emergency relief, rehabilitation and normalization of basic life functions. In this case warming up to 34 °C should be quick and further – gradual (several hours), fast warming from 32 °C to 37 °C can lead to overheating, hypoxia (due to increased oxygen demand), activation of inflammatory processes (through anaerobic glycolysis, rapid redistribution of blood flow), worsening of the newborn's condition may lead to complications. Extra oxygen and energy support are required.



Figure 28 – Nest in bed



Figure 29 – Protection of temperature sensors from radiant heat

The best treatment of any hypothermia is prevention!

Complications:

There are no complications in case of the right following of all the links.

Mistakes:

– overheating when using heating devices without servocontrol, that's why a child gets sunlight or other heat rays from sources that are not taken into account (radiators);

– burns after using hot-water bottle or a violation of a safe distance to the heating unit installed by the manufacturer. Using hot-water bottle with hot water can cause skin burns of a newborn. If necessary to use them, heat only a bed or blanket before putting the child, but not a newborn;

– shielding of a baby with a diaper under a radiant heat source leads to cooling of the child, because the rays warm the diaper, not the child;

– heating of an apartment and a child with fan heaters, air conditioners leads to the increased air flow, promotes heat loss by convection, evaporation (direct warm air toward the child, the minimum wind power);

– setting the reanimation table, scales, beds etc. close to a wall or other cold items contribute to the loss of heat by radiation (0.8–1 m to the wall);

– cold surfaces and objects, clothing, hand tools affecting the child, contribute to the heat loss by conduction (all must be pre-heated);

– application for reanimation of the cold, not warmed oxygen promotes heat loss by conduction, convection, evaporation (preferably use humidified, warmed oxygen), the administration of cold solutions isn't possible;

– hypothermia or overheating of a child during reanimation if there is no control of body temperature. Use skin sensors or measure the temperature every 15–30 minutes;

– improper work of thermometers and temperature sensors can lead to overheating or supercooling of a child.

8. Check of esophageal patency

Indications:

- polyhydramnios (large amount of amniotic fluid);
- detection of a small stomach in a fetus, or its absence during prenatal ultrasound screening of pregnant;
- the presence of the following clinical signs in newborn:
 - a large number of foamy discharge from the mouth;

- when you try to feed your baby, milk returns;
- coughing bouts with apnea, cyanosis.

Healthy babies do not need routine check of esophageal patency.

Contraindications: Hard condition of the child requiring reanimation – esophageal patency test is performed after stabilization of the child’s condition before feeding.

Preparation of the patient: Warm provided until the first feeding/application to the chest, on the back.

Equipment needed:

- availability of moist oxygen source;
- equipment for mechanical ventilation (bag and mask);
- electric pumps;
- catheter for sanitation of upper airways;
- gastric tube;
- 10–20 ml sterile syringe;
- phonendoscope.

Technique:

- wash hands, wear sterile gloves;
- check availability and serviceability of equipment;
- during the procedure control (preferably with a monitor) the heart rate and respiratory functioning;
- measure the depth to which the tube will be entered: distance from the root of the nose to the child’s ear lobe plus distance to the xiphoid process. Put the true mark on the tube;
- put the baby on his back, to make sanitation of the upper respiratory tract;
- moisten the tip of the tube with sterile distilled water or 0.9 % NaCl solution;
- enter a tube through the mouth, press the tongue and squeeze the tube to easily enter the oropharynx. Move slowly the tube to the required depth;
- continue to observe the child, because disorders of breathing or bradycardia may occur when you enter the tube;

– if the tube is entered easily without resistance, the measured depth in the stomach, connect the syringe and take gastric contents;

– if you have doubts about the patency of the esophagus and the location of the tube you should enter slowly to a syringe tube 2.3 ml of air while auscultating with a phonendoscope the noise over stomach and airways;

– after the procedure remove the tube or leave it for sanitation in case of revealing obstruction and/or trachea–esophageal fistula, fix it with a plaster.

Complications:

– the development of arrhythmias and bradycardia;

– laryngospasm;

– the risk of infection (high).

Mistakes:

– routine checking of esophageal patency in all newborns;

– incorrect selection of the diameter of the tube;

– apply additional efforts in case of resistance during conducting of a tube could cause mucosal injury and bleeding.

9. Care of umbilical cord stump and umbilical wound

Indications: To all active newborns.

Contraindications: None. If umbilical cord vessel is catheterized, daily change of dry bandage with an overview of the surrounding areas is performed, if necessary, palpation, cord and around skin treatment with antiseptic.

The methods of making:

Care for the umbilical cord stump:

1. It is taken daily to the falling off the umbilical cord stump.

2. Treat hands, use gloves if necessary.

3. The clamping and cutting of a cord is made under aseptic conditions using sterile instruments and sterile gloves, the clip is applied at a distance of 0.3–0.5 cm from the umbilical ring.

4. The umbilical cord stump should not be covered or bandaged with diapers; it must be open to the air.

5. During joint stay there is no need in treating with antiseptic and antibacterial medicaments the clean and dry umbilical cord stump that has no signs of inflammation.

6. In case of absence of early skin-to-skin contact of a mother and a child and subsequent separation from the mother, an umbilical cord stump and wound are treated with a solution of brilliant green or other skin antiseptics.

7. Child's clothes should be clean, to avoid friction and other effects of rubber belts and thick clothing details, diapers should be at the umbilical cord stump.

8. It is necessary to maintain the umbilical cord stump dry and clean.

9. In case of contamination of the umbilical cord stump (remains of urine, stool, etc.) you should immediately wash the vestige with warm boiled water with soap and dry thoroughly with a clean diaper or cloth.

10. Look at the following signs of infection: the appearance of redness, swelling, discharge, odor – treat them with antiseptic.



Figure 30 – Clip on umbilical cord stump



Figure 31 – To avoid skin irritation, don't cover umbilical cord stump with diapers

11. The child can be discharged home with clamped umbilical cord stump that has no signs of infection, after the mother's training and skills development about care for the umbilical cord stump and wound.

12. The normal term of falling off of umbilical cord stump is 5–15 days.

Care for the umbilical wound:

1. It is taken daily until complete epithelialization of the umbilical wound.

2. Always wash your hands thoroughly before dressing, changing a diaper.

3. You should maintain the umbilical wound always dry and clean.

4. Do not cover the umbilical wound with diapers, to avoid friction and other effects of rubber belts and thick details of clothing, diapers should not cover the area of the umbilical wound.

5. Bathe a baby in boiled water until the umbilical wound healing, after that dry the wound and treat if necessary.

6. Look at the following signs of infection: redness, swelling, discharge, and odor. Their appearance needs treatment with hydrogen peroxide and antiseptics (avoid using aniline dyes

before medical examination). Provide inspection and supervision of a pediatrician-neonatologist. Further treatment depends on the child's condition.



Figure 32 – Dry umbilical wound

Complications:

- traumatic affections of the skin around the umbilical cord stump/wound;
- infection (omphalitis, sepsis, osteomyelitis);
- cutting, tearing of umbilical cord and bleeding from the umbilical vessels.

Mistakes:

- care does not follow the rules of antiseptics;
- clip is put far from the umbilical ring, long umbilical cord stump (the distance from the skin to the clip is more than 0.5 cm);
- too frequent treatment (more than 1–2 times a day), the routine use of antibiotics and antiseptics.

10. Hygiene of a newborn

Indications: All healthy newborns.

Contraindications: None. If there are special conditions, prematurity, birth defects that require special care – hygiene measures are carried out by the same rules, with particular features.

Methodics:

A newborn baby should be in a clean, well-ventilated room, free of unnecessary items. Daily wet cleaning of surfaces and floors should be made with specific solutions (but not chloride or other disinfectants containing) in the room where the child is.

A place, where the child is, should be comfortable, draft-free. It is not recommended to put the crib near radiators and the place shouldn't be exposed to direct sunlight. Never leave a heating device in a bed of a newborn baby. The temperature of the air in the room, where the newborn is, should be maintained within 22–24 °C.

Use a crib with mattress, providing a slight rising of the upper body of the child due to a small flat pad, planted under the mattress, which contributes to improvement of lungs ventilation and facilitates the movements of the diaphragm. Wrap a mattress with a cotton blanket, put on it a diaper folded several times. A healthy child is lying in bed on his back, his position can be changed slightly, placing the roller made of diapers or a blanket, to lay the child “half-turned”. The child should sleep with a duvet blanket and wear a cap.

A newborn baby is dressed in two vests, sliders, socks, gloves, enclosing diapers (gauze, cotton or disposable industrial production). When leaving for a walk it is better to wear disposable diapers. No matter what diapers are used, they should be changed at least every 3–4 hours. A cap is put on a baby's head after bathing, sleeping, walking and ventilation of the room.

Hygienic care of newborns.

Your hands should be washed/dried and treated before any touching a newborn baby.

In the morning, the child is washed in boiled water; wash eyes with cotton balls moistened in boiled water from the outer corner of the eye towards the nose (for each eye using a separate ball).

Clean the nose if necessary. The nasal passages of a newborn are cleaned with cotton flagella (no sticks) moistened in boiled water, oil or dry flagella if discharges are wet. If there are discharges or it is difficult for child to breathe because of the narrowing of nasal passages, the purging of nasal passages is carried out before each feeding to ensure normal nasal breathing during sucking. A few minutes before the procedure instill 1–2 drops of physiological saline into each nasal passage. Sometimes a simple application (dripping) of this solution is sufficient to restore patency of the nasal passages.

Ears of a baby are wiped with a cotton ball just outside near the entrance to the ear canal. Do not clean the ear canal with sticks, it can cause injury.

You should examine daily the skin folds outside of the ears, neck, axillary and inguinal areas, near the genitals, dry them thoroughly after bathing/washing, if necessary use special baby cream. It is inappropriate to use skin powders and ointments without medical indications. During each dressing you should monitor the condition and cleanliness of the skin. At first manifestations of irritation or rash you must start local therapy. In the presence of irritations use creams based on zinc, which also reduces symptoms of ecchymosis, accelerates the resorption of subcutaneous hematoma. To speed up the healing in lesion of the integrity of the skin, you can use panthenol ointments. The use of local antiseptics may be indicated in case of secondary infection of mechanical damage.

After each defecation a child should be washed under running water with a temperature of 37 °C – girls are washed “from front to back” to prevent the ingress of feces to genitals, but it is more convenient to wash boys “from back to front” as it is easier to keep the baby.

The umbilical cord stump and wound are always needed to be kept dry and clean, do not cover this area with diapers. If the clip is on the umbilical cord stump, it is not necessary to be treated, provide a child with clean clothes and protect the

umbilical cord stump from contamination with urine and feces. In case of feces or urine contamination of the umbilical cord stump it should be rinsed with warm boiled water and soap and dried with clean cloth. After separation of the umbilical cord stump until healing of umbilical wound you should bathe the child in boiled water, the umbilical wound should be dried after bathing. If signs of inflammation appear (redness, allocations, swelling, bad smell) in the morning it should be treated with hydrogen peroxide and alcohol antiseptic, call a doctor immediately. Until the doctor's examination do not use the brilliant green, as intense colour may interfere with diagnosis.

Bathing of a newborn child. A healthy newborn baby is bathed at home after the umbilical cord fall off. It is recommended to bathe the baby daily, preferably before the evening feeding (after bathing and feeding the baby sleeps well). In the first months of life a child is bathed in boiled water with the temperature 36–37 °C. The water temperature for bathing of a newborn should be selected individually, bathe no more than 10 minutes, 1–2 times a week, wash your child with low-alkaline (liquid, children) soap. The water temperature should be measured in a bath with a water thermometer, you cannot orientate yourself by the sensitivity of the hands (sensitivity about the elbow can specify the needed range). After bathing the child is over with warm (34–35 °C) water, wiped dry quickly with a warm towel or diaper, and dressed.

As for the bathing of a sick child who is in the hospital, its duration and additional measures are assigned by the doctor. Normally, it lasts less, liquid baby soap, herbal teas are used, but rinsing is not used, after a quick drying a child is immediately warmed. Do not use it routinely: the skin of a prematurely born child is lipophilic, prone to self-cleaning, peeling (as in the utero), glands are significantly less effective than in full-term, there is a risk of infection and cooling.

It is better to be under the sun from 9 to 11 am and from 17 to 19 pm. In winter you can walk with your child outdoors at

temperature not less than – 5–10 °C. During good weather you can walk in the fresh air several times a day, limiting a single stay outside up to 0.5–2 hours depending on the age of the child and the temperature outside. In case of the prolonged hospital stay in the absence of contraindications a newborn is prescribed short-term walks several times a day.

Dress a baby for a walk according to the weather so that he or she is not overheated and not frozen. This is usually plus one extra layer of clothing to adult's ones, which is for a baby under these conditions. After walking a child's clothing should be immediately changed, and check if he's sweating or became cold. In extreme cold or precipitations, a child is left at home but you should provide a “veranda walk” when a warmly dressed and covered baby is in the room but not in front of an open window/ventilator. If a child is sick, you should thoroughly ventilate the room in the absence of the child, then the child is moved to the ventilated room and you can ventilate another one.

Complications and mistakes may occur in case of incorrect techniques of procedures making:

- injury of the mouth, nose, ears, eyes, skin;
- infections of the umbilical cord stump or umbilical wound, eyes, genitals;
- hypothermia of a child;
- overheating in a bath with hot water, drowning.

11. Estimation of the physical development of a newborn

Indications: All newborns.

Contraindications: Do not exist. If a child is in a serious condition, estimation is made after emergency help and provision with the required parameters of life.

The required tools, preparation of a child:

- scales with a clean home, or sterile disposable diaper;
- individual measuring tape or sterile paper tape;
- forms to be filled.

Estimation of the physical development is made by a pediatrician or neonatologist after the primary examination of a newborn. The evaluation is carried out in a bright warm draft-free room, following the warm chain links. Scales must be moved away from the wall not less than 0.8–1 m.

Technique:

1. Weighting: put a newborn in a sterile diaper equilibrated on scales and determine his weight.

2. Body length is determined with elongated feet from the occipital to the heel tubercles.

3. Head circumference is measured with a sterile tape by line connecting superciliary curves and occipital tubercle.

4. Chest circumference is measured with a sterile tape at the line connecting the nipples. After birth a healthy child's head circumference is 1–2 cm larger than the circumference of the chest. After 3 days it is recommended to repeat the measurement of the body length, head circumference and chest, because by this time the configuration of the head is changed and the labour tumour disappears.

5. Estimation of the size and condition of a large and small fontanel is made after birth and during the daily examinations: the size is measured between opposite sides (not corners) of the large fontanel. The maximum size is 3×4 cm – usually achieved by the age of 1 month. A size of the small fontanel is measured if it exists, also note the width of the skull sutures if it exceeds 0.3 cm. The data is noted in the development history of a newborn, in case of deviations (low weight, premature birth, hypotrophy, etc.) a proper form is filled.



Figure 33 – Weighting of a newborn baby



Figure 34 – Measurement of the head circumference



Figure 35 – Measurement of the chest circumference

Evaluation of anthropometric data is made according to percentile tables.

Measurements included in the interval between 10–90 percentiles meet a satisfactory physical development of a child, appropriate for gestational age (AGA).

More than 90th percentile – a child is large for gestational age (LGA).

Lower than 10th percentile – a child is small for gestational age (SGA).

If the baby weight is less than 2500 g or measurements are beyond 10–90 percentiles you should make estimation of the morphological and functional maturity.

Complications, mistakes:

- hypothermia of a child in case of failures in warm chain;
- injury of the baby's skin by ends of the metal tape;
- infection after improper disinfection of measuring tape.

To prevent it you should use individual measuring tape or make measurements with sterile cloth tape without divisions and make corresponding notes there, and after examination measure the distance to the marks by a ruler;

– incorrect indications of parameters in case of measurement techniques failures.

12. Evaluation of gestational age, morphological and functional maturity of a newborn

Indications:

- infants with low birth weight;
- inconsistency of physical development to gestational age.

Depending on the number of points the Ballard score lets to set the gestational age of the child within 26–44 weeks.

Contraindications: do not exist. The evaluation is carried out after stabilization of the child's condition. If the child's condition does not let evaluate neuromuscular maturity (mechanical ventilation, sedation, etc.) estimate only morphological and physical maturity.

The necessary equipment, preparation of child:

- baby changing table with heating, enough of daylight;
- forms to fill (new Ballard score).

Methodics:

Evaluation is made at the age of 12–36 hours of life, in a bright warm room without drafts following warm chain links. Evaluate morphological, physical and neuromuscular maturity (corresponding to a table). The evaluation is based on the total consideration of neuromuscular maturity indicators and indicators of physical maturity. Each of the indicators included in the scale is evaluated in points, the amount of which can range from 0 to 50. Indicators of physical maturity are examined at objective examination, studying of neuromuscular maturity is made when the child is resting and lying on his back.

Estimation of physical maturity

Skin, depending on gestational age, can be – pink, erythematous, cyanotic, shiny, gelatin, matte, may be covered with grease, swelling, visible veins, superficial peeling, rash, cracked, missing or thinned subcutaneous fat.

Vellus hair (lanugo) – is absent, single, much, fine, covers most of the back and extensor surfaces of the extremities, some parts of lanugo.



Figure 36 – Premature baby, gestational age of 34 weeks



Figure 37 – The full term newborn with intrauterine growth retardation

The sole. Estimate the size of the foot and heel, the presence, severity and prevalence of wrinkles, visible red scratches.

Breast, invisible or barely visible, flat areola, nipple comes out or does not come out of the skin's surface, its size; in infants with gestational age approaching 37 weeks, areola is formed, the

nipple – 5 mm.

Eyelids: open, closed, tightly closed.

Ears: moderately curved, soft; evaluate the presence of cartilage cracking and ability of straightening after bending – not straightening, slowly, quickly in infants with gestational age approaching 37 weeks, ears are well twisted, soft and are easily straightened or not bending.

Genitals: boy's scrotum can be empty or testicles can be found in the inguinal canal, estimate folds of scrotum's skin; in infants with gestational age approaching 37 weeks, both testicles are located in scrotum, but they can easily hide in the inguinal ring when pressing on them.

In girls, the clitoris can exceed the bounds of flat small labia, small and large labia can exceed the same way, at 37 weeks large labia are bigger, but do not cover up small ones fully.

Assessment of neuromuscular maturity

Pose of a child. Mark 0 points – the upper and lower limbs are straightened; 1 point – initial bending of the lower extremities in the hip and knee joints, upper ones – straightened; 2 points – more bending of the lower extremities, upper – straightened; 3 points – slightly curved upper limbs, lower – bent and moved apart; 4 points – full flexion of the upper and lower extremities.

Square foramen. The hand of a newborn pressed between the thumb and forefinger of a doctor is bent toward the forearm. During this manipulation do not allow a rotation in a radio carpal joint of a newborn.

Reaction of hands. The child lies on his back, upper limbs are bent at the elbow; hold in that position for 5 seconds and then unbend completely by pulling the hand and abruptly releasing it. If the upper limbs are unbent or only their involuntary movements occur, score 0 points; if the angle at the elbow is 100–180° – 2 points; if the angle is 90–100° – 3 points; if the angle is 90° – 4 points.

MATURATIONAL ASSESSMENT OF GESTATIONAL AGE (New Ballard Score)

NAME _____ SEX _____

HOSPITAL NO. _____ BIRTH WEIGHT _____

RACE _____ LENGTH _____

DATE/TIME OF BIRTH _____ HEAD CIRC. _____

DATE/TIME OF EXAM _____ EXAMINER _____

AGE WHEN EXAMINED _____

APGAR SCORE: 1 MINUTE _____ 5 MINUTES _____ 10 MINUTES _____

NEUROMUSCULAR MATURITY

NEUROMUSCULAR MATURITY SIGN	SCORE							RECORD SCORE HERE
	-1	0	1	2	3	4	5	
POSTURE								
SQUARE WINDOW (Wrist)								
ARM RECOIL								
POPLITEAL ANGLE								
SCARF SIGN								
HEEL TO EAR								
TOTAL NEUROMUSCULAR MATURITY SCORE								

SCORE

Neuromuscular _____
Physical _____
Total _____

MATURITY RATING

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

PHYSICAL MATURITY

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

GESTATIONAL AGE (weeks)

By dates _____
By ultrasound _____
By exam _____

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

Popliteal angle. A child is lying on his back; pelvis pressed against the surface of the table, the doctor's forefinger of his left hand holds the hip in knee-chest position, supports knees of a newborn with a thumb. Then lower extremities unbend by light pressure with the index finger of his right hand on the back surface of the ankle joint and popliteal angle is measured.

Symptom of scarf (oblique movement). A child is lying on his back, upper limb is taken by hand and try to push as much as possible behind the neck over the opposite shoulder. The implementation of this movement helps the movement of the elbow along the body. Grade 0 points if the elbow reaches the anterior axillary line; 1 point – elbow between the midline of the body and the opposite axillary line; 2 points – elbow reaches the midline and 3 points – elbow does not reach the midline.

The traction of the heel to the ear. The child is lying on his back; foot is pulled to the head effortlessly. Determine the distance between the foot and head, as well as the degree of limb extension in the knee joint. Results are evaluated in points.

Determination of gestational age by Ballard score:

Indicate (cross out) in the table the cell that corresponds to a particular sign of the child. After evaluating all criteria calculate the amount of points and according to the table on the right side determine the gestational age of a child.

If you cannot objectively evaluate neuromuscular maturity (a child receives sedatives or is on AVL), evaluation of physical maturity is multiplied by 2 and evaluate the results. The accuracy of the child's age may vary within two weeks of gestation.

Complications, mistakes:

– exhaustion of the premature baby due to long review. To prevent it, make examination and evaluation gradually estimating separate stages;

– hypothermia. To prevent it, the examination is carried out under a radiant source of heat or couveuse through the window (panel doors of the couveuse are not opened, a child is not removed);

– estimation by Balard score is made immediately after birth or in the first few hours of life: evaluation of neuromuscular maturity should be made at the end of the early period of adaptation, aged 12–36 hours.

13. Cleaning of hands by medical staff and persons taking care of newborns

Indications:

- any contamination of the skin;
- before putting on and after removing gloves;
- before and after each contact with the equipment for newborn care;
- at the end of the manipulation of a patient’s organ and before the manipulation on other ones in the same patient;
- before preparing medications, solutions, meals etc.;
- after the contact with equipment and materials that could be contaminated or contain microbial biological fluid of the patient.

Contraindications: Do not exist.

Required tools:

- sink with a lever tap that opens/closes with an elbow, warm water;
- fastened on the wall dispensers with liquid soap and alcohol-based antiseptic;
- paper towels for single use;
- trash bin with a lid that opens with foot (with pedal);
- the clock on the wall.

Methodics:

Before cleaning of the hands at the beginning of the day/duty the medical personnel should remove rings, bracelets, watches, hands should be free from clothing and jewelry to the elbow. For the medical personnel the artificial nails or cracked nail polish, fresh wounds and scratches are more dangerous place for contamination and transferring of microorganisms, so it is better to do hygienic manicure 1–2 days before a duty and

cosmetic manicure – after a duty or working week, and remove nail polish before the next duty.

There are traditionally such groups of hand cleaning as routine washing, hygienic antiseptics, and surgical antiseptics. You must wash hands: when coming to work, after using the toilet, before and after eating or when they become dirty. In other cases the personnel working with newborns needs hygienic and surgical antiseptics.

For mothers and relatives who take care of their child, usual hand washing is sufficient when providing all necessary movements. Antiseptic hand treatment with alcohol containing antiseptic is allowed. A mother must wash her hands before pumping milk, feeding, diapering and any other touching of a child, medicines, or care items.

Routine washing is carried out using liquid soap and paper towels. Brushes are not used; they violate the protective barrier of the skin and can be breeding ground for microorganisms. Pressing the dispenser with soap is made with external surface of the wrist or elbow. We recommend using disposable containers. If necessary, it is allowed to fill the new portions of liquid soap into thoroughly cleaned and dried bottles and dispensers. Duration of washing is about 1 minute, soaping hand movements should be performed according to the table, at least 10 movements in every single area. In general, friction is made for at least 30 seconds. After that wash hands under running water, holding fingers above your wrists.

Hands drying should be with a single-use paper towel, dry clean towel or dry sterile cloth. Before the contact with a newborn and after it you should make hygienic hand antiseptics.

Gloves are used in each case, when the contact with body fluids is expected (protection of personnel). Using gloves does not replace and does not negate the need of washing or hygienic hand antiseptics, made before and after using gloves.

Sterile gloves are used in case of vein puncture, umbilical vein catheterization, lumbar puncture, trachea and other

interventions on the internal organs and body fluids of patients that are usually sterile. In other cases it is enough to use clean disposable gloves.

Do not use gloves containing talc. When working with blood vessels (vein puncture, setting umbilical catheter etc.) penetration of talc from gloves to newborn blood flow can cause significant complications.

The sterilization of disposable gloves **is not allowed** (under high temperature the material from which gloves are made is destroyed, increasing their penetrability and they do not prevent the ingress of microorganisms from a patient to the staff hands and staff microflora to a patient, too).



Figure 38 – Intensively rub hand to hand and palm to palm, including wrists to distribute soap or disinfectant



Figure 39 – Intensively rub with the back of the fingers of the other hand



Figure 40 – Carefully rubbing all surfaces that come into contact, right hand above left hand back side and vice versa, including the interdigital spaces



Figure 41 – Intensively rub thumbs in a circular motion, including pads of the thumbs



Figure 42 – Intensively rubbing the inner surfaces of the palm and fingers, including the interdigital spaces, make movements up and down, shifting by 1 finger



Figure 43 – Intensive circular motion rubbing fingertips on the palm, fingers making circle movements on the surface of the palm

Hygienic antisepsis – washing with antibacterial soap and water-based or waterless antiseptics (based on ethanol or propanol). Due to the time required to achieve the necessary antiseptic effect, preference is given to modern antiseptic containing alcohol (alcohol solutions and gels). Apply alcohol containing antiseptic to a dry, intact skin.

When applied to damp skin (immediately after washing) full disinfection is not achieved and the skin can be irritated. So, if visually hands are clean, it is enough to treat them with antiseptic, following cleaning time according to the instructions (usually 30 seconds), making the necessary movements when rubbing antiseptic. Antiseptic should be applied to the palm of your hand in the required amount (3–5 ml according to the instructions for use), intensively rubbed into your hands by the standard procedure, until dryness, every movement is repeated at least 5 times.

If antiseptic is evaporated before completing all the required movements, add antiseptic and finish cleaning from the point where you interrupted. If after all the movements hands remained damp, you should continue rubbing hands until antiseptic is evaporated.

Surgical antisepsis is carried out before any manipulation on vessels and wound surface (treatment of umbilical cord, catheterization, intraarticular and lumbar puncture, etc.). Use the same antiseptic preparations, only with more processing time (according to the instructions the contact of skin with an antiseptic is 2–3 minutes). Method of treatment is the same, but additionally clean forearm and elbow bending surface, after cleaning use sterile rubber or latex gloves without talc.

Hands skin care is essential for the prevention of nosocomial infections, since only intact skin can be effectively treated with antiseptics. Care is performed by using modern creams and lotions specifically designed for use with antiseptics. Several times during the duty, if soon contact with patient is not expected (after morning or evening examination, procedures, before working with documentations), cream or other means of skin care should be applied to hands.

Complications, mistakes:

- contact dermatitis in case of individual hypersensitivity to disinfectants, preserving agents, fragrances, etc.;
- sweating under gloves during prolonged, improper use, putting on damp hands, contact with talc – swelling, skin irritation, dryness, etc.;
- dry hands, cracked, infection, and fungal superinfection after improper washing technique, strong rubbing, using brushes, applying alcohol solution to damp skin.

14. Reduction and prevention of pain. Anesthesia of a newborn baby

Indications:

- all newborns during any manipulations and operations related to the violation of the integrity of skin and stimulation of pain receptors;
- infants with birth defects, after asphyxia or birth trauma and other conditions that require stress response and disrupt physiological adaptation;

– in children born prematurely, the ability to feel pain is even greater than in full-term, but the ability of the organism to respond to irritation is decreased. Despite the lack of external manifestations of pain, suffering from the consequences of pain in preterm is significant for the current disease and long-term outcomes.

Contraindications: Do not exist. Depending on the condition, gestational age and manipulation it is necessary to choose an individual method of anesthesia: special care measures, physiological analgesia or pharmacological help.

Methodics:

1. Reaction of a newborn to pain contributes to hypoxia, hypercapnia, acidosis, hyperglycemia, respiratory distress and pneumothorax. Vagal response and stiffness of the diaphragm to pain stimuli contributes to hypoxia due to violation of oxygenation and cerebral blood flow.

2. Physiological response to pain and stress causes the release of catecholamines with an increase of blood pressure, heart rate and intracranial pressure. The long painful reaction leads to exhaustion and inactivation of sympathetic nervous system, which reduces compensatory possibilities of a newborn.

3. Special care measures include prevention of external stimuli and stress reactions. They are comfortable stay, the presence of the mother, her smell, taste, heart rate, moderate blackout, smoothly tactile influence on a large body surface and relative silence – i. e., creating conditions close to intrauterine existence. These conditions are realized by staying of a full-term baby next to his mother or on her hands, and for preterm – using “mother-kangaroo” method. It has been proved that it reduces stress and response to painful stimulation of the child and improves long-term neurological outcomes in such newborns.

During treatment of sick newborns in a couveuse, crib, open intensive care system use some rolls and nest that allow giving a child a physiological position and relieving pressure in some areas, increasing the general area of support. These are a

“donut” under a head of children with birth trauma and hypoxia, and a nest or rollers that hold the joints of the extremities of premature newborns in bending position, the position on own abdomen during mechanical ventilation, as well as periodic change of body positions to improve circulation and prevent pressure sores.

5. Heat treatment and general blackout of the chamber with local lighting of required areas of intervention, maintaining silence and avoiding sudden, loud sounds, the voice of the mother and her smell reduce stress in the child and increase the pain threshold for necessary treatments.

6. Preventing hunger (frequent enteral nutrition, nonfood sucking and maintain adequate blood glucose level) also reduces the feeling of pain and stress in a child.

7. Each manipulation that can cause or increase feelings of pain in a child must be reasonable:

- limit the amount of blood sampling for laboratory tests, intramuscular injections, replaces of tubes and catheters which are minimally necessary for life support of a child. Thus, blood group and Rh-factor of the child can be determined from the cord blood;

- patches used for fixation of catheters, tubes, sensors should not injure skin when changing them;

- frequent blood pressure monitoring can be acceptable only in children with a severe hemodynamic instability before the selection of the required dose of medicines. Then measure the pressure every 3–6 hours, depending on the child’s condition;

- sanitation of endotracheal tube in a baby on mechanical ventilation should not be routine, is performed after the doctor’s administration and requires additional analgesia.

8. Newborns should be evaluated for the presence of pain before and after treatment procedure according to pain scale (NIPS, BPS) based on behavioral responses and physiological parameters in full-term newborns or pain profile that includes evaluation of facial expressions plus physiological parameters depending on gestational age (PIPP) in premature babies.

9. During preparation for any procedure, you should consider methods of anesthesia. The mother can keep the baby in her hands, pressed him to herself, breast-feeding or nonfood sucking (pacifier). You can also hold a child lying in the position of moderate flexion (embryonic position).

10. Two minutes before the procedure, if necessary, give orally (on the tongue, under the tongue 0.1–0.5 ml for premature, 0.5–1.5 ml for a full-term baby) 30 % solution of sucrose or glucose. This method is less effective for premature newborn with very low body weight.

11. During the procedure distracting stimulation (rubbing, tapping, vibration of the limb, which is not involved in the treatment process, but such stimulation has to be mild, gentle and not to cause pain or hyperstimulation) can be carried out. Some procedures (capillary blood sampling, etc.) can be carried out on the mother's hands or in the contact "kangaroo".

12. To reduce stress and pain after the procedure carry out the comfortable procedure:

- feed the baby; put it to the mother's breast;
- take it into the mother's hands, pat, gentle massage, verbally calm with quiet voice, eye contact with the mother;
- contact with the mother "skin-to-skin" or the method "kangaroo".

13. The pharmacological analgesia does not replace the abovementioned procedures and is carried out on their background and only when physiological measures are inadequate. In the treatment of sick newborns undergoing invasive intervention, an important goal is to relieve pain, so it is better to choose using painkillers than sedatives. Thus, premedication is considered necessary at: tracheal intubation (except emergency), mechanical ventilation, administration or withdrawal of pleural drainage, laser surgery on the retina. Use fentanyl 1–3 mg/kg (slow, not more than 1 mcg/kg/min); morphine 0.05–0.15 mg/kg (every 4 hours, not used routinely). As sedatives oxybutyrate sodium is used, and as muscle relaxant – thiopental sodium. For

short-term pain relief, singly or for a short period enteral or rectal form of paracetamol is used. Local anesthetics can be used as a skin cream, gel and lidocaine infiltration through hypodermic needle into the further place of puncture/cut in case of vein puncture, setting central catheters and pleural drainage.

14. At review of the retina use eye drops with a local anesthetic in combination with sucrose orally.

Complications:

– complications do not exist for saving care measures and physiological methods;

– aspiration of glucose solution during enteral administration in premature baby with immaturity of swallowing reflex. To avoid this it is entered slowly, drop by drop or under the tongue;

– apnea after a rapid injection, increasing doses of muscle relaxants. The doctor must be always ready to make immediate help, initiate mechanical ventilation, administer medicines slowly, determine the correct dose;

– systemic side effects of NSAIDs, do not inject routinely, and consider the benefit/risk ratio.

Mistakes:

– assume that the child does not feel pain during the painful procedure if the child doesn't show any signs of pain (in preterm newborn, exhausted by pain, after a stress normal response is reduced, uncharacteristic or absent);

– administering the pharmacological pain killers if they are not needed;

– repeated use of drugs for analgesia and anesthesia;

– too strong compression, swaddling, fixation of a child during manipulation.

15. Preparation of the delivery room and equipment for a child birth. Checking of the equipment

Indications: before each delivery.

Contraindications: Do not exist.

Equipment that needed:

- reanimation table with a source of radiant heat and lighting;
- warm diapers, hats, socks, a roll under the shoulders, plastic food bag or film;
- reanimation bag, self-inflating or with a stream and other AVL equipment, oxygen source;
- individual bulb syringe for the respiratory tract sanitation, electric aspirator with a sterile catheter;
- laryngoscope with blades of appropriate size, endotracheal tubes with diameter 2.5–4; gastric tubes, umbilical catheters, syringes, scissors, adhesive tape, medicines.

Table 1 – A complete list of required equipment

General equipment and materials for newborns reanimation*
Aspiration equipment
Bulb syringe (only individual)
Electric/mechanical aspirator
Catheters for aspiration 5F or 6F, 8F, 10F or 12F
Gastric tube 8F and 20 ml syringe
Meconium aspirator
Equipment for AVL and oxygen therapy
A bag for newborns reanimation with a valve of pressure limitation or manometer (a bag should provide 90–100 % oxygen)
Facial masks of two sizes with soft edges (for full-term and premature)
Set of oxygen tubes

Continuation of the table 1

Other
Gloves and individual protective measures
Warmed diapers, clothes (hat, socks)
Roller under shoulders
Neonatal stethoscope
Plaster 1–1.5 cm wide
Scissors
Additional equipment, materials and medicines
Intubation equipment
Laryngoscope with straight blade – № 0 (for premature) and № 1 (for full-term)
Spare lamps and batteries for laryngoscope
Disposable endotracheal tubes with internal diameter 2.5; 3.0; 3.5; 4.0 mm
Stylet (conductor)
Medicines
Adrenaline 1:10000 (0.1 mg/ml)
Physiological solution of NaCl – 100 or 250 ml
Sodium hydrocarbonate 4.2 % (5 meq/10 ml)
Naloxon hydrochloride 0.4 mg/ml (1 ml ampoule) or 1.0 mg/ml (2 ml ampoule)
Set for catheterization of umbilical vein
Sterile gloves
Sterile scalpel or scissors
Iodine alcohol solution
Umbilical clip
Umbilical catheters 3.5F; 5F
Syringe of 1, 2, 5,10 and 20 ml

Continuation of the table 1

Needles with size 25, 21 and 18 G
Three-way stopcock
Other
Special polyethylene transparent food bags/films
Oropharyngeal air conduit (sizes 0.00 and 000 or 30, 40 and 50 mm length)
Hospital equipment for newborns reanimation
Firm with lining surface for reanimation (reanimation table)
Radiant heat source or other heat sources
Oxygen source with a stream counter (stream speed up to 10 l/min)
Pulse oximeter with sensors
Clock with a second hand or timer
<i>*From the Order of Ministry of Health of Ukraine №225 of 28.03.2014</i>

For every labour prepare two sets of equipment and materials – for primary and full reanimation, both sets must be ready for immediate use. In case of multiple pregnancies both sets are prepared for each child.

Reanimation bag and mask, laryngoscope blade and meconium aspirator should be sterile, and a bulb syringe, catheters, gastric tubes, endotracheal tubes – disposable.

Methodics:

Preparation of the delivery room. The delivery room (operating room) must be clean and warm. Failure in warm chain increases the risk of neonatal hypoglycemia, metabolic acidosis, infection, respiratory disorders, central nervous system affections (hemorrhages, seizures). The optimal (safe) for a mother and a child is considered to be the ambient temperature at least 25 °C, in case of preterm labour – at least 28 °C. There should be prepared and reheated everything you need for warming a baby (diapers, hats, socks, vests, sliders).

Checking of the equipment. Responsible staff of the delivery room before each labour should prepare: well-plighted place for possible reanimation of the newborn with a clean, dry and warm surface, check air temperature in the room (not below 25 °C), and make sure in absence of drafts (closed windows and doors, turned off air conditioners), turn on radiant heat source to warm the surface of the table and a diaper before labour, fold diapers and prepare a roller under the shoulders.

Check availability of equipment, supplies and medicines, oxygen tube to connect the oxygen source and check its availability in the container (or in the system), check the contents of the kit for reanimation true functioning of the reanimation bag and aspiration equipment. The bag checking is carried out in the gloves to avoid contamination of equipment: block patient's access with a hand and press a bag for checking its function and safety valve work. Such compression allows to check the tightness and integrity of a bag. The power of electric pumps should be installed to no more than 0.1 atm., or 100 mm. Hg. c.

Duties distribution. During every labour you must be prepared to give help immediately to any newborn. Every labour requires the presence of one medical worker (doctor, midwife or nurse) who will start the intensive care: able to provide primary reanimation of a newborn and knows a technique of artificial ventilation of lungs with a bag and mask. The same person or someone from medical personnel who are near must have the skills required for reanimation, including chest compressions, tracheal intubation and drug administration.

Primary reanimation of a newborn requires proper hands cleaning by the medical personnel, using gloves and clean medical clothes, compliance with other generally accepted infection control measures.



Figure 44 – Equipment for reanimation of a newborn



Figure 45 – Checking of reanimation bag and mask



Figure 46 – A table with a dense surface under a radiant heat source, the clock with a second hand

16. Algorithm of primary resuscitation

Indications: Those newly born infants who require resuscitation can generally be identified by a rapid assessment of the following characteristics:

- term gestation;
- crying or breathing;
- good muscle tone.

If the answer to any of these assessment questions is “no”, the infant should receive resuscitation.

And also resuscitation is necessary if the worsening of the child condition occurs in the first 2 hours of life during contact “skin-to-skin”.

Contraindications:

– if the answer to all 3 of these questions is “yes”, the baby does not need resuscitation and should not be separated from the mother;

– absence of the signs of live birth.

Equipment that needed.

Methodics:

Immediately after birth the baby should be dried (if amniotic fluid is clean), placed skin-to-skin with the mother, and covered with dry linen to maintain temperature. Observation of breathing, activity, and colour should be ongoing.

If the answer to any of abovementioned questions is “no”, the infant should receive resuscitation. If reanimation is acquired, it is necessary to cut the umbilical cord, put on a warm surface under radiant heat source, and after sanitation – finish drying. Put off wet diapers, put a clean cap and socks on a baby without stopping reanimation.

A child with gestational age < 28 weeks and weight less than 1500 g immediately after birth is put in transparent plastic food bag or wrapped in film with a cut for baby’s head, put on a cap and continue resuscitation.

On the table with radiant heat source:

1. Give your child the position on his back with a moderately straightened head and a roller under the shoulders (“snuffing” position).

2. Clearing the airway if necessary with a bulb syringe or suction catheter (negative pressure of electric pumps should be installed to no more than 0.1 atm., or 100 mm. Hg. c). When the airway is clear sanitation of the mouth is made first, then – of the nose.

3. If amniotic fluid was coloured with meconium, a newborn was depressed and required reanimation should receive tracheal suctioning immediately after birth and before stimulation.

4. Finish drying a newborn, wet diapers should be put aside (the child is naked under the radiant heat source). A plastic bag or film remains on the premature newborn till transportation to neonatal intensive care unit and is taken away only in the department.



Figure 47 – Equipment for sanitation and ventilation



Figure 48 – Reanimation table for primary reanimation of a newborn



Figure 49 – Head in a “sniffing” position to open the airway, with a roll under the shoulders



Figure 50 – Initial steps of reanimation, AVL and evaluation of actions efficiency



Figure 51 – Oxygen therapy via a face mask

5. To conduct tactile stimulation with one of acceptable methods.
6. To provide again the proper position of a newborn, give oxygen if necessary.
7. To evaluate breathing, heart rate and skin colour.

General algorithm of resuscitation based on the correct sequence of actions (ABCD-resuscitation), where A – airway patency, B – breathing (ventilation), C – restoration of circulation, chest compressions, D – use of drugs. Also it is necessary to provide ongoing assessment of the child and effectiveness of resuscitation (cycle “Evaluation-decision-action-evaluation”). Thus, you cannot perform steps C or D before A and B, and periodic (every 30 seconds) assessment of the child gives time to connect the next step or stop incorrect action.

Availability and adequacy of **independent breathing** is the main feature that determines the need of providing the neonatal resuscitation. Assessment of the availability and adequacy of independent breathing is conducted:

- immediately after birth to decide to start resuscitation actions;
- at the end of the 1st and 5th minutes (and later, if necessary) to assess Apgar score;
- during resuscitation actions every 30 seconds;

– every 15 min. during the stay of the newborn in the delivery room.

Signs of adequate breathing of a baby: scream and/or satisfactory excursions of the chest, frequency and depth of respiratory movements should grow a few seconds after birth, normal newborn respiratory rate is 30–60 for 1 min.

If a child undergoes artificial ventilation then the process should be stopped for 6 seconds to assess the availability and adequacy of independent breathing. Convulsive respiratory movements (“gaspings”), or bradypnea < 30 breaths in 1 minute are ineffective and their presence is an indication for the immediate start of mechanical ventilation of the newborn. Appearance of expiratory groan or other respiratory disorders during resuscitation indicates that the baby needs further post-reanimation care.

HR Assessment – heart rate is counted within 6 seconds to get the amount for 1 minute; the result is multiplied by 10. Methods for heart rate determining:

– listening of the heart beat by a stethoscope over the left side of the chest (is the best way);

– palpation of pulse at umbilical cord directly into the area of its accession to the anterior abdominal wall (this method allows only the probability to indicate the presence of bradycardia).

Normal heart rate of a just born child is more than 100 for 1 minute. Bradycardia < 100 for 1 minute of a newborn is always an indication for starting the mechanical ventilation.

Evaluation of mucous membranes and skin colour. Persistent central cyanosis (hypoxemia) requires intervention – oxygen therapy, and in case of its failure – AVL. Acrocyanosis (blue hands and feet) without central cyanosis, usually does not indicate a low level of oxygen in the blood of the child, but may indicate the cold stress (hypothermia) of the newborn. Pale skin or marble pattern may be nonspecific signs of reduced cardiac output, severe anemia, hypovolemia, hypothermia or acidosis.

If the child receives free flow oxygen or oxygen with mechanical ventilation, the level of blood oxygenation should be controlled via the pulse oximetry. For a premature baby it is recommended to keep the level of SpO₂ within 85–92 %.

8. If there is still central cyanosis despite oxygen therapy it's necessary to begin **ventilation by resuscitation bag and mask**.

As timely and effective ventilation is the most important procedure of neonatal intensive care, all medical professionals who work in the delivery room, must be proficient in it.

Artificial ventilation during primary resuscitation should start with room air.

Indications for mechanical ventilation by resuscitation bag and mask:

- absence or inadequate independent breathing after the v initial steps of care conducted within 30 seconds after birth;
- HR < 100 per 1 minute regardless of the availability and adequacy of independent breathing after the initial steps of care conducted within 30 seconds after birth;
- persistent central cyanosis, despite the presence of adequate independent breathing, heart rate > 100 beats per 1 minute and free flow of 100 % oxygen for at least 5 minutes.

9. If a child's condition does not improve, you should begin chest compressions and/or trachea intubation. If heart rate < 60 per 1 minute you should begin chest compressions after 30 seconds of adequate ventilation with a bag and mask.

Chest compressions – 2 people needed:

- One person compresses chest
- The other person continues ventilation

There are 2 compression techniques:

- Thumb Technique (preferred)
- Less tiring
- Better control of compression depth.

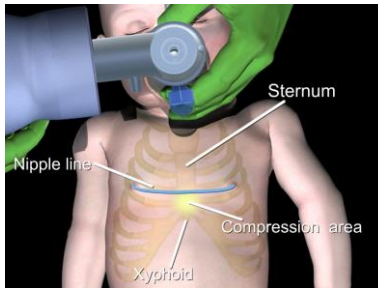


Figure 52 – How to choose the compression area

- 2-Finger Technique
 - Better for small hands
 - Provides access to umbilicus for medications

Positioning of thumbs or fingers:

- Run your fingers along the lower edge of the rib cage until you locate the xyphoid
 - Place your thumbs or fingers on the sternum, above the xyphoid and on a line connecting the nipples

Thumb technique:

- Thumbs compress sternum
- Fingers support



Figure 53 – Thumb technique

2-Finger technique:

- Tips of the middle finger and index or ring finger of one hand compress sternum
 - Other hand supports back



Figure 54 – 2-Finger technique

Pressure and depth:

- Apply pressure during compression on the sternum, releasing pressure to allow chest recoil and ventilation
- Depress sternum one third of the anterior-posterior diameter of chest.

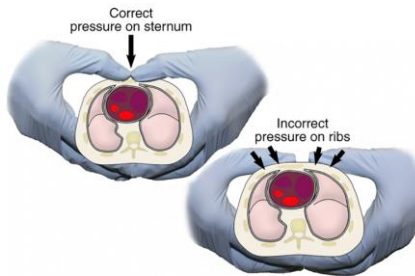


Figure 55 – Correct and incorrect position of fingers

Coordination with ventilation:

- One cycle of 3 compressions and 1 breath takes 2 seconds
- The breathing rate is 30 breaths per minute and the compression rate is 90 compressions per minute. This equals 120 “events” per minute.

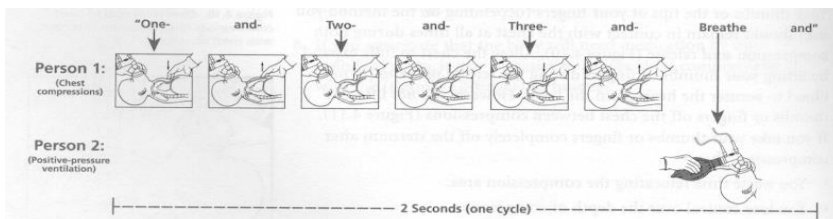


Figure 56 – Coordination of chest compressions with ventilation

Stopping compressions. After 30 seconds of compressions and ventilation, stop and check heart rate.

10. If the child's condition does not improve after 30 seconds of adequate ventilation and next 30 seconds of cardiac massage with ventilation, you should start the administration of medicines, while continuing adequate ventilation and cardiac massage (epinephrine, 0.9 % sodium chloride, sodium bicarbonate, naloxone hydrochloride).

A decision about the need for further assistance for the newborn during resuscitation is based on the simultaneous evaluation of three clinical signs:

- 1) the availability and adequacy of spontaneous breathing;
- 2) heart rate;
- 3) the colour of the skin and mucous membranes.

After every 30 seconds of primary resuscitation you need to:

- assess the abovementioned vital signs (respiration, heart rate, and colour);
- use a common algorithm of resuscitation, decide what to do next;
- perform the appropriate action;
- evaluate the 3 vital signs, decide which intervention is necessary at this case and make appropriate action;
- continue the cycle “Evaluation-decision-action” until the end of resuscitation.

17. Sanation of the upper respiratory tract

Indications:

- the presence of mucus, blood, milk in the upper respiratory tract;
- when a child is born premature, cyanotic, with low muscle tone and without active cry;
- restoring and maintaining a free airway pass;
- removing mucus in case of low drainage lung function.

Contraindications:

- the loud cry, active child;
- if meconium is present in amniotic fluid and a baby is inactive (heart rate less than 100/min, absence of breathing and muscle hypotonia), sanation of upper respiratory tract is conducted under the supervision of laryngoscope, endotracheal intubation and sanation through intubational tube.

Necessary equipment, preparation of the patient:

- tube 10 Fr, 12 Fr, 14 Fr or bulb syringe;
- clean rubber, latex or polyethylene gloves;
- electric aspirator with the tubes, and T-connector.

Methodics:

- put your child on the back or on the side with moderate straightening of his head and a roller under the shoulders;
- make aspiration first from the mouth, then – from the nose;
- remove secretions and mucus use disposable bulb syringe; in case of its absence use sterile disposable catheters;
- during aspiration do not push catheter or bulb syringe deep (not deeper than 3 cm from lips in full-term newborns and 2 cm in prematurely born children);
- aspirate briefly, gently, slowly removing the catheter or pear outside;
- duration of aspiration should not exceed 5 seconds;
- during aspiration it is necessary to control heart rate and breathing of a child.



Figure 57 – Sanation of upper respiratory tract with a bulb syringe – mouth first



Figure 58 – Sanation of upper respiratory tract with a bulb syringe – then nose



Figure 59 – Sanation with electric aspirator through the catheter

In case of a significant accumulation of secretions, blood, mucus it is preferable to turn the child's head to one side during aspiration or repeat the procedure.

In case of using aspirator the negative pressure should not exceed 100 mm Hg (or 13.3 kPa or 136 cm water column, or 0.1 atm, depending on the scale of manometer).

Complications and mistakes:

- hypoxia;
- injury of the mucous membrane of the mouth, nose and respiratory tract;
- infection;
- the development of lung atelectasis.

During aspiration the catheter can stimulate posterior pharyngeal wall that can cause vagus reaction, severe bradycardia and delay of spontaneous breathing. If during aspiration there appeared bradycardia, stop manipulation, make tactile stimulation – pass your hand over the spine, estimate the heart rate and breath rate again.

18. Tracheal intubation

Indications:

- the need to aspirate meconium or other pathological contents of the trachea;
- ventilation with a bag and mask is ineffective or long-term;
- the presence of severe respiratory disorders (indications for AVL);
- the need to facilitate coordination of cardiac massage and lung ventilation;
- the need to enter medicine by endotracheal way;
- suspected diaphragmatic hernia;
- newborn with extremely low birth weight (< 1000 g) for the administration of surfactant or in case of severe respiratory disorders;

– time of tracheal intubation is defined by qualification of medical staff that helps the child.

Contraindications:

– absence of the signs of live birth. Necessary tools, preparation of the patient:

– laryngoscope with straight blades, size № 0 for preterm and № 1 for full term;

– mount of laryngoscope and check the lighting system;

– endotracheal tubes of four sizes (see the table 2);

– conductor of the endotracheal tube; in case of entering the conductor into the tube, it must be securely fixed so that its end does not get into the trachea during intubation;

– meconium aspirator (connector with open side);

– 14 Fr catheter or a bulb syringe for aspiration of oropharyngeal content;

– sterile gloves;

– electric aspirator.

Table 2 – Recommended sizes of endotracheal tubes and depth of their administration according to the body weight and gestational age of newborns

Body weight, g	Gestation age, weeks	Tube size, mm*	Depth of entering from the upper lip, cm
< 1000	< 28	2.5	6.5–7
1000–2000	28–34	3.0	7–8
2000–3000	34–38	3.5	8–9
> 3000.0	> 38	3.5–4.0	> 9

* – *internal tube diameter*

The reanimation bag and mask, laryngoscope blade and meconium aspirator should be sterile, and a bulb syringe, catheters, endotracheal tubes – disposable.

Methodics:

Intubation for the trachea sanitation in inactive newborn with meconial amniotic fluid.

If first amniotic fluid is contaminated with meconium, routine aspiration from the upper respiratory tract of the child after birth of head is not required.

Immediately after birth, the time of birth is noted and announced. After putting it on the mother's abdomen before drying estimate the activity. A child is considered as inactive if there are present such signs as: absence of spontaneous breathing or breathing like "gaspings" or bradypnea (BR < 30 per 1 minute), or low muscle tone (no active movements, dangling limbs) or heart rate < 100 per 1 minute.

If the child is inactive, you should immediately:

- clamp and cut the umbilical cord;
- inform the mother that the child has a problem with spontaneous breathing and needs help;
 - without removing the diaper and avoiding tactile stimulation move baby to the reanimation table or other warm and dry surface;
 - put a child on the tack with moderately straightened back head and roller under the shoulders; provide additional supply of oxygen to the baby's face (Figure 60);
 - under the supervision of direct laryngoscopy make aspiration of the content of lower pharynx (anatomical area of the vocal cords) with a catheter of big diameter (14F);
 - visualize the glottis, extend your right hand, in which assistant puts endotracheal tube of the proper diameter;
 - hold endotracheal tube horizontally and enter it through the right corner of mouth, the end of the endotracheal tube enter into the trachea. In case of sanitation endotracheal tube is entered deeper and the mark of vocal cords is moving 1–2 cm behind them;
 - the duration of intubation attempts should not exceed 20 seconds, after you must start AVL.

To avoid tactile stimulation you must intubate trachea and make aspiration:

- directly through endotracheal tube or catheter of a large diameter (14F), slowly pulling out the endotracheal tube (catheter);

- if aspiration is made through an endotracheal tube, join the adapter (meconium aspirator), which allows you to connect endotracheal tube with an aspiration tube and create negative pressure during the procedure;

- if an adapter (meconium aspirator) is absent, you can use a large diameter catheter (14F), which is directly connected to the aspiration tube;

- duration of aspiration should not exceed 5 seconds.

If there is meconium in an endotracheal tube you can make re-intubation and sanitation, but you should take into consideration the condition of a child, because you must avoid progress of asphyxia. During the procedure prescribe free flow oxygen and ask the assistant to determine the heart rate of the newborn. If the baby's heart rate during sanitation of trachea is less than 60 per 1 minute – stop aspiration and immediately start ventilation.

Intubation and aspiration more than 3 times is not recommended. In the absence of spontaneous breathing or when the heart rate is < 100 per 1 minute make re-intubation of trachea and start AVL with reanimation bag via endotracheal tube. If endotracheal intubation is not possible – ventilate the lungs of the child with a reanimation bag and mask.

Intubation for the ventilation via endotracheal tube or endotracheal administration of medicines.

- Ensure the correct position and fix the baby's head, give free flow oxygen and note the time of beginning of the procedure (Figure 60).

- Hold a laryngoscope in the left hand, enter a blade along the right edge of the tongue pulling it to the left half of the mouth;

then push the blade to the end of recess just behind the root of the tongue (Figure 61).

- Slowly raising the laryngoscope blade, find and fix in a visual field the entrance to the trachea (glottis).

- Avoid lifting of the blade with shaking movement.

- Aspirate mucus if needed.

- Enter the tube to the right corner of the mouth (if glottis is closed, wait until it is open); put the end of the endotracheal tube into the trachea aligning mark of glottis on the tube with the vocal cords (Figure 62).

- Remove the laryngoscope blade from the mouth and a conductor from the tube (if used), securely holding the tube by the hand (fingers squeeze the tube to the upper corner of the mouth or palate).

- Attach a reanimation bag to the endotracheal tube and start AVL and then immediately verify the position of the endotracheal tube in the trachea, including:

- increasing of the heart rate (key indicator);
- the presence of symmetrical chest movements during ventilation;
- data of auscultation of the chest areas on both sides and epigastric area;
- fogging of the tube during expiration;
- absent signs of progressive enlargement of the abdomen;
- improving the colour and activity of the newborn.

If there is a suspicion of wrong input of the tube, pull it out, ventilate the lungs with a bag and mask, normalize the heart rate and skin colour, and then repeat the procedure of intubation.



Figure 60 – Preparation for laryngoscopy, “sniffing” position, oxygen inhalation

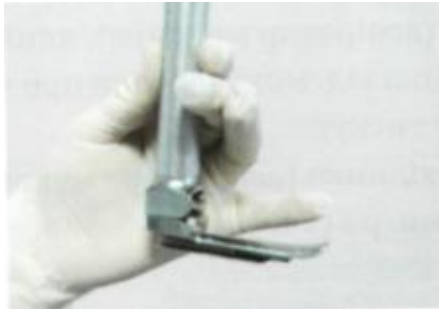


Figure 61 – Laryngoscope should be held in your left hand, three fingers against the thumb, the little finger is free to be fixed on the chin



Figure 62 – The laryngoscope is entered from the right angle of the mouth, tongue deviated to the left

The depth of the tube entering:

- centimeter mark on the endotracheal tube at the level of upper lip is body weight in kilograms + number 6;
- for meconium sanitation the tube is entered deeper 1–2 cm behind of glottis.

In case of permanent intubation note the centimeter mark at the level of upper lip and attach the tube with plaster to a child's face.

After the stabilization of the newborn's condition make the tube shorter, if it stands 4 cm and more above the upper lip.

The duration of one attempt of intubation should not exceed 20 seconds, because during its execution you stop other reanimation procedures (except free flow oxygen supply).

If a newborn's trachea is failed to be intubated for 20 seconds, stop the attempt of intubation and restore lung ventilation with a bag and mask with 100 % oxygen to normalize heart rate, skin and mucous membranes colour. Then, if necessary, you can repeat the intubation.

Complications:

- hypoxia, hypoxemia;
- barotraumas (pneumothorax, pneumomediastinum);
- increased intracranial pressure, intraventricular hemorrhage;
- spasm of cerebral vessels (ischemic brain damage);
- injury of the trachea, bronchi, the upper jaw;
- nosocomial infection;
- bronchospasm;
- lung atelectasis;
- during aspiration the catheter can stimulate posterior pharyngeal wall that causes bradycardia and apnea.



Figure 63 – Laryngoscopy



Figure 64 – Glottis visualization



Figure 65 – Intubation of baby with low birth weight for prophylactic surfactant administration

19. Sanation of the trachea and endotracheal tube

Indications:

- providing the airway pass in case of contamination of amniotic fluid with meconium in inactive newborn;
- aspiration with meconium, blood, milk, etc.;
- during prolonged AVL in case of accumulation of secretion in the airways, which is manifested by the appearance of moist rales, intercostals retraction, and child anxiety.

Required equipment:

- The source of oxygen.
- Respiratory bag for ventilation.
- Stethoscope.
- Catheters of required diameter (not more than $2/3$ of the endotracheal tube (ETT) diameter):
 - for ETT with a diameter of 2.5 – the size of the catheter 5Fr;
 - for ETT with a diameter of 3.0 – the size of the catheter 6.5 Fr;
 - for ETT with a diameter of 3.5 – the size of the catheter 6.5 Fr;
 - for ETT with a diameter of 4.0 – the size of the catheter 8Fr.
- Sterile gloves.
- Sterile isotonic 0.9 % NaCl solution.
- Bottle with sterile water.
- Aspirator (electric, vacuum, etc).

Methodics:

Sanation of the trachea in a newborn during primary reanimation is described in details below. For sanation of the trachea after aspiration of saliva, blood, milk in the newborn after the delivery room tracheal intubation is made according to the above mentioned way and aspiration of trachea content:

- Give your child the position on his back with a moderately straightened head and a roller under the shoulders (“snuffing” position).

- Provide an additional supply of oxygen to the baby’s face.

- Under the supervision of direct laryngoscopy make aspiration of the lower pharyngeal content (anatomical area of the vocal cords) with a large diameter catheter (14F).

- Visualize the glottis, extend your right hand, in which an assistant puts the endotracheal tube of the proper diameter.

- Hold the endotracheal tube horizontally, enter it into the right corner of the mouth and then to the throat, enter the end of endotracheal tube into the trachea (if cords are closed wait until they are open) and stop input when the glottis mark of the tube will be at the level of the vocal cords.

In case of sanitation of trachea the endotracheal tube is entered 1–2 cm deeper. Avoiding tactile stimulation connect and hold an electric aspirator and make aspiration directly through the endotracheal tube or catheter of a large diameter (14F), slowly pulling out the endotracheal tube (catheter).

If aspiration is made through an endotracheal tube, it is joined with a side opening adapter (meconium aspirator), which allows to connect an endotracheal tube with an aspiration tube and create negative pressure in airways. In the absence of the adapter (meconium aspirator), you can use a large diameter catheter (14F), which is directly connected to the aspiration tube. The duration of aspiration should not exceed 5 seconds. During the procedure provide free flow oxygen and ask the assistant to determine the heart rate of the newborn.

If necessary, the sanitation is carried out until the release of the trachea from pathological content, the duration of the procedure is determined by the requirements for tracheal intubation (no longer than 20 seconds) and the newborn’s condition. The main indicator is the condition of the child, in case

of its deterioration, decrease of the heart rate you should immediately start AVL.

Sanation of an endotracheal tube (ETT) is a necessary procedure after a prolonged intubation, which disrupts the function of mucociliary apparatus, causing irritation of the respiratory tract with increased mucus secretion, promotes phlegm in the trachea. Accumulation of secretion increases airway resistance, breath work, promotes the development of nosocomial infection. Sanation of ETT is made by necessity, which is defined by a child's condition. Routine, regulated by the time sanation is not recommended. The procedure of endotracheal tube sanation should not cause deterioration of a child's condition and should be conducted in sterile gloves in compliance with the rules of aseptic.

Methods of endotracheal tube sanation.

Manipulation requires participation of two medical workers following the rules of aseptic. It is permissible (depending on the child's condition and behavior during the past sanation) the oxygen concentration increases to 100 % for 2–3 minutes before the procedure, but other parameters of AVL do not change.

1. Both workers wash hands.
2. Turn on aspirator and check negative pressure (not > 100 mm Hg or 0.1 atm.).
3. Without removing the catheter from a sterile package, you need to measure the length of the catheter and fix it (endotracheal tube length + 1 cm).
4. Clean hands, wear sterile gloves.
5. Remove the catheter from the package without loss of sterility and connect the catheter to the aspirator's tube with an assistant's help.
6. The assistant disconnects the endotracheal tube from the AVL (CPAP) device.
7. Enter the catheter to the endotracheal tube to the required depth.

8. Close the open side of the adapter and slowly remove the catheter reducing pressure if needed (short time opening adapter hole).

9. Do not repeat the procedure at once if it is not essential.

10. Connect endotracheal tube to the AVL apparatus and continue ventilation.

11. Make auscultation of the lungs.

12. If wheezing is not gone, you can repeat the procedure slightly turning the child in a needed direction.

13. In the presence of thick secretions before sanitation enter 0.2–0.5 ml of isotonic NaCl solution to the tracheal tube, but it should not be a routine practice. The presence of thick secretions indicates insufficient moisture oxygen-air mixtures.

14. After the sanitation of an endotracheal tube conduct sanitation of the mouth.

15. Check the concordance of AVL parameters to the child's condition, reduce fractions of oxygen to previous numbers.

16. Make auscultation of lungs and heart.

Complications:

– hypoxia, hypoxemia;

– lung atelectasis;

– barotraumas (pneumothorax, pneumomediastinum);

– increased intracranial pressure, intraventricular hemorrhage;

– spasm of cerebral vessels (ischemic brain damage);

– injury of trachea, bronchi;

– nosocomial infection;

– bronchospasm.

20. Artificial ventilation of lungs with a bag and mask

Indications:

– absent or inadequate breathing of baby;

– HR < 100 per 1 minute, despite the presence and adequacy of spontaneous breathing;

– resistant central cyanosis despite an adequate spontaneous breathing, heart rate > 100 per 1 minute and free flow of 100 % oxygen for at least 5 minutes to a newborn.

Contraindications: Suspected diaphragmatic hernia. In this case intubation of trachea and AVL via endotracheal tube is made.

Necessary tools and equipment:

– reanimation bag, self-inflating or with a stream with the volume of 240–750 ml, equipped with safety mechanism of lung ventilation of a newborn: pressure limiting valve or manometer, or a stream control valve;

– reanimation mask with soft edges of appropriate size (“1” – for a child weighing > 2500.0 g, “0” – for a child with a birth weight < 2500.0 g) round or anatomical shape;

– source of oxygen;

– gastric tubes;

– syringe of 20 ml.

Preparation:

– Attach the appropriate mask.

– Check the working status of the bag and a mask. Ensure that the manometer registers the appropriate pressure. Check the valves.

– Check the correct position of the child: the head is moderately straightened, a roll is under the shoulders.

– Stand at the side or near the baby’s head, holding the bag with a right or left hand.

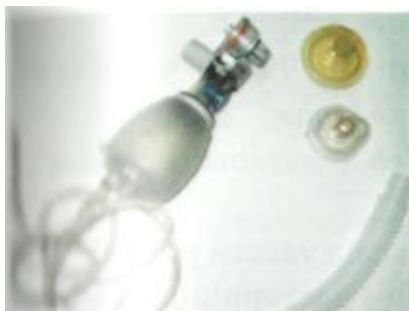


Figure 66 – Equipment for ventilation

– Apply the appropriate size mask, attached to reanimation bag, to a child’s face, covering the nose, mouth and chin tip. The mask which is anatomically shaped is put with a sharp tip on the nose. Fix the mask with a thumb and forefinger and hold a chin with a third finger. Check its fit, watching the movements of the chest.

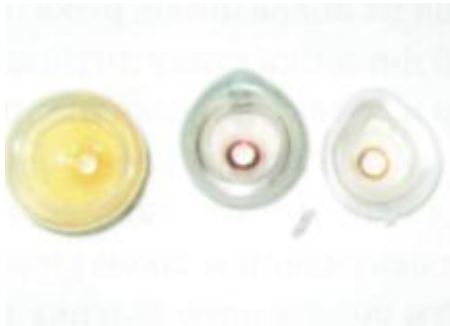


Figure 67 – Face mask with soft edges, round and anatomical



Figure 68 – During prolonged ventilation you should set gastric tube

Methodics:

1. Ventilation is carried out with a frequency of 40–60 per minute.
2. The pressure during ventilation depends on age, condition of lungs and birth weight of a newborn. The first inhale

after birth is made with a pressure of 20–25 cm water, c. Further ventilation in newborns with healthy lungs requires a pressure 15–20 cm of water column and for ones with immature lungs or congenital pulmonary disease – pressure 40 cm of water column.

3. Respiratory capacity of the lungs of the newborn, required for normal gas exchange is 4–6 ml/kg. A significant excess of this amount does not improve gas exchange and causes volume trauma, hyperextension of the lungs and terminal bronchi, promotes air traps, emphysema, bronchopulmonary dysplasia, increases the risk of pneumothorax.

4. During intensive care every 30 seconds you should check the heart rate, breathing and skin colour of a newborn.

5. If it is available do not use extra supply of oxygen during AVL with a bag and mask, if the skin colour of a baby is pink and the heart rate is over 100/min. The use of 100 % oxygen is required while conducting chest compression, critical condition of child, and prolonged reanimation.

6. Use supplemental oxygen if necessary (if the child's condition does not improve during the room air ventilation, oxygen saturation levels in a premature baby on pulse oximetry are low).

- Attach a bag to a rotameter with oxygen tubes.

- Set on the rotameter oxygen flow of 4–8 l/min.

- If possible, use warmed and humidified oxygen. If the source of compressed air (compressor) is present use air-oxygen mixture with such percentage of oxygen content, this provides oxygen saturation for premature child no more than 90 % by the pulse oximetry indications.

- To ensure the ventilation 90–100 % oxygen is attached to the self-inflating bag oxygen reservoir.

7. The use of 100 % oxygen during AVL is indicated for:

- a child born in critical condition – absence of spontaneous breathing, bad muscle tone and response to stimuli, sudden pallor of the skin;

- absence of positive dynamics of the child within 90 seconds after birth, despite effective ventilation with room air;
- HR < 100 per 1 minute after 30 seconds of ventilation with room air;
- indications for chest compression.

8. After a few minutes of the bag and mask ventilation enter an orogastric tube to prevent the bloat of stomach and following regurgitation of gas and gastric contents; enter the tube to a depth equal to the distance from the nose to the ear plus from the ear lobe to the xiphoid process.

After entering the tube aspirate gastric content with a syringe, the tube is left open and fixed to the cheeks with a plaster.

AVL is immediately restarted by putting a mask on top of the gastric tube.



Figure 69 – Measuring the depth of setting gastric tube



Figure 70 – Entering the gastric tube through the mouth

There are signs of proper ventilation: “light” symmetric movements of the chest, breathing is heard equally above the both sides, blowing of epigastric area is absent, heart rate is increasing rapidly.

Additional signs of effective ventilation:

– during auscultation there is symmetric breathing above the lungs;

– independent breathing appears;

– skin colour improves;

– muscle tone improves.

9. Ventilation with a bag and mask in case of its effectiveness can be carried out for a long time, i. e. drug depression of a newborn, after cesarean section, because this method allows air pass through the nose, where it is moistened and warmed.

10. Ventilation with a bag and mask is stopped:

– if during reanimation the heart rate and breathing are normalized;

– if the child’s condition is not improving, it’s necessary to provide tracheal intubation and continue ventilation through the endotracheal tube or start prolonged AVL;

– 10 minutes after the full asystole the death of the child is noted.

Complications and mistakes:

– injury of face and eyes;

– pneumothorax;

– the blowing of stomach and intestines with following regurgitation, restriction of movements of the diaphragm;

– infection;

– the lack of movement of the chest may indicate inadequate tit, airway obstruction, the use of insufficient pressure.

To fix the situation apply a face mask again, change the position of the head, make aspiration from the oropharynx, nose, open the mouth of a baby, increase pressure on inspiration to 20–40 cm water column.

21. Emergency medical help in case of pneumothorax

Indications:

- tense pneumothorax;
- intense pneumothorax, which causes lung collapse for more than 1/3 and provokes respiratory insufficiency or hemodynamic disorders.

Sign of pneumothorax is a sudden deterioration of a child's condition that has spontaneous breathing or takes AVL/SBUPP (system of breathing under a positive pressure): the appearance of cyanosis, respiratory insufficiency, and apnea.

Clinical symptoms of pneumothorax are: the asymmetry of the chest and swelling of the affected part, tympanic sound on percussion and weakened/absent breathing above the affected part of the chest, displacement of the heart to the healthy side, tachycardia or bradycardia, hypotension.

You can confirm the pneumothorax with the chest X-ray. Transillumination of the chest with high intensity fiber optic lamp is inaccurate method and can give false negative results.

Required equipment:

Due to the urgent need of puncture of pleural cavity, each neonatal intensive care unit, where mechanical ventilation is made, must have a sterile set for such manipulation, with a date of sterilization:

- sterile gloves;
- butterfly needle or intravenous catheter 22–23 G;
- infusion three-way stopcock;
- syringe of 20 ml;
- a solution of 0.9 % NaCl;
- spirits 70 %, spirits solution of iodine 0.05 %;
- a solution of 1 % lidocaine;
- sterile diapers;
- sterile cotton swabs;
- sterile forceps;
- plasters.

Preparation of a child:

– Ensure the position of a newborn on his back with a roller under the shoulders; hand on the affected part assigned to 90°.

– During manipulation control heart rate and O₂ saturation with a pulse oximeter, provide adequate ventilation/oxygenation of child.

– Make general anesthesia of the child on AVL (morphine); a child with spontaneous breathing is administered lidocaine for local anesthesia.

Methodics:

1. Clean hands.

2. Define the puncture localization that is made in 3–4 intercostal spaces on anterior axillary or medial clavicular line.

3. Clean the puncture place and area around it with circular movements (for spiral that diverges) with antiseptic solution, allow to dry and than clean again.



Figure 71 – Ordinary intravenous catheter can be used to remove air and drainage of pleural cavity

4. Edge the puncture place with sterile diapers.

5. Wear sterile gloves.

6. Make local anesthesia with lidocaine solution in a child with spontaneous breathing, infiltrating it subcutaneously up to 0.4 ml/kg of 1 % of solution.

7. Fill the syringe at $\frac{1}{4}$ – $\frac{1}{3}$ with 0.9 % NaCl and attach to the catheter.

8. Pull the skin a little bit down the rib.

9. Enter the catheter needle on the upper edge of the ribs (at the bottom there are nerves and blood vessels, which should be avoided) to a depth of 0.5 cm.

10. Pull the syringe plunger. In the presence of pneumothorax air creates bubbles in the syringe. Remove a metal needle while entering the catheter to a depth of 2–4 cm in cranial direction.

11. Again, pull the plunger of the syringe, close the three-way stopcock, and disconnect the syringe.

12. Fix the catheter in the place of puncture with a plaster.

13. Attach the catheter to a drainage by Belau method, the end of which is put down in a container with a sterile solution to a depth of 2–4 cm.

14. Tie a container with drainage to a couveuse/table where the child is placed.

15. Look for the discharge of air bubbles. Avoid making an active drainage of pleural cavity, i.e. creating a negative pressure.

Complications:

- infection;
- bleeding;
- nerve injury;
- lungs injury.

22. Setting the gastric tube

Indications:

- enteral feeding of a sick or premature baby;
- respiratory disorders requiring respiratory support;
- diseases of the nervous system with suppression of sucking reflex, soft palate paresis;
- congenital malformations of pharynx, larynx, mouth;

- preterm infants of 32–34 weeks;
- check of the esophagus patency;
- decompression of the stomach during AVL, CPAP, intestinal obstruction, necrotizing enterocolitis;
- gastric lavage.

Contraindications: Do not exist.

Required equipment:

- sterile disposable stomach tubes № 4-10 Fr;
- stethoscope;
- a solution of 0.9 % NaCl;
- sterile syringe (5–10 ml);
- plaster (width 1.5 cm);
- electric aspirator;
- pulse oximeter;
- equipment for AVL (Ambu bag, a mask).

A tube can be entered to the stomach through the mouth (orogastric) or through the nose (nasogastric). According to this and depending on the body weight you must selected the correct size of the tube:

Body weight, g	Nasogastric tube	Orogastric tube
< 1000	№ 4	№ 6
1000–2500	№ 4–6	№ 8
> 2500	№ 6	№ 10

Preparation of a child:

Put the baby on his back on a flat surface with raised head, in warm conditions, with adequate lighting.

Methodics:

1. Wash hands, wear clean gloves.
2. Check availability and serviceability of the equipment.
3. During the procedure you must control (preferably using a pulse oximeter) the heart rate and respiratory function.

4. Measure the depth to which the tube will be entered – a distance from the root of the nose to the child's ear lobe and to the xiphoid process. Make a proper mark on a tube.

5. Put a baby on his back; make sanitation of the upper respiratory tract.

6. Moisten the tip of the probe with sterile distilled water or saline.



Figure 72 – The tube set for gastric decompression in the child on AVL (open end of gastric probe is in a syringe with soldered tip)



Figure 73 – Fixing of the orogastric tube



Figure 74 – Nasogastric tube is set for feeding of the newborn

7. The entering of the tube:

– through the nose. Press on the tip of the nose, raise it up, and put the tube, sending it straight backward. Insert the tube to the desired depth;

– through the mouth. Press the tongue and put the tube in the oropharynx. Slowly move the tube to the desired depth.

8. Continue to observe the child, fearing the appearance of breathing disturbance or bradycardia that may occur when you enter the tube.

9. Determine the location of the tube:

– enter the air through a syringe to the tube with simultaneous auscultation of the stomach;

– aspirate the contents of stomach (with a syringe, use the of electric aspirator isn't allowed).

If there are doubts concerning location of the tube make the X-ray.

10. Fix the tube with a plaster so to be able to control the depth of its standing (mark).

The tube set for gastric lavage may be removed after the procedure. The tube for feeding or decompression (if functioning properly) should be replaced by a new one in 24–48 hours (depending on material of production and the manufacturer recommendations). In case of the blockage, the occurrence of other complications the tube is removed with a subsequent

replacement on a new one on demand.

Complications:

- infection;
- injury of a mucous membrane, perforation of the esophagus, the posterior wall of the pharynx, stomach or duodenum (the probe should not be entered with the pressure), and pressure sores;
- bradycardia (disappears without treatment);
- apnea, hypoxia (be ready to give help, have prepared equipment for ventilation with a bag and mask, source of oxygen).

Mistakes:

- routine stomach tubing;
- using too thin tube;
- frequent setting and changing of the tube.

23. Use of medicines in primary resuscitation of newborns

Indications:

- the child's condition does not improve despite adequate lungs ventilation with 100 % oxygen and chest compressions for 30 seconds;
- signs of hypovolemia;
- proven or probable severe acidosis;
- significant respiratory depression in pink colour baby with a heart rate $> 100/\text{min}$. despite adequate lungs ventilation with a bag and mask.

Contraindications:

- the absence of the signs of live birth;
- previously haven't carried out the steps of ABC reanimation, haven't established effective ventilation, oxygenation and circulation;
- relatively stable condition of a child that does not require immediate intervention (but necessary post-reanimation help).

Required equipment, preparation of the patient:

- Reanimation table with a source of radiant heat.
- Laryngoscope with the blade of suitable size, extra batteries, light.
- Endotracheal tubes with diameter 2.5–4, stylet.
- Sterile scalpel or scissors.
- Sterile gloves, diaper, spirits solution of iodine.
- Umbilical ligature.
- Umbilical catheters 3.5F; 5F, preferably three-way stopcock.
- Syringe of 1, 2, 5, 10 and 20 ml and needle sizes 25, 21 and 18 G.
- Plaster for fixation.
- Medicines:
 - Adrenaline 1:10 000 (0.1 mg/ml);
 - Isotonic solution of sodium chloride 0.9 % (100 or 250 ml);
 - Sodium bicarbonate solution 4.2 % (5 mEq/10 ml);
 - Naloxone hydrochloride 0.4 mg/ml (1 ml ampoules) or 1.0 mg/ml (2 ml ampoules).

General principles:

Endotracheal administration of epinephrine can be used once, temporarily, until the carried out venous access through the umbilical cord. For this you should intubate trachea.

If intravenous administration of medications is necessary, you should catheterize the umbilical vein in aseptic conditions to the minimum depth that provides free reverse blood flow (about 2–4 cm behind the umbilical ring).

Adrenaline (epinephrine).

Indications:

- the heart rate less than 60 per minute after at least 30 seconds of chest compressions and artificial lung ventilation with 100 % oxygen;
- absence of cardiac contractions in a newborn at any moment of reanimation (AVL and chest compressions should be carried out together).

Preparation of 0.01 % epinephrine solution (1:10 000).

In a syringe of 10 ml or 20 ml take 1ml (1 amp) of 0.1 % solution of epinephrine hydrochloride or 0.18 % solution of adrenaline hydrotartrate and add in the syringe 9 ml (to mark 10 ml) of 0.9 % solution of sodium chloride. The resulting solution is 0.01 % solution of epinephrine (adrenaline).

Take into a smaller syringe (1–5 ml) with a needle the correct amount of the prepared solution (1:10 000) depending on the estimated weight of the child and a way of administration (1–4 ml).

Dosage of the prepared solution.

For intravenous administration the dose is 0.1–0.3 ml/kg (0.01–0.03 mg/kg). If the repeated administration is necessary, the dose is 0.3 ml/kg. Do not use larger intravenous doses of adrenaline, they cause significant vasoconstriction and increase the pressure, can cause brain and heart affections in a child.

The dose for endotracheal administration is 0.3–1.0 ml/kg (0.03–0.1 mg/kg), this dose is used once. Smaller endotracheal doses in primary neonatal reanimation are inefficient, due to the peculiarities of pulmonary blood flow in the first minutes of life.

Methodic of administration:

1. Epinephrine can be administered intravenously, and endotracheal.

2. Intravenous method is more efficient, but to establish proper intravenous access (aseptic catheterization of umbilical vein) you waste valuable time.

3. Endotracheal way provides faster access, but endotracheal administration may be less effective, its effect would be visible later due to the peculiarities of blood flow and pulmonary absorption.

4. The decision about the first way of administration is made depending on the skills of neonatologist who provide intensive care, and the availability and qualification of assistants.

5. Endotracheal way is used only for the first dose of adrenaline, if repeated administration is necessary, you should catheterize umbilical vein.

6. Adrenaline introduced endotracheally by a syringe directly into the endotracheal tube or through a thin sterile catheter entered into the endotracheal tube. Since some of the drug remains on the walls of the tube or catheter it is used:

The method of flushing when immediately after rapid introduction of adrenaline to the tube or catheter 0.5–1 ml of sterile saline (0.9 % NaCl) is entered.

The method of cultivation when before the administration of adrenaline it is diluted by adding 1–2 ml of sterile saline (0.9 % NaCl).

7. After the injection of adrenaline into the trachea you should make a few effective positive pressure ventilations at once.

8. If necessary, repeated administration of adrenalin should be made aseptically with intravenous access (repeated administration of adrenalin is made only intravenously) after the intravenous administration of adrenalin start administration of medicines that normalize vascular volume.

9. After the umbilical vein catheterization adrenaline is entered intravenously quickly, and then the syringe is attached to the catheter with saline (flushing) and a slow infusion of 0.9 % NaCl begins.

10. If the child's condition does not improve after the first administration, and there are indications for repeated adrenaline introduction, it should be injected every 3–5 minutes. The effect of administration of adrenaline can be expected only with adequate ventilation, established circulation (correct technique of indirect heart massage, which provides blood flow in large vessels) and sufficient blood circulation volume.

Medications that normalize vascular blood volume (0.9 % NaCl).

Indications:

– hypovolemia;
– the child's condition does not improve after AVL and chest compressions, especially in the presence of signs of a possible blood loss;

– paleness, weak pulse and no signs of improving of peripheral circulation despite of all reanimation efforts.

Dosage: 10 ml/kg, prepare 40 ml of 0.9 % NaCl solution in sterile syringes or a system with a temperature not lower than the room temperature, warm it up before the injection (in hands, under the radiant heat source or heating system, etc.).

Method of administration:

After making intravenous access aseptically attach the syringe with 0.9 % NaCl solution directly or through a catheter or sterile system to linea mate, inject solution slowly for 5–10 minutes (speed is 2–3 ml/minute).

Do not stop intensive care of a child!

Sodium bicarbonate (4.2 % NaHC03).

Indications: probable or proven severe metabolic acidosis during the prolonged ineffective reanimation with an adequate AVL.

Contraindications: sodium bicarbonate cannot be injected until establishing the effective lung ventilation and tissue perfusion of a newborn (injection of 0.9 % NaCl solution).

Dosage: use a dose of 2 mEq/kg. This solution with a concentration of 4.2 % (or 0.5 mEq/ml) is prepared in 20 ml syringe for injection at the dose of 4 ml/kg.

Method of administration:

After the establishment of effective ventilation and renewal of blood circulation volume deficiency with 0.9 % NaCl solution (in the presence of reverse blood flow from the catheter

set in the umbilical vein), inject slowly for 3–5 minutes (not more than 2 ml/kg/min).

Naloxone hydrochloride.

Indications: significant respiratory depression of a newborn after **restoring normal heart rate and skin colour with AVL**, in case of input of narcotic analgesics (opioids) to a mother in order to reduce labour pain at least 4 hours before birth.

Injection of naloxone hydrochloride is not the first way of helping in the **absence of spontaneous breathing** in case of the opiates use; you must first of all **start ventilation** under a positive pressure.

Contraindications:

A child is from a mother with suspected drug dependence or a mother who is on long-term supportive treatment with narcotic drugs.

If other drugs that can suppress breathing of a newborn (anesthetics, magnesium sulfate, NSAIDs) were appointed to a mother.

Duration of narcotic analgesics action may exceed the duration of naloxone, it is important to monitor the respiratory function, because it may be necessary to start ventilation under the positive pressure or repeated injection.

Dosage: inject a dose of 0.1 mg/kg, the concentration of the solution – 1.0 mg/ml (use 0.1 ml/kg) or 0.4 mg/ml (use 0.25 ml/kg).

Method of administration:

If there is no spontaneous breathing after ventilation with a bag and mask in a child whose mother was injected opioids, pink skin and the heart rate is over 100, naloxone solution is injected quickly:

– intravenous – in a catheter set into the umbilical vein following aseptic conditions (more effective);

– intramuscular – if tissue perfusion is not impaired or (available) endotracheal but the effect of the drug will be delayed.

Until the start of spontaneous breathing don't stop ventilation, and after stabilization of condition don't leave the child unattended.

Complications and mistakes after administration of medicines:

- Possible in case of incorrect indications, ignoring contraindications and mistakes in the technics of administration of appropriate drug.

- The injection of the drug in “cut” of umbilical cord or by umbilical cord vessels puncture may cause infectious complications, sepsis, air embolism, in case of injection to the umbilical cord the artery may provoke calcinosis, vascular necrosis, embolism, destruction of internal organs.

- Deep venous umbilical catheter entering may cause chemical and traumatic liver injury.

- Violation of aseptic technique through “emergency” of the situation may provoke infection, thrombophlebitis, osteomyelitis, sepsis.

- Wrong injection of undiluted solution of adrenaline is a reason of uncontrolled increase of blood pressure, negative influence on cardiac output, cardiac arrest, hemorrhage, death of a child.

- The rapid injection of sodium bicarbonate together with inadequate ventilation and perfusion leads to an increase of metabolic acidosis with subsequent vascular, CNS and myocardium affections.

- Fast injection of saline causes a rapid increase of blood circulation volume and development of congestive heart failure, intraventricular hemorrhages, other hemorrhages, restore of fetal communications (open arterial channel, open oval window).

- Administration of adrenaline into the esophagus, but not into trachea in case of wrong esophagus intubation (no effect of medicines administration).

24. Administration of exogenous surfactant preparations

Indications:

1. Prevention of respiratory distress syndrome (RDS) (is made in the first 15–30 minutes of life, before the signs of respiratory disorders appear):

- in preterm infants with gestational age < 28 weeks;
- in preterm infants with gestational age 28–30 weeks if the antenatal prevention with glucocorticoids wasn't done or made incompletely, in preterm infants with gestational age > 30 weeks with a high risk of respiratory distress syndrome (chronic fetal hypoxia, diabetes mellitus in a mother, bleeding in the third trimester of pregnancy, arterial hypotension, signs of respiratory distress syndrome in previous childbirth, male gender of a newborn) and with lung immaturity confirmed by objective methods (Clemens foam test or the ratio lecithin/sphingomyelin in amniotic fluid).

2. Treatment of respiratory distress syndrome in infants with clinically confirmed diagnosis of RDS, who are on AVL through endotracheal tube:

- radiological signs of RDS;
- $\text{PaO}_2 < 50$ mm Hg or $\text{SpO}_2 < 88$ % in a newborn on AVL with $\text{FiO}_2 > 0.3$; $\text{MAP} > 6-7$ cm water c.;
- if you cannot identify PaO_2 or SpO_2 , the surfactant treatment is indicated in case of clinical signs of respiratory distress and there is need for AVL with $\text{FiO}_2 > 0.3$;
- if it is indicated, therapeutic treatment can be done again.

There are defining:

- early treatment in the first 2 hours after birth;
- late treatment in the first 8 hours, but not later than 24 hours of life.

Prophylactic administration has two approaches:

- intubation, surfactant administration, AVL;
- intubation, surfactant administration, extubation with subsequent CPAP through a nasal cannula or a mask.

Early treatment is the most optimal, because it lets to avoid preventive administration, but is rather early for prevention of the development of severe respiratory distress. Compared with the late treatment, an early use of surfactant reduces the risk of air leakage syndrome, the risk of death from respiratory distress syndrome and bronchopulmonary dysplasia development. The administration of the drug after 24 hours may improve gas exchange, but does not significantly affect the treatment of RDS so is not standard recommended.

Contraindications:

- instability of central and pulmonary hemodynamics;
- incompatible with life congenital malformation;
- significant disorders of vital functions and metabolism (hypothermia $< 35\text{ }^{\circ}\text{C}$, bradycardia, arterial hypotension, metabolic acidosis ($\text{pH} < 7.1$ and $\text{BE} < -15\text{ mmol/l}$);
- severe central nervous system affections;
- inappropriate level of medical institutions (relative contraindication);
- pulmonary hemorrhage (relative contraindications).

Required equipment:

- the preparation of surfactant prepared and heated according to the instructions;
- syringes of 2 ml, 5 ml;
- tube 3.5 Fr or 5 Fr (with a diameter less than $\frac{2}{3}$ of the diameter of endotracheal tube);
- endotracheal tube connector with a side adapter (if needed);
- phonendoscope;
- the electric aspirator;
- catheter for endotracheal tube sanitation.

Preparation of the patient, observation of the child:

1. By the time of surfactant administration endotracheal intubation should be done in the case of prophylactic use or AVL through an endotracheal tube. It is necessary to make sure that the

tube is properly located above the bifurcation of the trachea. Preferably, make control of the position of endotracheal tube using the chest X-ray.

2. Current data indicate that the distribution of surfactant in the lungs does not depend on the position of the child and is determined by the properties of the drug.

3. It is important to monitor heart rate continuously and SpO₂ or PaO₂, system blood pressure during the surfactant administration and during the next hours. When a patient is in an open reanimation system, AMRLA monitoring is possible with the built-in oximeter NELLCOR. In 15–30 minutes after endotracheal surfactant administration it is desirable to determine the blood gas level for the prevention of hyperoxia and hypocapnia.

Methods of administration:

There are two methods of administration of exogenous surfactant preparations:

- via a syringe through a tube that is put into the endotracheal tube;
- via a side adapter of endotracheal tube connector with dual contour and Ballard valve.

Method of administration via a syringe through a tube.

Method is carried out by two people, one person in sterile gloves performs actions with sterile tubes, catheters, syringes, and the other helps with the non-sterile equipment (connect and disconnect to the breathing contour, keeps and turns the baby's head, changes AVL settings if necessary, etc.).

Before administration of surfactant preparation you should slowly warm it to the body temperature in a couveuse or arm, but do not stir! For homogeneity of suspension/emulsion turn the bottle over slowly and carefully several times, avoiding foaming.

1. Shorten a tube aseptically so that its length is equal to the length of the endotracheal tube and slightly (up to 0.2–0.5 cm) perform below its end. To determine the correct length a new

endotracheal tube from the same manufacturer and same size is usually used (Figure 75).

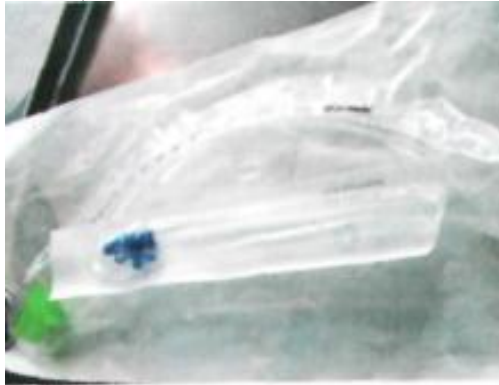


Figure 75 – The tube for surfactant administration is shortened without removing from the package



Figure 76 – Endotracheal tube sanitation before administration of surfactant

2. Make sanitation of endotracheal tube and continue AVL with the previous parameters.

3. Set the necessary dose (previously warmed according to the instructions (do not stir)) in a syringe or $\frac{1}{2}$ dose in two syringes, preventing the formation of air bubbles, connect to the tube and fill it with medication.

4. Ensure the baby's position on the back during surfactant administration with a head fixed at the midline.

5. Disconnect the endotracheal tube from the AVL apparatus, put into it previously shortened and filled with surfactant tube at full depth.

6. Enter a half of the dose as fast as possible (for no longer than 30 seconds), enter the following 1–2 ml of air or sterile solution of 0.9 % NaCl to clean the tube from surfactant.

7. Pull out the tube while turning the newborn's head to one side for 30 seconds.

8. Immediately continue AVL or (if the child was not on AVL previously) start manual ventilation with previous parameters for 30–60 seconds.

9. After 30 seconds, put the child in the position on his back with a head fixed at the middle line.

10. After stabilization of the child's condition disconnect the endotracheal tube from AVL apparatus, enter again a filled tube into the endotracheal tube, enter the second half of surfactant dose and extract the tube.



Figure 77 – Carefully fill syringes with surfactant



Figure 78 – The first half of the surfactant dose is entered



Figure 79 – “Wash” surfactant to lungs with 1 ml of air or saline solution



Figure 80 – The head of the child is turned sideways

11. Connect the endotracheal tube to the AVL apparatus; continue ventilation with previous parameters, while turning a child's head sideways for 30 seconds.

12. Provide the starting position of the child, continuing AVL.

13. Auscultate respiratory noises.

14. Adapt the AVL settings based on the blood gases level, SpO₂, graphical monitoring, chest excursion and auscultation data. First of all, you should reduce the concentration of oxygen in the breathing mixture, then – inspiration time and pressure on inspiration.

15. During the preparation administration you must control the general condition of a child, heart rate, blood pressure, SpO₂.

16. Make control chest X-ray.

17. Do not prescribe sanitation of the trachea for at least 2 hours.

18. In case of prophylactic administration of the preparation and the child without severe respiratory disorders, endotracheal tube should be removed and the child is observed. In the presence of respiratory distress provide CPAP or other respiratory support.

Method of administration via a side adapter of the endotracheal tube connector.

The suspension/emulsion of surfactant is entered into the endotracheal tube through the side adapter of endotracheal tube connector with dual contour and Ballard valve. This allows enter the drug to the respiratory tract without the use of additional catheters, without interrupting AVL and decreasing the airway pressure, especially at the end of expiration. Drug is entered by pressing the syringe plunger in time with each apparatus inspiration. It is important that the adapter is above the endotracheal tube, providing free drug draining by gravity. The speed of drug administration is determined by tolerance of a child, but do not extend significantly the period of administration,

because the faster surfactant intakes, the greater its effectiveness increases.

If applying the method of the drug administration via a side adapter of endotracheal tube connector, it is necessary:

1. To put the baby half-turned (angle approximately 45°) to the right side and enter $\frac{1}{2}$ dose of surfactant.

2. In 30–60 seconds after entering the surfactant the child is turned to the left side at an angle of 45° and continue entering the second half of the preparation.

3. 30–60 seconds after entering the preparation the child should be turned to his back.

4. Do not make sanitation of endotracheal tube over the next 2 hours after the procedure.

Monitoring the newborn status.

A large amount of the drug can cause transitory disturbance of gas exchange due to airway obstruction.

During the drug intake you must control the child's condition, skin colour, chest excursion, and the monitor's parameters.

The surfactant intake should be stopped if the child is excited and there appears a cough with the release of surfactant to the endotracheal tube, cyanosis of the skin and mucous membranes, decreased heart rate; SpO₂ decreases more than 15 % from baseline.

Transient decrease of SpO₂ can be eliminated by temporarily increasing PIP of apparatus inspiration on 3–5 cm of water c.

The absence of effect of the surfactant use.

In some children oxygenation does not improve after administration of two doses of surfactant. Probable causes of absence of surfactant effect are:

- inadequate ventilation parameters;
- inadequate infusion therapy;
- the presence of pneumonia or sepsis;
- hemodynamic instability;

- pulmonary hypertension with right to left blood shunting via fetal communication;
- air leak syndromes;
- severe metabolic disorders.

In such situation, especially until the presence or absence of comorbidities is checked, you should increase FiO_2 to 0.9–1.0 and also increase PIP and PEEP until significant movements of the chest appear.

It is important to properly synchronize the child with AVL. If you cannot achieve this through the use of sedatives and narcotic analgesics, muscle relaxants are used.

Complications:

- Obturation of endotracheal tube.
- Pulmonary hemorrhage. Prevention of pulmonary bleeding includes creating positive end-expiration pressure no less than + 4–5 cm of water column (3 cm water c. in children weighing less than 1000 g).
 - Syndrome of air leakage.
 - Hyperoxia.
 - Hypocapnia.

Prevention of these complications includes timely change of the AVL parameters after the surfactant administration.

Prevention and treatment of respiratory distress syndrome in premature children.

Respiratory distress syndrome, or “hyaline membrane disease”, is manifested by severe breathing disorders caused by lung immaturity and primary deficiency of surfactant. Respiratory distress syndrome as the cause of respiratory distress in preterm occurs more often in case of low birth weight and small gestational age of the child.

In the last years the success of nursing premature babies with low birth weight in the world is related to the following main achievements:

- new devices for mechanical ventilation, noninvasive respiratory support, CPAP were designed for infants and children with low birth weight;
- the administration of antenatal corticosteroids for RDS prevention;
- the use of exogenous surfactant preparations for replacement therapy of its primary deficit;
- the decrease influence of asphyxia, hypoxia, acidosis, hypothermia due to the introduction of modern perinatal technologies and expanding indications for cesarean section in preterm labours;
- preventing the oxygen affection of immature organs and systems (eyes, brain, lungs, etc.).

However, the problem of nursing of children with low birth weight remains relevant because of the increased number of such children due to the deterioration of reproductive health and implementation of new reproductive technologies. Relevant remain the survival and recovery of newborns with low weight, long-term consequences of nursing and quality of life.

For the prevention of RDS one course of glucocorticoids intramuscular (dexamethasone 6 mg every 12 hours, course dose is 24 mg, or betamethasone 12 mg every 24 hours, course dose is 24 mg) is appointed to pregnant women with the risk of preterm labor in the period from 24 to 34 weeks.

Corticosteroids are not used in the presence of clinical manifestations of severe infection. Repeated courses are not administered, because this increases the risk of delays in psychomotor development of children and increases the problems of their behaviour.

Pathogenetic therapy of RDS is replacement therapy. Endotracheal administration of exogenous surfactant in case of its primary deficit in lungs leads to a gradual disclosure atelectasis, reduction of the surface tension in the alveoli. Alveolar stabilization with preventing of their adhesion, even distribution of air in the lungs, adequate gas exchange, improve mucociliary

transport and stimulation of macrophage reaction in the lungs, and therefore, reducing hypoxia and hypoxemia, child's needs in supplemental oxygen and rigid parameters of AVL or CPAP.

Prophylactic administration of surfactant preparation can prevent the development of RDS in a child with gestational age 25–32 weeks if antenatal prophylaxis with corticosteroids was not performed. Therapeutic administration of preparation to a child with respiratory disorders or radiographic signs of RDS reduces the severity of the disease and possible complications.

For the prevention and treatment of RDS in newborns it is important to give preference to natural, rather than synthetic surfactant.

The product Neosurf (NEOSURF) “Dokfarm” Ltd. is a lung surfactant emulsion containing natural phospholipids, 25 mg/1 mL, 50 mg bottle (2 ml). Contraindications to the administration are hypersensitivity to the surfactant and intraventricular hemorrhage of III–IV degree.

The therapeutic effect of Neosurf is replacement of deficiency of endogenous surfactant in immature lungs of a premature newborn or in case of their pathological destruction. The drug shows pronounced surface-active properties, evenly distributed in the lungs, spread over the surface of the alveoli, cover their internal surface, reduces surface tension in the lungs at the phases borders: gas-liquid, and stabilizes the alveoli, preventing their adhesion at the end of expiration, promotes adequate gas exchange throughout the respiratory cycle, restoring the level of oxygenation, providing normal gas exchange and the function of the whole lung system related to circulation. Restored oxygenation level reduces the oxygen concentration in the gas mixture; reduces mortality and frequency of respiratory diseases.

The preparation Neosurf is fully utilized in the lungs, does not accumulate, does not penetrate through aero-hematic barrier and does not get into the blood. Full utilization of drug is made by its phagocytosis by alveolar macrophages, about 30 % of phospholipids are reused by alveolocytes type II for resynthesis of

own, endogenous surfactant.

The drug is administered endotracheally to intubated children in a single dose of 100 mg/kg (4 ml/kg) with further continuous monitoring of heart rate and oxygen saturation level (SpO_2).

Preventive medication is administered in a single dose during the first 15 minutes after birth. After confirmation the diagnosis of RDS treatment should begin as soon as possible. If necessary, apply 1–2 repeated doses with intervals of 6–8 hours, if positive dynamics of oxygenation is absent. The maximum total dose is 300–100 mg/kg.

Before using the bottle is heated to 37 °C in a water bath, turn it upside down, and gently, not shaking, take the drug into a syringe via a needle of a large diameter. Shortened in comply with aseptics catheter is filled with emulsion of Neosurf, drug residues are removed, leaving in a syringe with a catheter a proper dose of surfactant.

If AVL is made, before the surfactant administration set ventilation rate to 60 per 1 minute, duration of inspiration – 0.5 sec, FiO_2 – 100 %. If the child is breathing independently, intubate the trachea.

Neosurf is entered in two doses according to its own instructions.

After resumption of surfactant intake of AVL, change parameters of ventilation, or in case of stable condition of the child (adequate independent breathing, $SpO_2 > 88$ %, HR – 100/minute) extubate trachea and prescribe CPAP through a nasal cannula.

During surfactant administration it's necessary to look at the movements of the chest and SpO_2 parameter. Reduced range of motion of the chest may indicate airway obstruction with surfactant. If effective movements of the chest do not recover on the background of ventilation, increase the peak inspiration pressure on 1–2 cm of water column.

In case of reduction of SpO₂ or the appearance of cyanosis ensure the adequacy of chest movements and then raise FiO₂. During the administration a short-term airway obstruction is possible, which can be removed by increasing the peak inspiration pressure. In rare cases bradycardia, hypotension, and oxygen desaturation may occur. After the drug application pulmonary hemorrhage may occur very rare due to the rapid improvement in lung function and the inopportune changes of ventilation parameters.

After entering Neosurf do not make sanitation of the respiratory tract for at least 2 hours.

25. AVL: Basic methods and parameters

Indications:

- a newborn is not breathing; breathing is ineffective or “gaspings” breathing;
- severe respiratory disorders, despite the reason, revealed by the scales of Silverman or Downes;
- the progressive increase of the severity of respiratory disorders, PaO₂ < 50 mm Hg, despite the use of CPAP technique with FiO₂ > 60 % and pressure on expiration 9–10 cm of water col. or oxygen therapy with FiO₂ > 60 %;
- recurrent pathological apnea (three hours or more, requiring tactile stimulation or ventilation with bag and mask);
- stable bradycardia (heart rate < 80/min.) or hypotension (means arterial pressure is less than gestational age of the child in weeks);
- massive pulmonary hemorrhage;
- the child is cyanotic despite breathing with 100 % oxygen;
- respiratory disorders of moderate severity, if you can not establish respiratory support with CPAP;
- after surfactant administration for its even distribution in the lungs (possible short-term AVL).

Basic methods:

- with a bag and mask/endotracheal tube;
- with the use of mechanical ventilation devices.

Required equipment:

- reanimation bag with volume of 240–750 ml;
- mask of appropriate size (“1” for mature, “0” for premature);
- endotracheal tube according to gestation age and weight of the child;
- laryngoscope with spare batteries and lamp;
- plasters or intubation tube holder;
- source of oxygen and a hose;
- tube 8 Fr;
- syringe of 20 ml;
- AVL apparatus.

Preparation of the patient and monitoring his condition:

1. Newborn is lying on his back, with a roller under the shoulders, neck is moderately straightened.

2. During prolonged AVL to improve circulation and gas exchange, to prevent pulmonary edema and bedsores you must regularly (every 3–6 hours) change the baby’s position. Use special rollers; the position on the abdomen improves gas exchange in the posterior areas of the lungs.

3. During AVL you must monitor the hemodynamic status, blood gases. If you can not control PaO₂, PaCO₂, acid-base balance, you should obligatory control vital functions, SpO₂ and heart rate using a pulse oximeter or during objective examination.

Method of AVL with a bag and mask:

1. Check the working status of the bag and a mask before each labor and immediately before use. Ensure that manometer registers the appropriate pressure. Check the valves. Attach the mask of appropriate size.



Figure 81 – During prolonged AVL endotracheal tube should be shortened



Figure 82 – Sanation of endotracheal tube is made if necessary



Figure 83 – Sanation of upper respiratory tract during AVL

2. Stand at the side or near the baby's head, holding the bag with a right or left hand.

3. Apply the mask on the face so that it covers the nose and mouth; chin tip must remain inside the rim of the mask. Fix the mask with a thumb and forefinger, and keep the chin with a third one. Check its fit, watching the movements of the chest during a bag compression. If the mask is put on correctly there are observed movements of the chest, blowing of epigastric area is absent. The signs of proper ventilation are "light", subtle movements of the chest and symmetric respiratory sounds above both sides during auscultation.

4. The lack of movement of the chest may indicate inadequate fit, airway obstruction, the use of insufficient pressure. To fix the situation apply a face mask again, change the position of head, make aspiration from the oropharynx, open a mouth of a baby, increase pressure on inspiration to 20–40 cm of water column.

5. Ventilation is carried out with a frequency of 40–60 per minute.

6. The pressure during ventilation depends on age, condition of lungs and birth weight of a newborn. Ventilation of newborns with healthy lungs requires 15–20 cm of water column, in patients with affected lungs – 20–40 cm of water column.

7. Respiratory capacity of the lungs of the newborn, required for normal gas exchange, is 4–6 ml/kg. A significant excess of this amount does not improve gas exchange and causes hyperextension of the lungs and terminal bronchi, promotes air traps, emphysema, bronchopulmonary dysplasia, increases the risk of pneumothorax.

8. After a few minutes of the bag and mask ventilation you should enter gastric tube through the mouth for stomach decompression. This facilitates lung smoothing and prevents regurgitation of gastric contents with subsequent aspiration. The tube should be fixed with a plaster and left open.

Do not use extra supply of oxygen during AVL with bag and mask, if the skin color of baby is pink and heart rate is over

100/min. The use of 100 % oxygen is required while conducting chest compression, critical condition of child, and prolonged reanimation.

10. Ventilation with bag and mask in case of its effectiveness can be carried out for a long time, i.e. drug depression of a newborn, after cesarean section, because this method allows air passing through the nose, where it is moistened and warmed.

Method of ventilation through endotracheal tube with a bag (self-inflating or with a stream) is not fundamentally different from mechanical ventilation through a mask. This method is used in reanimation if breathing through a mask is ineffective, when there is suspicion of a diaphragmatic hernia or other malformations of the airways, and to improve interaction during chest compression, etc.

Size of the tube is chosen according to the table, considering the weight and gestational age of the child.

Main steps of ventilation through endotracheal tube with a bag are:

1. Newborn is intubated, the mark of glottis on endotracheal tube should be on one level with the vocal cords, centimeter mark on the endotracheal tube at the level of upper lip must correspond to the formula $m + 6$, where m is weight of the baby in kilograms. For a newborn with body weight < 750 g it is sufficient 6 cm.

2. Attach the bag to the endotracheal tube and start breathing with a frequency of 40 per minute for full-term and 60 per minute for premature newborns.

3. Ask the assistant to auscultate the respiratory sounds above the lungs and stomach area – breathing should coincide with pressing on the bag, it is heard symmetrically in both lungs, but not auscultated above the stomach.

If endotracheal tube is standing correctly, fix it and immediately set gastric tube to decompress the stomach.



Figure 84 – Automatic humidifier provides the proper temperature of oxygen-air mixture



Figure 85 – AVL is making in couveuse for a child with extremely low weight. Newborn is lying in a “nest”



Figure 86 – ALV of premature child in an open system

5. Movements of the chest should be barely visible to the eye, increasing the pressure or volume of inhaled air can cause lungs' barotrauma. Pressing on the bag should be performed with

2–3 fingers, considering the fact that the respiratory volume of newborn's lungs is about 6 ml/kg.

6. If necessary use supplemental oxygen for premature baby, its level in respiratory mixture should be selected depending on the child's condition. You must use a pulse oximeter for this. It is considered that during primary reanimation sufficient blood oxygen saturation is about 85 %, because oxygen can cause damaging effects on immature lungs, brain, and other tissues.

7. Breathing through the endotracheal tube of dry cold air with uncontrolled oxygen flow for more than a few minutes increases the risk of lung damage, destroying surfactant, cooling of a child. In case of necessity of prolonged AVL you must set apparatus breathing as soon as possible, so that oxygen mixture passes through the humidifier and heats.

Method of apparatus AVL:

1. Use only devices made specially for children.
2. Before the work refer to the instructions for each device, as devices from different manufacturers and even different series of the same manufacturer may vary.

3. Estimate the child's condition; select the device, medical and technical characteristics which are more suitable for the treatment of this disease.

4. Pour the water in the humidifier, turn on, set the desired temperature (depending on the type of the humidifier set indicator "endotracheal intubation", which will provide 37 °C or set 39 °C minus 2 °C).

5. Turn the device on, set the initial parameters. Make the testing, calibration, if it is demanded by instructions. Initial settings depend on apparatus and are installed according to the pressure or volume. It is recommended to choose mean parameters according to gestational age and weight of the child, and further, depending to on a child's condition, decrease or increase the parameters, but no more than one parameter at one time, and wait for the patient's response during 15 minutes.

– The frequency of ventilation (FV) is 30–60 per 1 min.

– Peak inspiratory pressure (PIP): it is recommended to start ventilation with minimal pressure 15–18 cm of water column.

– Respiratory volume is 4–6 ml/kg.

– Positive pressure at the end of inspiration (PEEP) is 4–5 cm of water column.

– Time of inspiration (Ti) is 0.3–0.4 seconds.

– The value of the gas flow is 2–3 l/kg.

6. Intubate the child, checking by auscultation position of the endotracheal tube with several breaths using a bag, put the newborn with fixed endotracheal tube and gastric tube in couveuse or open intensive care system, fix the respiratory paths, then stop breathing with a bag, disconnect it from endotracheal tube connector and connect to the breathing contour of device.

7. During apparatus AVL monitor the child's condition (pulse oximeter, blood pressure measurement, objective examination, neurological status, control of acid-base balance, etc.).

8. Weighing of the child if necessary should be made in couveuse on built in or out close scales without depressurization of breathing contour: each depressurization leads to a fast drop of pressure in the airways, which causes “sticking” and promotes formation of lung atelectasis.

9. Sanation of endotracheal tube during prolonged AVL should not be a routine procedure; it is made only for medical reasons, preferably by two people.

Complications:

– Trauma of face, eyes, throat, vocal cords, laryngeal edema, tracheolaryngitis.

– Ventilation trauma (baro-, volume trauma) due to excessive pressure on inspiration, excessive volume.

– Syndrome of air leakage due to excessive pressure on inspiration, excessive volume.

- Hypoxia, asphyxia (in case of prolonged failed intubation attempts, intubation and ventilation of esophagus or blockage of airways or endotracheal tube, etc.).

- The blowing of the stomach and intestines with following regurgitation and aspiration, restriction of movements of the diaphragm.

- Infection, ventilator-associated pneumonia.

- Bronchopulmonary dysplasia.

- Retinopathy of newborns (in case of high SpO₂ and FiO₂).

The AVL apparatus INTER NEO is designed specifically for children and infants, fully meets modern requirements for devices of this class. The device has 2 triggers – for pressure and flow, with the main trigger for flow as it is more sensitive. Flow sensor is located proximally directly next to endotracheal tube of the patient which is especially important on ventilation of preterm children. For a small patient it is difficult to create a negative pressure in the contour's volume, that's why a flow trigger will track the slightest attempt of inhalation and device supports it.

Apparatus of the next class INTER 7 RLUS is oriented on ventilation with maximum possible freedom for secure variation of ventilation parameters, leading to improved oxygenation, gas exchange, respiratory mechanics, disclosure of alveoli and release of surfactant, reducing the time of separation from the apparatus.

26. Providing independent breathing under positive pressure (CPAP, Continuous positive airway pressure)

Indications:

- prevention of RDS in preterm children;

- initial respiratory support of newborns with very low birth weight (VLBW) immediately after birth;

- moderate breathing disorders of various etiologies with progression of severity, despite the oxygen therapy;

- the disease with reduced residual capacity (RDS, transient tachypnea of newborn, pulmonary edema);
- broncho-obstructive disease (bronchopulmonary dysplasia, bronchiolitis);
- meconial aspiration syndrome;
- apnea in premature newborn;
- withdraw from AVL;
- tracheomalacia;
- paresis of diaphragm.

CPAP – is a method of treatment of respiratory disorders, which allows during spontaneous breathing create continuous positive airway pressure on both the inspiration and expiration. As a result the pressure in the airways increases their diameter and area of gas exchange increase, minute ventilation, functional residual capacity increase, and airway resistance and dynamic compliance reduce. Respiratory rate changes: decreases in case of tachypnea and increases in case of apnea. Also ribs are stabilized, suprasternal retraction is reduced, efficiency of the diaphragm work is increased.

The aim of CPAP is to stabilize and/or reduce respiratory disorders defined by the scale of Downes or Silverman.

Mechanism of action:

- increasing the functional residual capacity and increasing PaO₂;
- increasing the compliance of the lungs;
- increasing the respiratory volume and decreasing the respiratory effort;
- reducing the alveolar-arterial oxygen pressure gradient;
- prevention of alveoli atelectasis;
- increasing the airways diameter (decreasing the resistance);
- maintaining the stability of surfactant;
- strengthening of the airways;
- strengthening of the diaphragm;

– reducing the mechanical obstruction (with meconium etc.).

Contraindications:

– severe respiratory disorders, which are an indication for AVL;

– anomalies of the upper respiratory tract (atresia of choanae, “cleft palate”, trachea-esophageal fistula, etc.);

– diaphragmatic hernia;

– congenital heart diseases with reduced pulmonary blood flow (tetralogy of Fallot, pulmonary stenosis);

– significant disorders of hemodynamics. Required equipment:

– the source of compressed air and oxygen;

– the apparatus for AVL/CPAP;

– generator of positive pressure;

– breathing contour;

– heater-humidifier;

– the nasal device (bilateral or unilateral cannula, short double cannulas, nasopharyngeal tube, intubation shortened (pharyngeal) tube or nasal mask);

– tools for fixing nasal device.

Preparation of a child:

– Ensure thermoneutral environment and high humidity for preterm newborns.

– Measure a head circumference and select a cap of required size or tape to fix the nasal mask or cannula, and cannula/mask of appropriate size (according to the manufacturer’s instructions for the device). Using a nasal mask has fewer complications.

– Put a child on the back with moderately straightened back head and roller under the shoulders (“snuffing” position) which provides better airway passage.

– Enter gastric tube for decompression through the mouth, check its location, and fix it.

– Check up monitoring devices (pulse oximeter, blood pressure meter, etc.).

Methodics:

1. Prepare the apparatus:

– Attach hoses with oxygen and air, open taps, and turn on the device.

– Take breathing contour and attach it to the humidifier and the apparatus.

– Pour distilled water into the humidifying chamber of heater to the appropriate tags according to aseptic principles.

– Turn on the humidifier following the manufacturer’s instructions. Set the temperature to 37 °C (if it is possible by instruction). If you use a humidifier without heating of inspiration contour, set the temperature in the distal end of the tube at 30–32 °C. In case of automatic humidifier with heating of inspiration contour, set it into work regimen with a mask/nasal cannula.

– Turn on the apparatus for AVL/CPAP. Make calibration procedure according to the instruction manual. Select CPAP mode. Set the proper concentration of oxygen in the apparatus. Set the proper flow rate for CPAP apparatus.

– Connect cannula (mask) to the flow generator or connect nasal device to the breathing contour.

– Check the pressure in the system by blocking the exit from the respiratory contour/cannula.

– Set the required alarm indicators in the device.

– If you use a “bubble” CPAP, dip and fix the expiration tube under water to a depth in centimeters, corresponding to the proper positive pressure indicator.

2. Put a cap on the head of a child; give the child the correct position with a tight roller under shoulders.

3. Gently aspirate the contents of the upper respiratory tract.

4. Gently enter cannula (other nasal device) in the nasal passages (nasopharynx) or put a nasal mask, providing maximum possible tightness.

5. In case of long binasal cannulas, enter them to a depth which is approximately equal to the distance from the middle of the nose to the middle of the eye. Each cannula's tube is fixed with separate tape patch. When using pharyngeal CPAP significantly shortened endotracheal tube is entered through the nose, set so that its end is in the nasopharynx.

6. Check the positive pressure created in the airways, according to air gauge indices.

7. If necessary (insufficient pressure and open mouth), fix lower jaw with a tape (you can also use a pacifier or change the baby's position).

8. Fix the nasal device, avoiding pressure of binasal cannula on nasal septum.

9. If use the apparatus for noninvasive ventilation:

– Fix the position of cannula or mask, carefully tightening the tapes on a cap on both sides (avoid too tight fitting).

– By holding generator, fix the tubes that depart from it (inspiratory, pressure and expiratory) with clamps located in the middle of the cap.

– Separate in different sides inspiratory and pressure tubes and then fix them on the cap with clamps.

– You must tie the tapes on the back of the cap, fixing it better.

– Check the pressure, according to the schedule outlined in the instruction manual. Standard medium pressure must be within 5 cm of water column, if the level of the base flow is 8 l/min.

– When the pressure reduces less than 4 cm of water column, check the fit of cannula/mask and fix their position using generator tapes. Further, to achieve the required pressure level, increase base flow.



Figure 87 – Fixation of nasal cannulas with a special cap, gastric tube for decompression



Figure 88 – CPAP via short binasal cannula



Figure 89 – CPAP via nasal mask

10. Start clinical and instrumental monitoring. You should support SpO₂ within 88–94 %, and evaluate the severity of respiratory disorders by standard scales at least 1 time per 3 hours.

11. Check the position of cannula every 2 hours to ensure proper tightness and the level of positive airway pressure.

12. Every 3–4 hours remove the cannula from the nasal passages, check airways passage and the absence of injuries, make a toilet of nasal passages in accordance to hospital protocol. Change the cannula of the mask if necessary.

Complications:

- air leak syndrome;
- trauma, including injury of the nasal mucosa, soft palate, larynx, trachea, formation of bedsores. Septum damage occurs in case of incorrect canula installation or its mobility causing pressure and/or friction. Increased humidity due to the application of gel or lubricant violates the integrity of the skin;

- infections – bronchitis, pneumonia, rhinitis;

- bloating;

- hyperoxia with the development of retinopathy and other side effects;

- hypoventilation/hypercapnia;

- increased intracranial pressure, impaired cerebral blood flow in case of strong parameters of CPAP;

- increased work of breathing, reduced cardiac output in case of strong parameters of CPAP;

- anxiety of a child, especially full-term.

Reducing complications promotes the use of modern active CPAP generators. Thus, the benefits of active CPAP generator Medijet are:

- low levels of working pressure;

- reduced work of the patient's breathing;

- ability to use in children with body weight from 500 g;

- stable positive pressure in patient's airways;

- absence of direct flow into the patient's airways;

- compensation of air leaks;
- controlled short-term increase of CPAP pressure;
- low noisiness level;
- port for connecting the nebulizer (disposable generator);
- maximum easiness and safety of use (the risk of lungs barotrauma is absent);
- the ability to use devices of other manufacturers together with AVL;
- big choice of disposable materials (caps of 7 sizes, nasal masks of 3 sizes, nasal cannula of 5 sizes).

Mistakes:

- the absence of control of respiratory disorders or severity by the scales of Silverman or Downes during CPAP;
- prolonged CPAP with unmoistened and not warmed mixture or oxygen;
- prolonged CPAP with 100 % oxygen instead of air-oxygen mixture;
- prolonged CPAP with high FiO_2 without control of SpO_2 ;
- making CPAP through endotracheal tube longer than 30 minutes.

27. Monitoring of heart rate and blood oxygen saturation – pulse oximetry in newborns

Indications:

- monitoring of the child's condition during AVL, CPAP, and oxygen therapy;
- unstable hemodynamic, respiratory disorders, apnea;
- primary reanimation of a newborn using air-oxygen mixture to determine the minimum necessary oxygen concentration;
- invasive interventions and research (lumbar puncture, intubation, transfusion, etc.);
- during transportation;
- all hospitalized children.

Oximeters allow to continuously measure hemoglobin oxygen saturation (SpO₂) by non-invasive method.

Method of pulse oximetry is based on different absorption by oxidized and reduced hemoglobin of red light that passes through the tissue. The sensor has two diodes: one is a source of red light and the other sees the light that has passed through the tissue. Oximeter analyzes pulsating arterial blood circulation. When hemoglobin is fully oxygenated, the indication devices will be “100 %”. The normal level of oxygen saturation (SpO₂) is 88–95 % for a healthy full-term newborn and 85–92 % for premature.

Pulse oximeter does not measure the partial pressure of oxygen in the blood, so you cannot focus only on indices of saturation (in case of 100 % saturation partial pressure can range from 70 to 600 mm Hg).

Contraindications: Do not exist.

In case of hypovolemia, hypothermia, hypotension and microcirculatory disorders saturation data on device may be wrong. This problem untypical for devices (pulse oximeter, patient monitor, etc.) with Masimo SET technology that allows you to measure accurately and displays the level of saturation in case of low perfusion and/or movements of the child.

Methods of use:

Put a new (disposable) or decontaminated sensor on the hand or foot so that one diode aligns correctly with the other. The sensor is fixed by a special clamp or plaster (do not stick to the skin, but fix around through a napkin). Do not apply clamp too tight not to impair blood flow/venous outflow in the limb. A flex can also be additionally fixed on the extremity 3–4 cm proximal for more reliable fixation in anxious child. From time to time change the position of sensor for prevention of circulation disturbance.

At intensive outdoor lighting, phototherapy additionally covers sensors to reduce the possibility of incorrect measurement.



Figure 90 – Sensor set on the child's leg



Figure 91 – Monitor indices – heart rate, saturation.
Blood pressure sensor is disabled

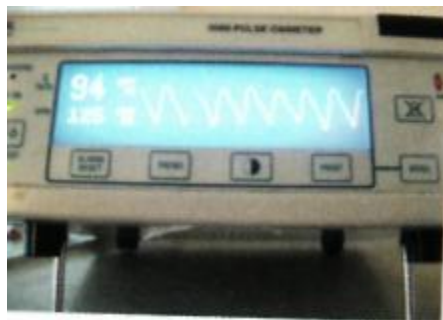


Figure 92 – Plethysmogram (pulse wave variation),
heart rate and SpO₂

The alarm system makes possible to set the index of maximal and minimal permissible SpO₂ and pulse rate for determining their excess in-time. For this indicator “max SpO₂” is set at the level 95, min SpO₂ at 85, pulse rates depending on the condition of the child at min 100–120 and 140–160 max. Alarm sound volume can be regulated, but do not turn off the signal.

If a child’s condition does not match with the device indices, check heart rate with phonendoscope. Mistakes occur when a child is anxious, moving the limb with a sensor, improper fastening of a sensor and low peripheral blood flow (blood flow centralization). The impact of artifacts such as motion, low perfusion, external noise (light, electromagnetic, radio waves, etc.) on measurement accuracy and correctness of pulse oximeter indices can be minimized using disposable Masimo sensors with protruding photodetector (“shock absorber”), which decrease mistakes in case of movement of the patient, external light or electromagnetic waves from other devices.

Also, the signal may be weak after pollution of a sensor with grease, oil etc. In this case wipe the sensor window with 70 % alcohol, apply the sensor to another area.

Mistakes and complications:

- Wrong fixing of sensors – measuring errors.
- Prolonged fixation of the sensor in one place can cause swelling, necrosis, irritation, infection of the skin.
- Attempts to keep the newborn SpO₂ above 95 % during oxygen therapy.
- Increasing the concentration of oxygen in the respiratory mixture due to the low level of SpO₂, if the reason of saturation decrease is insufficiently of intensive signal associated with the wrong fixing or long standing of sensor in one point.

Routine pulse oximetry is uninformative in case of blood circulation disorders, hypotension, shock, edema, supercooling of a child, and has a large measurement error if SpO₂ < 80 %. Especially dangerous is hyperoxia, because routine pulse oximetry

cannot always reflect its true level, that's why even at the level of $SpO_2 > 95\%$ PaO_2 may be more than 100 mm Hg.

Masimo SET technology works even at low perfusion, especially when using Masimo disposable sensors. This sensor reduces the risk of cross infection, increases the comfort and safety of the newborn.

Routine pulse oximetry technologies are also not able to recognize carboxyhemoglobin and methemoglobin, in such cases it is dangerous to underestimate the risk of tissue hypoxia in the child. New multiwave Masimo Rainbow pulse oximetry technology allows continuous and noninvasive measurement percentage of methemoglobin SpMet, carboxyhemoglobin SpCO. Laboratory and clinically equivalent results of these indicators are now quickly available via pulse oximeters with Masimo Rainbow technology, in real-time and non-invasive, i. e. without blood sampling.

28. Blood pressure (BP) measurement in newborns

Indications:

- monitor the status of blood pressure and heart rate (HR) of a child in the intensive care unit;
- control of sympathomimetic actions during their administration.

Contraindications:

Do not exist. Control of blood pressure is stopped when the child's condition is stabilized and does not require the appointment of inotropic drugs.

Required tools:

- comfort conditions of stay for the child;
- the blood pressure measuring device;
- neonatal cuffs of different sizes, cleaned, disinfected or disposable.

Measuring of blood pressure in a newborn is made by indirect bloodless method. Measurement method is oscillatory method. The device consists of a monitor, pneumatic hose and a

cuff. Modern devices can measure and display on the monitor the following parameters: systolic pressure, diastolic pressure, mean pressure, heart rate.

Preparation of a child:

– The limb on which the measurement is made should not be engaged in other therapeutic and diagnostic procedures. Unacceptable measures pressure on the limb with intravenous vascular access.

– Cuff size depends on body weight. Among standard cuffs with width 2.5–7.0 cm (neonatal sizes № 10–13 or pediatric № 1) you should selected one, the cuff width of which is equal $\frac{1}{2}$ of the shoulder's circumference.

Standard number	Shoulder's circumference	Cuff's width
№ 13	8.5–13	5
№ 12	7.5–10	4
№ 11	5–7.5	3
№ 10	3.5–6	2.5

– Measurement of the circumference of the shoulder is carried out with individual or paper tape; if the tape is without divisions, it is applied to the ruler and determined appropriate size of the cuff.

– Inside of the neonatal cuffs there are usually divisions that indicate the allowable interval of the shoulder's circumference. Maximal and minimal sizes match the contours of cuffs of the related sizes (larger or smaller), for final selection take into account the cuff's width and shoulder length of the child.

– Try on a certain size of a cuff directly to the child. If the chosen size didn't actually fit (in width etc.), replace it with a larger or smaller.

If device is possible for pressure measurement in patients of different age groups, use a special neonatal hose, compatible with neonatal cuffs (pink or other, depending on the

manufacturer) and select the appropriate tag “infant” on the device.

Methodics:

1. Clean hands.
2. Put the cuff of the matched size on a nude (or thin, without folds, shirt) shoulder so that the distance from the bottom edge of the cuff to elbow is 1 cm, and the hose is on the inner surface (for details see manufacturer’s instructions).
3. Fix the cuff and connect it with the apparatus through the hose.
4. Turn the device on and set alarm limits and maximum forcing pressure, and then press the “Start” button.
5. The measurement starts automatically.
6. The pump raises the pressure in the cuff to 130 mm Hg (or set previously) and slowly decreases.
7. After the measurement the levels are shown on the monitor. If the numbers do not appear, the device automatically repeats measurements.
8. It is possible to install a manual measurement method when it starts only on the command “Start” or automatically, depending on the desired frequency of monitoring. Define the required frequency depending on the child’s condition. Manual mode is recommended every 3 hours or more frequent.
9. The interpretation of results.



Figure 93 – Divisions inside of the neonatal cuff for correct choice

Normal indices of systolic, diastolic and mean pressure depending on body weight and age of the child are presented in the table:

Normal blood pressure in full term newborns, mm Hg				
Age	Boys		Girls	
	Systolic	Diastolic	Systolic	Diastolic
1 day	67±7	37±7	68±8	38±7
4 day	76±8	44±9	75±8	45±8
1 month	84±10	46±9	82±9	46±10

After birth, blood pressure of full term and preterm newborns increases to 1–2 mm Hg a day during the first week and 1 mm Hg a week during the next 6 weeks.

Systolic and diastolic blood pressure in children with body weight 500–2000 g after birth at 3–6 hours of life		
Birth weight, g	Systolic, mm Hg	Diastolic, mm Hg
501–750	50–62	26–36
751–1000	48–59	23–36
1001–1250	49–61	26–35
1251–1500	46–56	23–33
1501–1750	46–58	23–33
1751–2000	48–61	24–35

Mean pressure is the most stable and integrated indicator, its level is normally equal to a week of gestation on the first day of life and gestation age + 5–10 mm since the 3rd day of life. After the 3rd day of life most preterm infants with gestation less than 26 weeks have mean blood pressure > 30 mm Hg and most of full term newborns > 50 mm Hg.

If the child's blood pressure goes beyond the norm, estimate the general condition of the child. Before you start to treat high (elevated) or low (decreased) blood pressures make sure that the measurements were correct and the cuff corresponds to the diameter and size of the shoulder. After 5 minutes (not earlier) repeat the measurement, correlate the measurement results with the clinical condition of the child.

Mean blood pressure in children with birth weight 500–1500 g			
Birth weight, g	Mean blood pressure \pm standard deviation, mm Hg		
	3 day	17 day	31 day
501–750	38 \pm 8	44 \pm 8	46 \pm 11
751–1000	43 \pm 9	45 \pm 7	47 \pm 9
1001–1250	43 \pm 8	46 \pm 9	48 \pm 8
1251–1500	45 \pm 8	47 \pm 8	47 \pm 9



Figure 94 – The device indices – systolic, diastolic, mean pressure, heart rate and SpO₂

Hypotension – is a condition in which blood pressure falls below normal values by more than 2 standard deviations. Clinical signs of systemic hypotension may be tachycardia, pallor and lack of perfusion of the skin, limbs, CNS depression, reduced urine output, metabolic acidosis.

Hypertension – is a condition in which blood pressure increases from normal values by more than 2 standard deviations. Nonspecific clinical signs: tachypnea, heart failure or cardiomegaly, neurologic disorders, gastrointestinal problems.

Blood pressure isn't a single indicator that determines the cardiovascular system. In case of hypotension defined by apparatus hemodynamics may be stable and increased blood pressure with medications does not always improve the general condition of the child.

The main causes of hypotension:

1. Shock due to:
 - hypovolemia (blood loss, dehydration);
 - disturbance of peripheral vessels tone (sepsis, capillary leak syndrome).
2. Heart failure:
 - asphyxia;
 - heart defects;
 - cardiomyopathy: metabolic, infectious.
3. Pneumothorax.
4. Metabolic disturbances (decrease of cardiac output):
 - significant alkalosis;
 - hypocalcemia;
 - hypokalemia.
5. Medicines (magnesium sulfate, prostaglandin E₂, droperidol, vancomycin, etc.).

Possible causes of hypertension:

1. Kidney diseases (thrombosis, congenital stenosis of the renal vessels, tumors, polycystic kidney, renal failure).
2. Coarctation of aorta.
3. Congenital adrenal hyperplasia.
4. Increased intracranial pressure.
5. Bronchopulmonary dysplasia.
6. Medicines:
 - methylxanthines (caffeine, aminophylline);
 - sympathomimetics;

– glucocorticoids.

7. Fluid and/or electrolytes overload.

The treatment of hypotension – restore blood volume in case of hypovolemia with isotonic solution (slow infusion of 10–20 ml/kg of 0.9 % NaCl or fresh frozen plasma in case of significant blood loss), sympathomimetic amines (dopamine, dobutamine), treatment/correction of hypoxia, acidosis, hypoglycemia, hypocalcemia.

Treatment of hypertension – eliminating the main cause. In case of stable hypertension which isn't associated with fluid overload or the influence of medicines, the appointment of antihypertensive drugs (furosemide, chlorothiazide, nifedipine, captopril) is possible.

Complications and mistakes:

– Using improper cuff size: too wide cuff gives too low pressure, and too narrow gives too high pressure. Loose imposed cuff also lowers blood pressure.

– Indices may be wrong in case of disturbance of peripheral blood flow in the area of measurement (hypothermia, hypovolemia) or arrhythmia.

– Permanent pressure measurement (in monitoring regimen) in a relatively stable child impairs blood flow and venous outflow from the limb where the cuff is installed, increases blood pressure, that's why the often redistribution of blood flow increases the possibility of fetal communications functioning.

– Processing of measurement results without considering the state of a newborn, revaluation of decrease or increase of blood pressure, neglect of mean pressure and deviations (standard deviation).

29. The lumbar puncture

Indications:

- suspected meningitis or encephalitis;
- suspected sepsis in premature baby;
- suspicion of subarachnoid or intraventricular hemorrhage.

Lumbar puncture may be a part of the primary examination of a sick child or may be made later if there are temporary contraindications. It is better to receive the results of the cerebrospinal fluid investigations before prescribing antibiotics, but the presence of contraindications and the inability of lumbar puncture should not be a reason to delay the treatment of children with signs of meningitis or sepsis.

Contraindications:

Clinical signs that require immediate antibiotics and/or delay lumbar puncture for 1–2 days until the child's condition improves:

- Coma.
- Signs of high intracranial pressure, cerebral edema (abnormal reaction of pupils, unilateral or bilateral affection of motor function of pupils or swelling of the optic nerve. Swelling of the optic nerve is obligatory and late sign of the increase of intracranial pressure in meningitis. Tense fontanel in the absence of other signs of increasing intracranial pressure is not a contraindication for the lumbar puncture.
- Hemodynamic disorders/shock.
- Severe respiratory disorders.
- Recent seizures (within 30 minutes).
- Coagulopathy/thrombocytopenia.
- Manifestations of a local infection in the area of lumbar puncture.

In difficult clinical situations, the decision about lumbar puncture should be made by concilium.

Lumbar puncture should not be performed if the severity of the child's condition requires antibiotics for meningitis treatment, despite the results of cerebrospinal fluid investigations and microscopy that will be received.

Lumbar puncture requires the informed consent of the parents. Information should include the advantages of manipulation to diagnose problems and potential complications.

Equipment:

- sterile gloves;
- diapers and sterile tray;
- disinfectants for the skin: betadine or alcoholic solution of chlorhexidine;
- local anesthetic lidocaine, 2 ml syringe, a needle 25G;
- test tubes for cerebrospinal fluid (3);
- needles for spinal puncture 22G with beveled end and mandrin (the use of needles without mandrin is associated with the risk of spinal epidermoid tumors).

Experienced assistant plays an important role in a successful spinal puncture, because he provides the correct position of the patient. The position is an important aspect of the success and safety of the puncture.

Preparation of the patient:

1. Analgesia, anesthesia and sedation.

Before the procedure, the child should be administered orally 25 % glucose solution: full-term – 0.5–1.0 ml, premature with the body weight < 1500 grams – 0.25 ml, premature with the body weight 1000–1500 g – 0.15 ml, with a weight less than 1000 g – 0.1 ml. This method is low effective for this procedure, especially in preterm babies, so it cannot be used as a single one.

In the area of puncture lidocaine of 1 % solution (4 mg/kg) as an additional or single method of anesthesia is administered subcutaneously.

2. Position of the child.

Lumbar puncture requires warm conditions (high operating/reanimation table under a radiant heat source), sufficient lighting in the area of manipulation.

Lumbar puncture is made in the position on the side. The aim is to maximize the bending of the back (embryonal position), knees pressed to the chest, but avoid excessive bending of the neck to prevent respiratory disturbance. The spine of the child should be located strictly horizontally, parallel to the table surface

and the back surface located at 90° to the table, not inclined forward or back (check that shoulders and hips are lying straight).

3. Monitoring. Continuous pulse oximetries, observation of breathing are required.

4. Identification and cleaning of the puncture area.

To determine the puncture area you should draw an imaginary line that connects the upper edges of iliac bones, which crosses the spine on the level of L3–L4. Clean the skin in the puncture area and around with the spiral movements outside with povidone-iodine or chlorhexidine, and impose with a sterile diaper. Wait while the skin will completely dry (exposure time). With the clean hands in gloves make a local anesthesia by infiltration of the skin in the puncture area with 1 % solution of lidocaine using needle 25G.

Methodics:

1. After aseptic cleaning hands, put on sterile gloves.

2. Determine the puncture area:

– horse tail of spinal cord in newborns ends at the level of L3;

– the line connecting the upper edges of iliac bones crosses the spine at L3–L4;

– puncture is made in the interval between L3 and L4, or L4 and L5 in premature babies.

3. Puncture is carried out in the middle of the intervertebral space according to the connecting line.

4. The tip of the needle should be located towards umbilicus. Orient the needle parallel to the spine for separating, but not cutting the fibers.

5. Make puncture in the skin with a needle with mandrin and stop until the child stops moving.

6. Ensure the correct location (back is located straight and perpendicular to the table, needle is parallel to the table and perpendicular to the back).

7. Enter the needle through the interspinal ligament (it increases resistance). Slowly push the needle further through the tissue until resistance disappears. Remove mandrin from the needle.

8. If the cerebrospinal fluid is not dropping out of the needle insert the mandrin and push the needle forward carefully, checking the presence of spinal fluid.

– An alternative technique is to remove the mandrin from the needle after the passage of ligament and slow movement without mandrin till the appearance of cerebrospinal fluid. So, you can not unintentionally leave the subarachnoid space.

– If the needle encounters resistance – remove it slowly, watching the appearance of cerebrospinal fluid. If cerebrospinal fluid did not appear, insert mandrin, re-orient it and try again.

9. When cerebrospinal fluid appears, look for its colour and leaking character – slow or frequent drops or stream, and changes over time, collecting the liquid in test tubes (0.5 ml each, not more than 1.5 ml per puncture).

10. If the liquid is mixed with blood, it may be due to injury (in the first and the last test tubes will be difference in colour visually or during laboratory investigation), mistaken puncture of vessels or vascular plexus (same colour in all test tubes, forming clots), or intraventricular bleeding (same colour in all test tubes, but clots aren't formed).

11. The collected cerebrospinal fluid is sent for microscopic (counting cells and their differentiation), bacteriological (crop, Gram staining, microscopy, sensitivity to antibiotics) and biochemical (glucose, protein, Pandy test) research.

12. After the procedure remove a needle and press on the puncture area with a gauze ball for several minutes.

13. Treat the puncture area with alcohol and put aseptic bandage on the puncture.

14. Provide rest and vertical position and do not load a baby few hours after manipulation.

Complications:

- inability to obtain cerebrospinal fluid/need to repeat puncture/injury;
- respiratory disturbances due to incorrect body position (rarely);
- spinal hematoma or abscess (very rare);
- brain roots injury in case of high puncture;
- wedging of brain structures into foramen magnum (very rare);
- the formation of epidermoid tumors when parts of skin penetrate to the lumbar area using conventional needles without mandrin.

Mistakes:

- use of a puncture needle without mandarin;
- collecting more than 1.5 ml of cerebrospinal fluid during one puncture;
- making procedures in case of cerebral edema, increased intracranial pressure, cramps or immediately after them.

30. Bases of physiological care of premature and sick children

Indications:

- prematurity, low birth weight;
- effective independent breathing or respiratory support.

Contraindications:

Do not exist. Severe child's condition requires intensive interventions, special diagnostic and therapeutic measures, but they are based on physiological characteristics of preterm born children. Always, despite the child's condition follow these general recommendations.

Equipment:

- warm room with the presence of blinds on the windows and curtains to darken the room;

- the presence of mothers and/or other family members;
- couveuse (incubators) with optional darkening, screens on couveuse and individual lighting;
- source of radiant heat, heated beds, nest, soft multipurpose rollers, etc.

Methodics:

Basic principles of physiological care for children with low birth weight are:

- compliance with thermal protection, comfortable condition for the child;
- the validity and safety of medical interventions, prevention of pain;
- early contact with the mother, the mother is involved in the nursing of the newborn(s) which require intensive care, including AVL;
- early non-invasive respiratory support with the benefit to nasal CPAP therapy;
- early start of breastfeeding according to the clinical condition of the child;
- parenteral support with the basic ingredients (glucose, amino acids, fat emulsions, trace elements, vitamins);
- protection from bright light and noise;
- prevention of complications associated with aggressive medical measures that are necessary to treat the child, through careful consideration of interaction of many factors that may affect future treatment result/survival.

1. For preterm children after the birth create conditions close to the intrauterine existence: constant heat, humidity, darkening, muffled sounds, even eased constant pressure on the entire surface of the body, reduced by the water environment feeling of the real weight of internal organs, taste and smell of maternal amniotic fluid, constant satiety and stable blood glucose level, which correlates with the mother's eating, soothing background sound of maternal heart, ease of small and medium movements, a sense of peace and security.

2. The joint stay of a mother and a newborn with a low birth weight provides immune protection, psycho-emotional support, physiological pain management, timely care and 24 hour surveillance, regular meals without haste.

3. Darkening is provided by the window curtains and a special screen-cover on couveuse, crib, shielding eyes with a cap during intensive care in an open reanimation system, protective glasses at phototherapy. General lighting in the room is not turned on without need, if adequate lighting is necessary for procedures, use individual lighting – lamps of directional lighting.

4. Reducing the constant noise, routine for intensive care unit is provided by establishment of separate compressor room with the supply of compressed air and oxygen to each working place, motivation and education of the staff habits to walk and work quietly in the ward, talking in a whisper, carefully open and close the window of couveuse, doors and other equipment. Sudden movements and loud sounds should be avoided, all electrical and mechanical equipment, especially infusion pumps must be fixed separately on a tripod or special shelves, but should not stand on a couveuse. Volume of alarm signals must be installed the smallest one, which will be heard by medical staff. Alarm sound should be immediately disabled, helping a child (alarm lamp usually stays on). Sometimes, most devices recall the signal volume independently. Allowable noise in the intensive care unit is 55 dB.

5. Do not bother a child without any need, do not open doors and windows and do not remove a child from a couveuse. Daily examination should be carried out in the presence of the mother or a family member in comfortable circumstances for a child (in couveuse) when he sleeps calm. The examination results are written in a diary form to a history of the development of a newborn.

6. Weighing of a premature baby should be at least once a day, at the same time, in a warm room on the same scales covered with warm diaper. If the child began to steadily gain weight (20–

30 grams per day), he should be weighed every other day for a week, and then once a week until the child body weight increases to 2500 g.

7. Provide additional thermal protection by films when you open couveuse, the use of films in open systems helps to save humidity. Anything that touches the child should be warm, including the hands, surfaces of stethoscope, X-ray film, cuffs and sensors. Particular control is necessary for the temperature of intravenous solutions and medications that are injected, and also feeding, respiratory mixture during AVL and CPAP, warm up and humidify the oxygen during oxygen therapy. Measuring the body temperature of a premature baby is made at least 4 times a day with an electronic thermometer in the axillary area, and more often in case of problems. It is important to maintain a constant body temperature of the child, without changes. Overheating of a child is as dangerous as hypothermia.

8. Start an energy support and enteral feeding as early as possible, in case of full parenteral nutrition since the 2nd–3rd days of life, begin minimal trophic feeding with the mother's milk. In a severe, unstable condition of the child enteral nutrition should not be forced, it is enough to provide 10–15 ml/kg/day. Provide total parenteral nutrition using glucose and adapted amino acids since the first day, fat emulsions within the 5th day, if possible vitamins and minerals to consider energy needs. To avoid complications during feeding read instructions carefully, consider the contraindications.

9. To create comfort and prevent bedsores and contractures you should increase the surface on which a child is lying and provide additional surface of skin contact – “touching”. For this purpose use various rollers, nest, pillows, envelopes, etc. Rollers under the head and shoulders provide better airway passage in a baby with breathing disturbance, for CPAP. Position on the abdomen when the baby is on a pillow-roller and limbs are slightly hanging down on either side provides partial tactile anesthesia and improves ventilation in posterior segments of lungs

during AVL. For prevention of contractures of immovable limbs put small rollers or rolled absorbent diapers under the legs and hands, changing often their position. “Nests” and envelopes – “pockets” also fix the limb in a comfortable position; increase the area of “touching” and the surface on which the child is lying, reducing pressure on the skin. To prevent bedsores and atelectasis also frequently (every 2–3 hours) change the position of the body, head, and flip to the other side or from the back to the abdomen, etc.

10. Skin care, maintenance and preservation of the skin integrity and its functions are provided by careful supervision, especially in places of installation and fixation of catheters, tubes, etc. Reduce amount of plasters and other adhesive materials and use of non traumatic and “breathable” patches, which provide air access and removal the excess of fluid from the skin. To reduce the bonding surface cut along the patches, lay sterile wipes under sterile wide films, fix splints through diapers. During fixing the pulse oximeter sensor do not stick it to the skin, but fix around the limb with a special clamp or with a patch through a napkin.

If during medical procedures the integrity of skin is violated, use povidone-iodine as a local antiseptic, after the procedure remained amount of the drug from surrounding areas should be washed off with distilled water or saline to reduce the absorption of iodine to the body of the newborn. A solution of elemental iodine for application to the skin or creating antiseptic “locks” of infusion compounds is not used in neonates (risk of skin burns and affections of the thyroid gland).

The position of pulse oximeter, servocontrol sensors, and a cuff for pressure measurement should be changed every 2–3 hours to prevent edema and necrosis. If necessary use ECG monitoring, sensors must be changed only after their disconnection, cut the adhesive surface to minimal, use fixation gels (preferably thick).

During each examination carefully observe the skin condition, its purity, first manifestation of irritation or rash needs immediate local therapy. If there are any indications you should

prophylactically use zinc-based ointments which reduce manifestations of ecchymosis, accelerating the resorption of subcutaneous hematoma. To treat (acceleration of healing) irritation in case of violation of the skin integrity you should use panthenol containing preparations. Use local antiseptics (miramistin, decamethoxin, octenisept, etc.) indicated in case of the secondary infection of mechanical damages. In case of infectious rashes appoint the appropriate systemic antibiotics.

11. Blood test is made if there are objective indications. Transcutaneous and micromethod is used for monitoring the child's condition. In the presence of arterial catheters take blood from them. When taking blood capillary by transcutaneous way anesthetize physiologically (fixing, on hands, breast feeding) or orally with glucose solution (0.1–1.5 ml, depending on weight). It is necessary to take the minimal quantity of blood (biochemical analysis – 1 ml, haematocrit, acid-base balance, and glucose – 0.2 ml)! The whole amount of blood taken from a child must be recorded in the observations card. If necessary, compensate the blood that was taken for tests (especially in extremely small premature newborn, compensate volume or erythrocytes, depending on the situation).

12. When calculating the daily volume parenteral fluid for a child you should add entire volume of intravenous infusions (especially for the dilution of antibiotics). For this purpose write a dose of medication on a list and correspond the amount of saline solution/solvent or determined for each drug in the department's algorithms and all nurses take the same amount, and doctors, preparing infusion list, take into account the total number of additional liquid, depending on the preparations and their frequency. In this case make a note in the column of injections, for example, 20 ml – infusion. For preventing intraventricular hemorrhage carry out intravenous injections of drugs carefully, very slowly (1 ml/kg/min.). For antibiotics and volumes over 10 ml better use infusion pump. Do not routinely disconnect and connect the system to enter stream injections. For preventing

infectious complications you should use catheters with the 0 additional port or three-way stopcock. All solutions for intravenous injections should be warm, heated to body temperature. During the drip entering the main part of a system should be located in couveuse or directly under the source of radiant heat (except fat emulsions).

13. During respiratory support carefully monitor the oxygenation to avoid hyperoxygenation, which is particularly dangerous for premature babies. If a child receives additional oxygen SpO_2 should not be $> 95\%$. On AVL or CPAP with supplemental oxygen in respiratory mixture SpO_2 should be maintained at $85-95\%$ and for children with gestation age < 29 weeks at the level of $88-92\%$. In case of improvement of a child's condition, the first parameter of respiratory support that you should change is % of oxygen (FiO_2).

14. During invasive AVL the sanitation of endotracheal tube should be made in the existence of objective indications. To prevent formation of thick phlegm in the endotracheal tube with secondary obstruction of airways, to prevent excessive condensation in the contour with secondary increasing inflows of fluid to a child, you should watch carefully the temperature and water level in the humidifier and time to time drain fluid from the contour tubes. In a position of a child on one side it is recommended to keep the inhalation tube on top.

15. When carrying out infusion therapy and parenteral nutrition you should monitor urine output, but installation of urinary catheter is not desirable. Control of urine is made by weighing diapers or diaper lining, if necessary collect urine for clinical analysis, it is collected in special disposable urine bag, in boys there may be used sterile containers (test tubes, bottles). In case of acute urine retention or necessity to collect urine for bacteriological investigation bladder puncture or catheterization may be recommended. These are sterile procedures, so they should be carried out under aseptic conditions with sterile gloves, but always consider their need.

16. Extremely valuable method for nursing newborns with very low birth weight is a method of continuous contact “skin-to-skin” with the mother. Such child care method as “mother kangaroo” is an effective way of caring for premature newborns with low birth weight. This method enables forming close emotional bond between a mother and a child, increase the frequency and duration of breastfeeding, avoid nosocomial infections and perinatal problems.

Complications:

Do not exist for physiological methods with proper carrying out.

Mistakes:

- the underestimation of the child’s condition;
- neglecting individual needs of the child;
- making unnecessary examinations and procedures (which don’t change the tactics of treatment) at the moment.
- polypharmacy (the study shows that in case of the appointment simultaneously of more than 5 preparations to newborns each subsequent drug reduces the chance of recovery and survival of the child);
- the prohibition for mother to carry out nursing for her child in the intensive care unit;
- the absence of anesthesia during most procedures, especially in premature born, whose reaction to pain is different;
- underestimating the importance of nursing and overestimating the importance of treatment.



Figure 95 – Laying “nest”



Figure 96 – Additional thermal protection in primary care and transportation



Figure 97 – Couveuse darkening



Figure 98 – For inhalation humidified and heated oxygen is used (Bobrov's apparatus placed in electro heater)



Figure 99 – Administration of exogenous surfactant for therapeutic purposes



Figure 100 – Oxygen tent, baby is on the roller



Figure 101 – CPAP via facial mask. Newborn is laying in couveuse on the roller



Figure 102 – Improved “envelope” supports legs and body



Figure 103 – Noninvasive respiratory support through a nasal mask

31. Bases of feeding sick and premature children

Indications:

All newborns need food.

If breastfeeding is not available because of severe immaturity or critical condition of a newborn, special needs associated with the disease of the child, it is appointed alternate feeding or trophic food.

In case of failure or inability of enteral feeding, parenteral feeding is provided.

Contraindications:

Do not exist. Breastfeeding is physiological and safest method of newborn feeding. Severe child's condition requires intensive interventions, specific diagnostic and therapeutic

measures but nutrition and energy supply are the bases of life, recovery and subsequent development of child.

Equipment:

- colostrum or breast milk collected aseptically;
- adapted specialized or therapeutic mixtures, made or diluted according to the instructions in aseptic conditions;
- enrichers of mother's milk for premature born children;
- sterile specialized solutions for parenteral nutrition (amino acids, lipids, glucose);
- vitamins and minerals for babies with intravenous or oral administration;
- devices for enteral feeding;
- infuse pumps and “lines” for parenteral nutrition;
- electronic scales.

Methodics:

The main purpose of feeding a child is to achieve normal growth, weight gain, according to postconceptional age, ensuring optimum development and health of the child.

Prenatal needs of the fetus, which is rapidly growing and developing, are very high; and the greater they are, the smaller the gestational age is. Most of the plastic material required for the growth and development, a fetus gets from its mother as a ready product. The ability to assimilation and digesting the main ingredients after the birth in premature and sick children is less, so it is difficult to meet their needs in full. In addition, immaturity of intestines and enzyme system are not conducive to the assimilation of enteral nutrition, but parenteral way is difficult to ensure full needs, so feeding of patients in intensive care unit and premature children is the “Achilles heel” in newborn's nursing. The needs of children are very individual, so each time it must be based on the clinical situation characteristics and capabilities of each patient. The current strategy is not to choose one way, but to combine all available methods of feeding.

1. Identifying the needs of a child in nutrition.

Since birth to the 7th day of life the child may lose 10 % (if the birth weight is 1500–2500 g) and 15 % (if the birth weight is < 1500 g) of body weight. During this period you should provide the child with the nutrients in quantities that prevent catabolism. When calculating the required daily amount of food, consider ways of losing calories:

- 50 kcal/kg/day for metabolism and maintenance of heart, brain, liver work;
- 5–10 kcal/kg/day for motor activity of the child;
- 15–20 kcal/kg/day for excretory activity and stabilization of body weight;
- the total amount of calories per day for life keeping of a child is about 75 kcal/kg/day. After the 7th day of life this provides such body weight gain, which corresponds to the intensity of fetal development, so prenatally fetus of 25–35 weeks gestation is gaining on average 15 g/kg/day.

Child's ensuring is sufficient if:

- a newborn under the age of 32 weeks gains not less than 150 g per week (15–20 g per day);
- a newborn aged 33–36 weeks is gaining 200–250 g per week (25 g per day);
- a newborn aged 37–40 weeks is gaining 250–300 g per week (30 g per day).

Such dynamics of body weight is provided when a child gets at least 120–140 kcal/kg/day with breast milk, so it is necessary to achieve this energy supply of the sick child.

Some (premature) children may need more than 120–140 kcal/kg/day. Therefore, the best reference is the daily weight gain – 10–25 g/kg/day, on average – 15 g/kg/day. Increasing of body weight for more than 25 g/kg/day is an evidence of fluid overload.

2. Ability of enteral nutrition, providing daily volume.

The volume of the stomach of a newborn baby is about 20 ml/kg,

so the amount of milk that can keep the newborn with low birth weight for one feeding is much smaller compared to full-term newborns.

Approximate stomach volume depending on a child's body	
Body weight, g	Stomach volume, ml
900	18
1000	20
1250	25
1500	30
1750	35
2000	40
2500	50

To provide low weight child with necessary calories you must increase feeding frequency and reduce gaps between them, without night breaks. Breast milk is evacuated quickly from the stomach, so the number of feedings for preterm newborns may be 10–12 times a day and intervals should be no longer than 3 hours. If a child shows no activity on feeding in 3 hours awaken and feed him. During breastfeeding the application to the breast can be done more often, but not less than the abovementioned quantity, in case of alternative feeding daily volume is distributed evenly on the number of feedings and a baby is regularly entered the necessary amount of food.

3. The best method of early enteral feeding in newborns with low birth weight and extremely low birth weight is minimal trophic feeding, which comprises of the early (1–2 days of life) minimal use of colostrum/breast milk portions for the purpose of functional and morphological maturation of the gastrointestinal tract. Only maternal colostrum can provide gastric tract of a premature child with secretory immunoglobulin IgA which is necessary to protect the intestine from massive pathological colonization. It is proved that the minimum portion of colostrum from the early days is the prevention of necrotizing

enterocolitis in premature babies. Children who receive minimal trophic feeding with breast milk are switching faster to full enteral feeding and are faster discharged home. Minimal trophic feeding is recommended to premature children with gestational age of 28 weeks or less from the end of the 1st–2nd day of life in a dose of 0.1–1.0 ml every 2–4 hours. The speed of expansion of enteral nutrition is individual and depends on the food tolerance of the child. For children who are on total parenteral nutrition, enteral feeding expansion is carried out individually and very carefully – from 1.0 ml every 4 hours to 1.0 ml for 24 hours under constant review of general clinical condition.

Enteral administration of breast milk to a baby with very low birth weight can be carried out through a tube into the stomach or in the presence of a swallowing reflex, with the syringe, pipettes, spoons, considering the small amount of needed milk. Milk, which got into the stomach through the mouth, is better absorbed through enzymatic action of saliva and provides better protection due to the presence of secretory component required for secretory sIgA.

At the beginning of early minimal trophic feeding a quantity of milk intended for a child is not considered to the total needs of the child. Parenteral nutrition is appointed in full volume until reaching with enteral nutrition 10–12 ml/kg/day, which is absorbed by a child with a satisfactory peristalsis.

4. To ensure optimal child development, intensive care and nursing efficiency parenteral feeding with the early appointment of amino acids (first-second day of life) is necessary.

Amino acids are used by the body for growth and immune functions. In newborns with very low birth weight amino acids are prescribed in the first days of life at a dose of 1.0–1.5 g/kg/day and gradually the dose is increased to 2.0–3.0 g/kg/day.

Optimal assimilation of amino acids is possible only if there is a sufficient energy supply of the child. As soon as possible, after the birth of a sick/premature baby who can not assimilate enteral nutrition in full, start entering of 10 % glucose.

However, remember that glucose is not yet parenteral nutrition, as well as in combination with the amino acids it can not optimally provide high energy and plastic needs for normal life, growth and development of a newborn.

The main source of energy and essential fatty acids is fat emulsion, which should be used with caution in children with very low birth weight. If there are no contraindications (sepsis, hyperbilirubinemia, thrombocytopenia, pulmonary hypertension, hypercholesterolemia), fat emulsion is administered from the 2nd – 5th day of life, gradually increasing the dose in case of a steady condition of a child. Considering the significant negative effect of the prolonged energy deficit to the premature baby, intravenous lipids should be included in the scheme of total parenteral nutrition within the 5th day of life.

Premature children with very low birth weight have a higher need for calcium and phosphorus than children of greater gestational age. The required amount of calcium is 150–400 mg/kg (4 ml of 10 % calcium gluconate), phosphorus – 31 mg/kg/day. Premature children with osteopenia need larger doses of electrolytes.

Electrolytes are administered under the supervision of their content in serum (normal serum calcium is 2.2–2.6 mmol/l, ionized – 1.18–1.3 mmol/l, phosphorus – 1.5 mmol/l), the ratio of calcium and phosphorus is 1:1 or 2:1.

Magnesium is administered at a dose of 0.3–0.4 mEq/kg/day in a 25 % solution of magnesium sulfate.

Sodium is administered at a dose of 2–4 mg/kg/day (1 ml of 10 % NaCl = 1.7 mg of sodium chloride), in case of hypernatremia the dose is reduced (normal level of serum sodium is 135–145 mmol/l). Abovementioned electrolytes are administered since the first day of life.

5. The control over parenteral nutrition is important.

This control is made through continuous monitoring of the clinical condition of a child, the dynamics of body weight, urine output, and biochemical parameters of blood.

6. If a minimum trophic feeding with colostrum started on time, continue to feed the child parenterally, gradually increasing the volume of enteral feedings. Depending on the amount of each feeding, use a syringe or spoon, the tube is used if it is set for decompression during AVL or at high volumes if the child gets tired during feeding with a spoon.

After the child reaches 30 weeks of postconceptual age, if condition allows, start applying a baby to the breast for formation of non-food sucking and feeding with enriched breast milk with a spoon, cup or tube. If tolerance to enteral nutrition is not generated, you should recommend full or partial parenteral feeding with mandatory enteral or minimal trophic feeding without increasing the volume of feedings. Only atresia of the gastrointestinal tract, necrotizing enterocolitis or reasonable suspicion are absolute contraindications to minimal trophic feeding.

From 34 weeks of postconceptual age sucking and swallowing reflexes are usually available and sufficiently coordinated, with this age children can effectively be fed with mother's breast. If necessary, add enriched breast milk or special mixtures. If the condition does not allow the child to obtain all the necessary amount of milk, you must feed with alternative methods.

Complications and mistakes:

- late start of enteral feeding, unjustified “hungry pause”, continued parenteral feeding without formation of tolerance to minimal trophic feeding;
- using solutions of glucose, 0.9 % NaCl, distilled water for the first enteral feedings;
- start of enteral feeding with milky mixtures, fast (more than 15 ml/kg/day) growing of enteral volumes (this is one of the risk factors of necrotizing enterocolitis);
- incorrect calculation of the child's needs, long plastic and energy deficiency;
- late entering of amino acids and lipids;

- continued enteral feeding of a child with the signs of necrotizing enterocolitis;
- the absence of definition of real daily child's needs, prolonged partial parenteral feeding without recalculation of needs in liquid and calories, proteins and fats, lack of satisfaction or significant exaggeration of the child's needs.

Modern technologies of feeding children with very low birth weight

The best food for a prematurely born baby is mother's breast milk. Milk from a mother who gave birth prematurely has a different composition from breast milk of mothers who gave birth in term.

Features of milk of a mother who gave birth prematurely:

- increased amount of protein (1.2–1.6 g per 100 ml);
- increased concentration of essential amino acids;
- elevated levels of essential fatty acids;
- reduced total fat (2.0–3.2 g in 100 ml);
- reduced lactose at the same level of carbohydrates;
- increased amount of protective factors, especially lysozyme.

Composition of milk in case of preterm labor meets the special requirements for feeding premature newborns related to the immaturity of the digestive system and features of metabolism of main nutrients such as: reduced or completely absent sucking and swallowing reflex, decreased secretion of gastric juice, reduced production of pancreatic proteases, lipases and intestinal disaccharidases (particularly lactase), high activity of peptidases of intestine, reduced absorption of fats and carbohydrates, low ability of bile to emulsify fatty acids, increased permeability of the mucosa of a bowel, increased excretory capacity of kidneys to remove sodium and potassium, slow and irregular bowel peristalsis.

But despite all benefits of breast milk for feeding of premature born baby, its composition cannot fully meet all needs of premature newborn in basic nutrients and requires enrichment.

There are 2 ways of enriching food for a prematurely born child:

1) amplifiers of breast milk – special supplement to breast milk, which are protein-mineral or protein-vitamin-mineral complexes;

2) special mixture based on serum protein hydrolyzate with a high content of total protein and adapted fat, carbohydrate and vitamin and mineral components.

Amplifiers are used only together with breast milk and cannot be as a single source of the child's nutrition.

Special mixture for premature infants can be used as a form of enrichment food for a prematurely born child who is breastfed, and as self feeding, which provides premature baby needs in basic nutrients for growth and development, if there is no possibility to receive expressed breast milk for feeding the child.

All mixtures are allowed for use in premature infants and children with low birth weight, must meet the following requirements: increasing protein content with advantage of serum fraction (preferably hydrolyzed), the facilitated composition of fats with medium chain triglycerides, low content of lactose, adapted vitamin-mineral composition, high energy value.

32. Breastfeeding of a newborn baby

Indications:

- all healthy newborns;
- a newborn with perinatal pathology after stabilization;
- premature babies and children with low birth weight after they are ready (coordination of sucking and swallowing reflexes).

Contraindications:

On the part of the child:

- severe condition of the newborn that requires reanimation;
- prematurity (gestational age < 32 weeks or weight < 1500 g).

– hereditary diseases accompanied by metabolic disorders (galactosemia, maple syrup urine disease, phenylketonuria, etc.).

On the part of the mother:

– severe condition of the mother after labor (obstetric complications);

– the open form of tuberculosis;

– HIV/AIDS;

– taking certain medications (psychotropic, anticonvulsant drugs, etc.);

– acute mental illness.

General rules:

1. Healthy full-term baby in the first days/weeks of life is fed on demand, on average 10–12 feedings per day, including night feeding.

2. Gradually, with age, the number of feedings decreases to 6–7 and the night gap increases, but not more than 6 hours.

3. If a child is sick, tired, weakened, with low weight at birth, hypoglycemia, he does not require feedings so explicitly and actively as a healthy child, but this does not mean that he should be fed less. This child should be applied to the breast at least every 3 hours and in the first 3–5 days – every 2.5 hours with the night interval of about 5 hours. If the baby is sleeping – wake him up, undress and make a light stroking massage, short air bath, change diaper, dress and apply immediately to the breast.

4. Routine control of the amount of milk that the child receives is inappropriate.

5. The main sign of sufficient amount of mother's milk with the proper feeding technique is normal urination – at every diaper change (3 hours) there must be urine, or weigh the diapers.

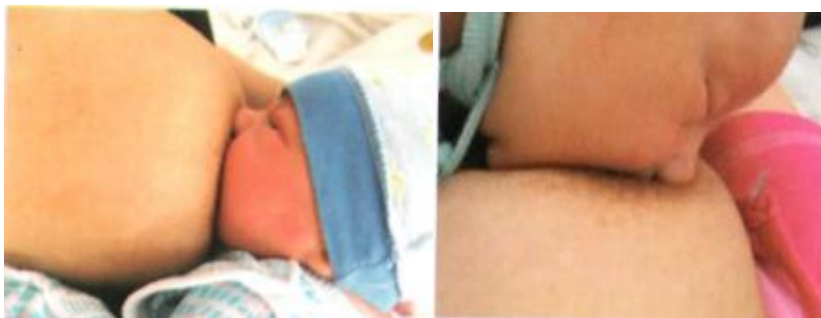
6. If there are doubts about the sufficient amount of milk a newborn is weighed in clothes before and after feeding during the day and the entire amount of received milk is calculated. Single “control weighing” will worsen the situation, make uncertain mother's ability to breastfeed, because the baby receives different amounts of milk at each feeding and in an unfamiliar environment

(after the doctor's examination or other procedures) it will suck to calm down but not to eat.

7. Exceptional breastfeeding is recommended up to 6 months; from 5.5 months you can begin to enter, drop by drop, fruit and vegetable juices, purees without thermal treatment, to form a food tolerance, taste buds and minimum subsidy of trace elements and vitamins.

8. By this age any feedings and other additives are appointed by a doctor. A healthy child satisfies the need for fluid through breast milk. If there are indications for an additional entering of liquid, medicines, amplifiers, etc., a doctor appoints mode and a number of entries. In this case, all needed food is entered with a spoon, cup or sterile syringe/pipette to the mouth.

9. A woman who is breastfeeding should intake full varied diet, without increasing the number or special restrictions of any products. It is advisable to limit the salt, spices, sugar (60 g/day), fatty foods (sour cream 20 g, butter 30 g, oil 15 g), milk and sour milk products (500 ml/day), cheese (20–50 g), cottage cheese (50–100 g). At the same time, meat and fish should be enough (150 and 120 g) and the menu should base on vegetables (various 500 g + potatoes 200 g) and fruits (300 g).



Figures 104, 105 – Correct capture of areola by a child



Figures 106, 107 – Breast feeding in sitting position

10. In the first week, especially during the transition of a newborn from amniotrophic to lactotrophic feeding, vegetables and fruits should be thermally processed; the use of juice, cabbage, cucumbers, grapes, strawberries, citrus fruits should be limited. Also, it is recommended to exclude halva and condensed milk from the menu, the number of nuts is reduced to 2–3 pieces a day.

Methodics:

After the first feeding in the delivery room and transferring to the ward of compatible stay, a skilled medical professional who has been trained and has experience or successful breastfeeding counseling, checks feeding technique by watching the feeding and helps the woman explaining her fundamental points and corrects mistakes.

Signs of the proper nursing techniques:

- the child's whole body is turned and pressed to the mother;
- the child's chin touches the breast;
- the baby's mouth is wide open;
- the lower lip of a baby is inverted outwards;
- the child captures the lower part of the areola;
- it is noticeable how the child is doing slow deep sucking movements;
- the mother doesn't feel pain in the nipple area.

How to apply a baby to the breast:

1. A mother should sit or lie down in a comfortable position and relax. She can sit, holding a baby in front of her or lie down and put the baby near. If it is convenient, she can put the baby on a pillow.

2. Feeding can take up to half an hour, so make sure that it will be convenient for a mother to sit in this position and keep the child this much time, otherwise feeding is stopped before the baby gets posterior milk and does not satisfy the need for sucking.

3. Hold the baby so that whole body is turned to the mother, not just the face.

4. The baby's head should be on the same line with the mother's body and his abdomen is in front of the mother's one. The child's whole body must be turned to the breast so that during feeding he wouldn't rotate or tilt his head.

5. If necessary, you can support the child's shoulders from behind, but not the occiput. His head should be slightly flexed to the back.

6. Give a child the whole breast, not just the nipple.



Figure 108 – Breast feeding in standing position



Figures 109, 110 – Breast feeding in lying position

7. You cannot pinch a nipple or areola with fingers and try to push it to the child's mouth.

8. Wait until the baby opens his mouth wide and detect readiness. Quickly attach the baby to the breast.

9. Put the baby to the breast so that his lower lip inverts outwards under the areola. Thus the child's chin will fit to the breast and the tongue will be located directly under the milk sinuses. In this position the nipple will be located a little further from the center of the child's mouth and the tongue can easily pin sinuses to the palate.

10. Explain to the mother that the child not only pulls, but also expresses milk to his mouth, so most of her areola should be between tongue and palate. The movements of the tongue sequentially (from the depths to the nipple) grip areola and using negative pressure milk is exuding to the root of the tongue.

11. With the proper technique of sucking a mother does not feel as a child sucks or pulls, she must feel gently tickling the tongue and hear the baby swallowing milk.

12. After several successful attempts of feeding the child learns proper technique, and his further application to the breast will not cause problems, but during all period that a mother and a child stay in the hospital, check the feeding state every day, inspect the nipples and breasts.

13. If a child coughs or belches during feeding, you should feed the baby in the vertical position: mother supports breast and

chin of a child with a hand, and the neck and throat of the child are above the nipple.

14. Feeding a baby with low birth weight continues longer than a full-term. The sucking rhythm is changed: fast sucking, slow pace, swallowing, rest... repeat the cycle.

15. To stimulate milk production in case of its failure and in infants with low birth weight, which can not get sufficient amount of breast milk, you can propose applying the child to breasts with a tube placed to the nipple. In this case, the child will be sucking breast, learning the correct sucking technique and stimulating oxytocin and prolactin reflexes and milk to his mouth falls through thin soft tube.

Positions of a mother while feeding a child:

The mother is sitting:

– The mother is sitting in a comfortable, relaxed position; preferably has support for the back. If the seat is too high, you can use the stand under feet, knees, but they should not be raised too high. If the mother is sitting in bed, pillows will help to make it comfortable.

– If the child is on the mother's lap, the child should be raised above, so that she doesn't bend down to apply the baby to the breast.

Position of a baby during the breast feeding in the sitting position:

The position "under hand" – the baby's head is on the mother's hand, but the mother should not push it to the breast. This position can be useful for:

- feeding twins;
- if the mother has some trouble applying baby in front to the breast;
- for treatment of lactostasis;
- if this position is more convenient for mother.

A situation when the child is on the hand opposite the breast for feeding – the trunk of the child is lying on the forearm

of the mother, her hand supports the baby's head at or below the ear, without pushing it to the breast. This method is useful when:

- a child is small to the gestational age or premature;
- a child is weakened or has congenital defects;
- a mother prefers this position.

The mother is lying:

The mother should lie in a comfortable relaxed position (in which she can sleep), her head may lie in a slightly elevated position (better use a pillow or put a hand under the head). She can support her child with another free hand.

Quite often the reason why it is difficult to apply a baby to breast in the lying position is that the child lies too high, and his head must bend forward to reach the nipple.

When feeding in the lying position the bodies of the mother and the child must lie in one plane, so we should not raise the child's body or upper part of the mother's trunk. Only mother's head is lying on the pillow and mother's whole body bends a little to the child, so that a corresponding nipple (left in the position on the left side and right in the position on the right side) is just in front of the nose of the child. The child's whole body is turned and pressed to the mother; his head is lying on the bed close to the mother's breast.

Feeding in the "lying" position is useful in the following cases:

- after obstetric interventions which impede feeding in a sitting position (caesarean section, epiziotomy, perineotomy, forceps, etc.);
- if the mother is tired, she can feed without getting up from the bed.

Other positions:

Standing (if a mother cannot sit or lie down, or if a mother prefers this position).

Lying on back (child above) is a convenient position in case of lactostasis, excessive amounts of milk in the mother. The same position is used when a baby is first applied to breast in the

delivery room. Its disadvantage is that the shape of the breast changes and it is difficult for a child to take the whole areola into his mouth.

The mother leans with the whole body over the child: in bed, lying on his abdomen and leaning on the elbow or on the table where the child lies. This position allows the areola to make a conical shape comfortable for a child, if a child is difficult adapted to the breast.

Complications:

- cracks in the nipple after the wrong sucking technique;
- insufficient feeding in case of improper technique;
- lactose deficiency, malabsorption syndrome. Breast milk, together with lactose contains lactase, which promotes the absorption of lactose, that's why this complication is rare.

Mistakes:

1. The wrong application to the breast.

Improper sucking technique can lead to:

- Pneumophagia and vomiting, intestinal colic. To eliminate symptoms you can prescribe drugs – defoamers (simethicone, dimethicone). But consider this is temporary help, which reduces pressure and pain, but does not release the cause of increased amounts of gas in the intestines. You should identify and eliminate the primary cause of increased intestinal gas filling in the child.

- Irritation, cracked nipples, infection, and mastitis.
- Bad emptying of the breast, lactostasis, hypogalactia.
- Pain while feeding will suppress prolactin and oxytocin reflexes, decrease the amount of milk in the mother.
- Improper feeding of newborn while the mother suffers from hypogalactia with the applying of additional feeding with mixture leads to agalactia, weaning, and transfers a child to artificial feeding.

2. Dietary restrictions of the mother.

33. Methods of tube and alternative feeding

Indications:

- the lack of sucking reflex or its discoordination from swallowing due to morphological and functional immaturity or illness of the child;
- regurgitation of different etiologies in the presence of a passage in the intestine;
- respiratory, cardiovascular failure;
- condition after surgery on stomach and intestines in newborns.

Feeding via tube is a method of enteral feeding through a tube entered into the stomach or small intestine. Along with other alternative methods it is used if breastfeeding is not possible. It is more physiological compared to parenteral method of the child feeding, accompanied by fewer complications. They are:

- full entering of all necessary ingredients only via a tube or alternatively;
- optional (combined) administration of certain food ingredients (enriched breast milk or additional volume of mixture) through a tube, spoon or cup on breastfeeding;
- partial enteral feeding or minimal trophic feeding through a tube which is set for decompression during AVL, CPAP in case of the partial or total parenteral nutrition.

Contraindications for enteral feeding:

- severe child's condition that makes impossible enteral feeding;
- congenital malformation of the gastrointestinal tract;
- necrotizing enterocolitis (suspected or confirmed);
- significant bloating or discoloration of the anterior abdominal wall;
- bleeding from the stomach, intestines;
- lack of tolerance to enteral nutrition (limited by setting a tube for decompression, the minimal trophic feeding is possible).

Equipment:

- sterile disposable gastric tubes, sterile syringes of appropriate size (5.0–20.0 ml);
- physiological solution of NaCl, sterile water;
- atraumatic patch to fix the tube;
- electric aspirator with a catheter for sanitation of the upper respiratory tract;
- stethoscope, pulse oximeter for the child monitoring;
- sterile containers for pumping breast milk and breast-feeding that are easy to wash and sterilize;
- clean sterilized spoon, cup, and dropper (depending on method);
- breast milk, therapeutic mixture and amplifier of breast milk are prepared in aseptic conditions;
- containers for the control of stasis (plastic test tubes, etc.).



Figure 111– Feeding with a spoon



Figure 112 – Feeding with a cup



Figure 113 – Feeding of a child with congenital defect through a bottle with a large pacifier (as the alternative to tube feeding)



Figure114 – Feeding through a nasogastric tube



Figure 115 – Feeding through an orogastric tube



Figure 116 – Feeding of children in intensive care unit is made by mothers

Teach a mother the technique for pumping breast milk. She must wash her hands, express milk from one breast in a sterile container. There can be used breast pumps, but they should be thoroughly washed and disinfected after each use. Expressed milk can be stored:

- at room temperature – 6–12 hours;

- in the refrigerator – up to 3 days;
- in the separate freezer with -18°C – 4 months.

Defrost of the expressed milk is better in the fridge and heated before feeding – in warm (not hot) water up to $39\text{--}40^{\circ}\text{C}$ (at 40°C proteins denature) or with a special electric heaters for baby's food with a fixed temperature of 37°C . Never defrost or heat milk in a microwave oven.

Methodics:

1. Individual choice of food, feeding mode and volume.

The best food for babies, especially premature ones, is breast milk! It provides immune protection, bacteriological safety, best digestion and assimilation, the optimal amount of ingredients necessary for a particular gestational age of the child. It is proved that premature babies and newborns with low birth weight who received breast milk, in future will have a lower incidence of necrotizing enterocolitis and sepsis.

If you cannot ensure breastfeeding or in case of insufficient amount of breast milk adapted formula is appointed, in case of illness (malabsorption syndrome and lactase deficiency, phenylketonuria, etc.) a special mixture that meets the needs of the patient is assigned. Half-element mixtures do not provide the needs of children and should not be used for feeding. They can be used in some cases for medical reasons as a transitional stage.

In preterm children in addition to breast milk the amplifier that contains the additional amount of necessary proteins, vitamins and minerals is recommended.

For optimum nutrition of the child calculate regularly (daily in the early stages, then every other day) the individual needs of the newborn in proteins, fats, calories and adjust volume, speed and route of administration of food accordingly.

2. Feeding method is chosen depending on the child's condition. If gastric tube is entered due to the child's condition (for decompression, control of stasis), attempts of enteral feeding start through it. If not necessary to set the tube and the swallowing reflex is present – start with alternative methods of feeding. With

the proper technique alternative methods are safer, have fewer infectious and traumatic complications.

3. The mode of breast milk or milk mixture input:

– Continuous feeding (equal entering of food during the day) is carried out through a tube or drip using perfusors, may be conducted via syringe or pipette. In this case, in the stomach there is a small amount of food that does not cause hyperextension. The duodenal input of food is also possible.

– Intermittent – putting food in portions during the day, at regular intervals (every 1.5–3 hours). It is more physiological, so the fermented mixture enters to the intestine and in stomach; after its evacuation gastric juice is collected for the next feeding fermentation. Small portions of breast milk are able to evacuate quickly – in 0.5–1 hour.

4. Tube feeding of a child.

The tube is entered into the stomach through the mouth (orogastric) or through the nose (nasogastric). Due to the high resistance of the respiratory tract in infants, in case of respiratory disorders and in children with low birth weight, the advantage is given to orogastric tube (probe set through the nose may reduce airway passage). The duodenal placement of the probe is also possible.

Set the probe. Depending on its location and body weight, choose the appropriate size of the probe: № 4–6 for premature, № 6–10 – for full term.

Check the position of the tube (having measured before entering mark) and get the contents of the stomach with a syringe or enter 0.3–0.5 ml of air with a syringe through a tube with simultaneous auscultation of the stomach.

Fix the probe with a plaster so to be able to control the depth of standing (mark).

The tube for feeding or decompression (if functioning properly) shall be replaced by the new in 24–48 hours (depending on the material and the manufacturer). In case of the blockage or

the occurrence of other complications the tube is removed with subsequent replacement on a new one on demand.

In case of continuous feeding you must set up food administration using infusion pump. Connect infusion system filled with milk to the probe and set the desired speed input. The syringe with food should be changed every 3–6 hours and the infusion line – every 12–24 hours, depending on the food. Breast milk retains longer its antiseptic properties; milk mixture is more dangerous because of bacteriological standpoint.

With intermittent feeding mode:

– Connect the tube with a volume desired in one feeding to a sterile syringe without the plunger and allow fluid to drain slowly into stomach (it is more physiological way). You should not enter the milk under pressure to prevent hyperextension of the stomach and secondary vomiting.

– Speed of milk drip during feeding is regulated gradually raising and dropping syringe.

– If the fluid is not moving, carefully connect the plunger and start to feed the baby, slowly pushing the plunger. When you enter about 1 ml of milk, remove the plunger and restore free milk input. If the output of the tube was hindered by mucus the feeding will continue without any obstacles.

– Milk should be given at a rate that corresponds to the active feeding of a baby. The required volume should not be entered faster than for 15 minutes, in some cases up to 30 minutes. Mother must be taught a probe feeding and carry it out. This will reduce the risk of infection of the newborn, belching and complications, and milk will always be fresh.

– During the feeding through a tube carefully monitor the child's condition: colour of the skin and mucous membranes, frequency of breathing.

– After finishing the feeding enter the air to the tube via a syringe to force out milk (depending on the diameter of the tube 0.5–1.5 ml of air is entered), and close the tube's port.

The time needed for fermentation and evacuation of food from the stomach depends on morphological maturity of the child, condition of the gastrointestinal tract and type of entered food (for breast milk – up to 1.5 hours, for mixtures – 3–3.5 hours).

Before the next feeding, for about 30 minutes, the tube port has to be opened and the transparent container (test tube) for the control of stasis has be connected.

Active checking of gastric residual volume (pulling out of gastric contents via the syringe with a plunger) is not recommended if clinical signs of intestinal obstruction and paresis are absent. If after a half an hour pathological stasis is absent, you can feed the baby.

In the presence of stasis evaluate its character and pathological impurities. Stasis should be considered pathological when:

- it has a green colour, containing fresh or old blood, large amount of mucus;
- it exceeds the amount that was entered in the previous feeding (if this is not minimal trophic feeding).

In the presence of pathological stasis the feeding should be significantly reduced (reduced volume) or suspended (1–2 intake), starting the next time with less quantity.

If there is suspicion of necrotizing enterocolitis or tolerance to the food is absent, the tube should be kept open for decompression, via a tube should be administered 2–3 ml of normal saline at least twice daily, and leave it open for the control of stasis.

In the absence of necrotizing enterocolitis you should start minimal trophic feeding (start with 0.5 ml of colostrum, 2–3 ml directly into the oral cavity slowly drop by drop or to the stomach through a tube). Such feeding is not taken into account in the daily requirement; it is performed at an open tube and is essentially a feeding of intestine. Periodically you should provide auscultation of stomach and intestinal motility.

Residual gastric contents received by active stretching via the syringe with plunger, is not pathology if:

- contains 5 ml of transparent contents (gastric juice);
- contains digested milk in a quantity that does not exceed the amount of the previous feeding. In this case there is a slow evacuation of gastric contents, and you should increase the interval between feedings and slightly reduce the number of entered milk or mixture (return to the previous volume, which was evacuated and assimilated in time).

If stasis, which back through the open tube:

- containing milk in quantities not exceeding $\frac{2}{3}$ volume of previous feeding – slightly reduce the volume and increase the gaps between the food intakes;

- has a yellow colour or contains bile, should be excluded duodenal location of the tube tip (check the position of a tube, measuring the required depth by the same clean tube and compare the marks). If the tube is in the stomach, there may be a lack of sphincter function and duodenal reflux (you can continue feeding with small portions).

One of the means of necrotizing enterocolitis prevention is an early start (in the first day of life) of the minimal trophic feeding or enteral nutrition with small volumes of colostrum and breast milk with gradual slow buildup without a significant increase of food volume during few weeks.

5. Alternative feeding.

If the child's condition allows, the swallowing reflex and good tolerance to food are present, but a sick child cannot still apply to the mother's breast, a newborn should be fed by alternative methods. These methods are used after the tube feeding as well as in parallel of using the tube which is set for gastric decompression in case of respiratory support.

Can be used:

- Feeding with a syringe or pipette. One hand should hold the baby's head; milk by few drops is entered to the mouth on the tongue, after swallowing you can enter the next portion.

– Feeding through a tube during sucking the mother’s breast – transition stage from feeding with a syringe to breastfeeding of a child who is not yet able to suck the desired quantity of milk. Aseptically expressed breast milk in a bottle, cup or a syringe without plunger is placed or kept at mother’s breast (upper level of the liquid is about the upper border of the areola). A thin sterile tube is inserted in a container with milk or attached to the syringe, the other (distal) part of it is fixed with a thin patch on the breast of the mother so that the end is just on the edge of the nipple. Baby is put to the breast, he makes sucking motions with his mouth and milk falls through a tube. By adjusting the level of the bottle/syringe you should choose a correct flow speed of milk so that the baby sucks and swallows quietly and slowly.

This method is also used if you want to restore or stimulate milk and its secretion at hypogalactia, the adoption etc. The total duration of such breastfeeding corresponds to the usual duration – 15–30 minutes, but in children with very low birth weight it depends on the child’s condition, in case of the child’s signs of fatigue it should be stopped and continued through a syringe.

Feeding with a cup is possible for the child which allows taking vertical position. Holding the baby in the arms of half vertical/vertical position, bring a cup with a fluid to the child’s mouth, tilt it so that milk is touched to the upper edge of the upper lip. The baby begins “to slurp” milk. The milk should be kept at the mouth level of the child. Do not pour the milk to his mouth and do not stop feeding until the baby stops “to slurp” the milk. After you estimate the amount of the eaten food by a baby – plan the correct amount of milk for the next feeding.

Feeding with a spoon is used as a phase transition from a syringe to the cup. First spoon with a small amount of liquid is poured onto the child’s tongue, waiting for swallowing and when a child begins “to slurp” very well with a spoon, go to feeding with a cup.

The rules of administration of amplifiers and additional therapeutic mixture (if indicated) for a premature baby on

breastfeeding are the same. Sometimes, when breastfeeding and feeding with cups is not possible, it is allowed to feed with expressed breast milk from a bottle with a pacifier, if this method is acceptable for the child and if other indications for establishing the tube are absent. Though feeding from a bottle is more physiological than via the tube, the number of such cases is small. You should not routinely use bottle with a pacifier if the child is not abandoned by his mother and there is hope to renew breast feeding.

Complications:

- apnea and bradycardia;
- regurgitation with followed aspiration due to hyperextension of the stomach, stimulation the vomiting centre. You should conduct decompression (open tube) before feeding;
- irritation, bedsores, infection after a prolonged indwelling of the tube;
- perforation of the esophagus, posterior wall of the pharynx, stomach or duodenum (the tube should not be administered with the pressure);
- injury of mucous membrane, pain in a child with the entering of the new probe at each feeding;
- milk aspiration if swallowing reflex is absent or too much milk is entered to the mouth by alternative method.

Mistakes:

- ungrounded “hungry pause”, continued parenteral feeding without attempting minimal tolerance to trophic feeding;
- using solutions of glucose, 0.9 % NaCl, distilled water for the first feeding;
- start of enteral feeding with a milk mixture (a risk of necrotizing enterocolitis);
- aspiration of residual gastric contents before feeding (withdrawal of gastric juice worsens digestion; provokes bad assimilation of next portions);

- interrupting enteral nutrition in the presence of residual volume without pathological impurities, vomiting, delayed evacuation from the stomach;
- setting the probe through the nose for feeding a baby with breathing disorders (reduces airway passage, increases respiratory effort and therefore the severity of respiratory disorders);
- feeding with alternative methods, pour the milk to the mouth of the child (a child should actively take milk using a spoon, a cup, according to his willingness to swallow);
- too fast input of the entire volume of food through a tube, small duration of feeding (rapid hyperextension of stomach provokes vomiting);
- providing “night gaps” in feeding for the “child’s rest”.

34. The use of a couveuse (incubator) for intensive care of newborns

Indications:

- prematurity, low birth weight;
- diseases accompanied by increasing of heat loss, hypothermia;
- unstable hemodynamics and breathing of child requiring intensive care;
- carrying out phototherapy, blood replacement surgery and other conditions where the child is naked and you should prevent the loss of heat and moisture.

Contraindications: Do not exist.

Required equipment:

- couveuse (incubators);
- skin temperature sensor for servocontrol;
- distilled water;
- disinfectant solution;
- electronic thermometer;
- clean diapers, which are put on anti bedsores mattress.

Methodics:

Study in details the incubators manual, which must be in a native language.

Check the serviceability of electrical wiring, pour distilled water into a clean and dry humidifier, turn on a couveuse, and set the desired temperature, based on the gestational age of the child. For premature babies better use incubators with double walls or additional plastic cover.

To prevent loss of heat by radiation set the couveuse so that the child's body is located no closer than 0.8–1.0 m from the walls, windows and other cold equipment. Direct sunlight, radiators, fans and heaters influence also at temperature stability in couveuse. You should also ensure access to the child from different sides therefore it is rational to establish the couveuse with a face end to a wall or at 45 %, but not close to it, away from heating devices, air conditioners, windows, that are not exposed to

the sunlight.

To determine the desired temperature in a couveuse you should use the following table, which takes into account the age and weight of the child.

Recommended air temperature in a couveuse					
Weight, g	Age, days				
	1 day	2 days	3 days	4–7 days	8–10 days
< 750	37.0	36.5	36.0	35.0–35.5	35.0
751–1000	36.0	35.5	35.5	35.0	34.5
1001–1500	35.0	34.0	34.0	33.0–34.0	33.0
1501–2000	34.0	33.0	33.0	32.0–33.0	32.0
2001–2500	33.0	33.0	32.0	32.0	31.0
2501–3000	32.0–33.0	32.0	32.0	31.0	30.0

A newborn is placed in a warm couveuse, and then the temperature parameters are set according to the temperature of the baby’s skin (in a couveuse with servocontrol). The sensor is set predominantly on the anterior abdominal wall. When using a couveuse without servo sensors the air temperature is exposed to greater fluctuations.



Figure 117 – The allocation of a couveuse in the intensive care unit



Figure 118 – Darkening of a couveuse with a premature baby



Figure 119 – All procedures are carried out through the couveuse window

Fluctuations of temperature in a couveuse are possible in the care of the child. In some (older) models before you open the window, it is necessary to increase the air temperature in a couveuse. You should not unnecessarily open the door and window, premature babies are weighed using scales built into the incubator or set closely. When the baby is weighed the time is used for the simultaneous changing of diapers which is carried out to the extent of their pollution, but not less than once a day.

In a modern couveuse with double walls, uniform heating and lack of air movement a child can be naked in diaper (disposable or gauze). If possible, prefer disposable materials. In

one wall couveuse where the movement of warm air present, to reduce energy losses use a cap, socks, if necessary, other cotton clothing is permitted, cover a baby with a diaper or a blanket made of natural fabrics.

In all cases it is necessary to measure axillary or rectal temperature of the child with an electronic thermometer. The body temperature of a child should be 36.5–37.5 °C in the first days of life and 36.5–37.2 °C – in the future. The use of a couveuse instead of the radiant heat source reduces fluid loss, maintains a constant body temperature. Reducing energy losses in a child is also provided by increased humidity in a couveuse (50–80 %).

Recommended air humidity in a couveuse					
Weight, g	Age, days				
	1 day	2 days	3 days	4–7 days	8–10 days
< 750	90 %	90 %	85–90 %	85 %	80–85 %
751–1000	85–90 %	85–90 %	85 %	80 %	7 %
1001–1500	85–90 %	85 %	80–85 %	80 %	75 %
1501–2000	80 %	75–80 %	75 %	70 %	70 %
2001–2500	75 %	70 %	60 %	60 %	50 %
2501–3000	70 %	60 %	50 %	50 %	50 %

To prevent contamination of locks on windows and cross contamination of patients, open locks and close windows by pressing them with the outer part of wrist or an elbow. In case of the wall (mattress) pollution with biological fluids (urine, blood) rinse immediately with distilled water. To prevent the proliferation of microorganisms in humidifiers distilled water should be completely replaced (not topped up!) every 24 hours. You should act according to the instruction for the incubator.

Disinfection in the couveuse is made not less than once a week, for children weighing less than 1500 g – twice a week, and also when a baby is transferred to neonatal department, discharged or transferred to a bed. For patients whose treatment lasts, it is

made a change of the couveuse to a clean one, washing, treatment, disinfection with an appropriate disinfectant solution exposure time, rinsing with disinfectant solution, wipe, upholding until it dries. Disinfectants are used in accordance with current regulations and recommendations of manufacturers, most of them require rinsing with distilled water before a contact with the patient. Antiseptics containing phenols (toxicity) are not recommended for use.



Figures 120, 121 – All equipment is stored on shelves or mounted on a tripod. There should be nothing in couveuse

Complications and mistakes:

- setting a couveuse close to walls, windows, near heating devices or in the sunlight;
- faulty equipment, overheating or cooling of a child. For prevention never mistrust only indices of devices – you should

monitor real temperature tactile and every 6 hours with a thermometer;

- the lack of control of the level of distilled water in humidifiers and other violations of rules of operation of the device according to the manufacturer's instructions;

- routine door opening in the couveuse, frequent moving of a child for the examination, treatment, injections and other procedures;

- touching the couveuse, handles, buttons with treated before contact with the child hands, untreated after a contact with patient hands or gloves – promotes microbial contamination of objects and a patient with further proliferation;

- late change of linen and a couveuse promotes increased growth of pathogenic microflora in favorable conditions of high humidity and temperature, increasing the infecting dose, the patient re-infection with own microflora that can cause infectious disease in premature, immune compromised child.

The incubator for premature babies 1186c is a typical representative of incubators, high-end with embedded microprocessor, which checks and handles all settings, provides precise control of the temperature, humidity, oxygen concentration. The camera with double walls minimizes heat loss through convection and radiation, opens easily for disinfection. Water tank is removed for autoclaving.

The incubator contains built-in temperature sensors of the baby's skin and a sensor for the temperature control inside the device, the possibility of installing the temperature inside the chamber according to the air and skin sensors. Also there are fans for air circulation inside, the control of oxygen concentration. The device makes the possibility of oxygen therapy, contains integrated pulse oximeter and built-in scales.

Basic parameters are displayed on the liquid-crystal screen in the form of curves. The control unit carries out self-test and displays a fault message on the screen, accompanied by an audible signal.

35. Using of the open reanimation system for intensive care of newborns

Indications:

- Reanimation of a newborn in the delivery room.
- Diseases requiring intensive care, mechanical ventilation.
- Surgical intervention in the newborn.
- Carrying out phototherapy, blood replacement surgery and other conditions where the child is naked and you should prevent the loss of heat.
- Intensive care of children with low birth weight.
- Increased heat loss, hypothermia.
- In open reanimation systems the body temperature of the newborn is provided by infrared radiation with an average wavelength. In case of using them the access to the patient during a number of therapeutic and diagnostic manipulations is easier, the fluctuation in temperature and humidity during treatment is reduced (unlike a couveuse after opening the windows).

Contraindications: Do not exist.

Required equipment:

- open reanimation system or a table with radiant heat source;
- temperature sensor with a device that is attached to the skin and has rays reflecting cover or pieces of foil, mirror film;
- electronic thermometer.
- cap, socks, clean diapers.
- food transparent plastic film.
- disinfectant solution.

Preparing of equipment:

1. Check the serviceability of equipment include radiant heat lamp, set the desired temperature, focusing on gestational age of a child.
2. Set the table with the rear end to the wall of at least 0.8–1.0 m from cold walls, equipment and windows, providing access to the child from at least three sides.

3. Cover the table surface (special mattress) with a diaper, if necessary use rollers for shoulders or for special stacking, a nest.

4. Set the distance from the source of radiant heat to the surface, where the child will be located at 80 cm or another (according to the manufacturer's instructions). The distance depends on the power of the lamps; it should comply in order to prevent burns or hypothermia of a child.

5. Connect the skin temperature sensor, set the temperature of heating power according to the body of a child, set alarm limits to 36.2–37.2 °C.



Figure 122 – Ready for work modern open reanimation system



Figure 123 – A child with respiratory support (oxygen therapy) on reanimation table



Figure 124 – AVL of a child in open intensive care system

Preparation of the patient:

1. The child must be naked because heat rays must heat the body. If the baby is covered with a diaper, it is warmed up, but a child is cool down.

2. Put on a cap and socks on a child, because distal parts are located on the limits of heat rays, where their intensity is the smallest.

Methodics:

1. Place the baby in the center of the table where there is the greatest intensity of rays.

2. Apply the skin temperature sensor to the surface of the body of a child (not above the large blood vessels or liver), fix with a special or conventional atraumatic plaster.

3. The temperature sensor should not be located directly under the influence of heat rays, so it should be covered with the rays reflecting film. Special disposable labels for thermal sensors are usually silver and do not allow the sensor to warm up under the rays. If they are absent and the sensor is fixed with a conventional patch, you should use additional pieces of food silver reflective film (if using foil, it should not contact with the skin – thick, traumatic).

4. For premature babies together with the temperature control, it is important also to ensure high humidity in the environment. When such babies are nursed in open intensive care

system, better put them in a food plastic bag or cover the entire surface of the table with a transparent film (leaving access for hoses of breathing support). This transparent screen reduces imperceptible fluid loss in newborns. According to current data, a child under the age of 28 weeks without the screen requires 25–30 % more liquid to cover imperceptible losses.

5. Even if the system is equipped with a servo sensor and heating power is set according to the temperature of baby's skin, you should regularly (at least 4 times daily) control the child's body temperature through axillary measurement with an electronic thermometer. The body temperature of a child should be 36.5–37.2 °C.

Complications and mistakes:

– set the table in drafts, near an open window, door or close to heating devices, convectors, air conditioners, direct sunlight, lateral surface close to wall – the extra heat losses of a child by convection, radiation;

– using a table without a mattress, placing the child in unheated table – cooling of a child by conduction;

– overlay the temperature sensor to the area of the projection of the liver, large vessels, lack of sensor's protection from thermal radiation – hypothermia of a child through increased temperature data from an uncovered sensor;

– lack of parallel control of the temperature by tactile way and axillary thermometry – due to equipment failure, sensor detachment overheating or overcooling of a child is possible.

36. Care for a newborn with low birth weight by the method of “Kangaroo Mother Care”

Indications:

– care of premature babies with low birth weight;

– provision of physiological conditions of nursing and breastfeeding of children with very low weight at birth;

– ensuring optimal conditions for maturation of the nervous system in preterm children, protection from stress.

Criteria of the child's readiness to use the method:

- postconceptual age of the child at least 26 weeks;
- relative somatic stability (see Contraindications);
- the ability to respond to external stimuli and stimulation.

The advantages of the method to the child are that the child is longer calm, less crying, longer periods of deep sleep and the frequency and severity of episodes of apnea decreases.

The advantage of the method is that small babies can be discharged early, mothers feel more competence, confidence and responsibility when use “Kangaroo Mother Care”.

If there are doubts about the readiness of the child for the method, there should be a trial teaching for 15 minutes with monitoring of the heart rate, respiration, saturation and so on.

Contraindications:

– severe, unstable condition of the mother, condition after surgery, fever, rash (relative contraindications, possible variants are “Kangaroo Father Care” or “Kangaroo Grandma Care”);

– severe, unstable condition of the child, the need for intensive care, surgery;

– the need for a stable child in respiratory support, including CPAP, transportation, infusion therapy or parenteral feeding can be provided in the position of “Kangaroo” with a mother or relatives.

Contraindications for children:

– hyperthermia;

– the acceleration of heart rate more than of the basal rate;

– HR < 85/min., the necessity of stimulation for the disappearing of bradycardia;

– apnea longer than 10 seconds, which requires stimulation;

– saturation less than 75 % during oxygen support;

– saturation less than 88 % in a child who is breathing with room air;

– unstable venous access;

- arterial access;
- pleural drainage tube;
- unstable pressure, the need for entering a sympathomimetics;
- the level of bilirubinemia increases rapidly or corresponds to the level of blood transfusion.

The main aim of “Kangaroo Mother Care” is to ensure the formation of a close emotional contact between a mother and a child, increasing the frequency and duration of breastfeeding, reducing the risk of nosocomial infections, providing support to the body temperature of the child, optimization of equipment and human resources in nursing infants with low birth weight, promote family members’ involvement in nursing children with low birth weight.

Difficulties of this nursing are associated primarily with psychological reluctance of mothers and their families at every minute, uncompromising subordinate themselves, their desires and livelihood needs of the child and also medical staff reluctance in permanent presence in the department/intensive care ward of other people.

The conventional view that sick children should be “treated” with medicines, procedures, operations, and apparatus, which should be done by doctors and medical personnel, while a mother must “repose” after the childbirth. Such position helps mothers refusing to assume responsibility for the recovery of their child. Meanwhile, advanced technical support and the possibility of intensive care of preterm children require a significant increase in burden on medical staff with insufficient number of nurses. Active involvement of mothers to nursing, feeding and caring for their premature children (after mothers training) can significantly reduce the overall burden on nursing staff and improve long-term results of taking care of premature infants.

Father or mother skin-to-skin kangaroo position, breastfeeding support and childbirth in a vertical position aren’t something new, avant-garde, but a return to physiological human

basics of survival that have been tested for millennia. Disclaimer of these traditions was conditioned by comfort for others – a doctor, a mother, but not the child. Proclaiming slogans on the rights of the child as a person and fetus as a patient, you should choose what is best for newborn baby, even if it creates some inconvenience for parents or medical personnel.



Figure 125 – Emotional unity of the family in case of “Kangaroo Care”



Figures 126, 127 – The method “Kangaroo Father Care”



Figure 128 – Feeding a child during the contact
“Kangaroo Mother Care”



Figure 129 – “Kangaroo Mother Care” is approach
to prenatal existence



Figure 130 – Infusion therapy together
with “Kangaroo Care”

Required conditions:

– availability of hospital inputs for compatible stay of
mother and child.

- availability of the prepared and trained medical staff with experience of using the method;
- creating such conditions as: availability of wards, forms of observation, equipment, etc.;
- the desire of mother and her family to use the method, physical and psycho-emotional ability to use the method, compliance with hygiene requirements;
- training mothers individually and in groups;
- assistance in child care be can carried out by the father or other family members.

Required equipment:

- the warm room without drafts;
- equipment for prolonged contact “skin-to-skin”: belts or other accessories to secure fixation of the child’s body;
- chairs, pillows for mother;
- a cap, socks, diapers for the baby;
- clean comfortable clothing with a zipper in front or wraparound for a mother/father;
- swaddle table under radiant heat source or another heating device;
- equipment for care, beds with heating or a couveuse for a child in case of forced interruption of contact;
- equipment for emergency help if necessary.



Figure 131 –A mother and a baby are sleeping tight



Figures 132, 133 – A mother can move freely,
to tackle her personal affairs

Methodics:

1. Conduct conversations with a mother, relatives, explain the benefits of the method, the range of her duties and that she would be given the necessary information, assistance and support of the medical staff.

2. Ensure the availability of the necessary equipment and explain how to use it.

3. Change a child's clothes on a warm swaddle table: a clean diaper, a cap, socks, you can put on a light shirt, but not button it up in front.

4. Place the child in vertical position between the mother's breasts. A head, a neck and a trunk of the child should be straight, hands are placed on the mother's breasts, legs are bent and placed under the breasts – the child is in the "frog" position.

5. Fix the child on the mother's body with a tissue or a wide belt, a shirt with fixation (long strings) so that the head of the child is under the mother's chin, and the cloth covers part of the baby to the ears, but not the entire baby's head.

6. Cover a child with clothes of a mother and keep him with hands during the whole time of "Kangaroo Care".

7. Contact "skin-to-skin" should be maintained as long as possible, because each putting to bed/couveuse is an additional stress for the child who feels secure in a "kangaroo".

8. During the method of "Kangaroo Mother Care" a mother can rest, sleep, but to prevent gastroesophageal reflux and

aspiration of the child there should be provided the angle of the mother's body at least 20 degrees. For this purpose comfortable chairs, big cushions and other accessories are needed.

9. For the purpose of contact "eye-to-eye" use a mirror that transmits the mother's view to the child, and child's view to the mother, and allows monitoring status, grimace, activity, breathing of a baby.

10. It is better to conduct the contact for 14 hours a day with breaks for changing clothes (change a diaper) of a child. If possible, it is advisable to contact for 24 hours. For continuous contact other family members who will nurse a child if mother should eat, take a shower or rest should be attached to the child's care.

11. In case of reliable fixing of the child to the mother's body she can satisfy most of her needs during the contact "skin-to-skin" with the child. Therefore, women should be ensured to eat, meet with relatives, other "Kangaroo mothers", listen to music or train without breaking contact. During the contact a mother should move in her usual mode because movement in space, rocking to the beat of mother's steps can accelerate the maturation of the central nervous system and improve dynamics of cerebrospinal fluid.

12. If a mother needs to leave the newborn and relatives are absent the child is put in couveuse or heated crib. The recommended daily length of stay of the child in the "Kangaroo Mother Care" is 14 hours. Although prolonged contact "Kangaroo Mother Care" is more effective, when it is impossible to provide, usually in care of premature and sick newborns, use prolonged contact "skin-to-skin" with the elements of "Kangaroo Mother Care": during transportation, mechanical ventilation – periodically during the day (2–3 sessions lasting 3 hours), during the subsequent nursing.

13. The application to the breast when using the "Kangaroo Mother Care" is held, usually, as often as the child wants. The proximity of the breast, the smell and the availability

of breast milk often stimulates the child “being applied” to the breast and eat slowly, accelerates tolerance to enteral feeding, reduces the need for parenteral nutrition, accelerates weight gain and discharge from the hospital.

14. During breastfeeding it is not necessary to remove the child from the “Kangaroo” position; you should only change the position of the child, leaving him in a belt-bag.

15. If a child’s condition does not allow sucking breasts there should be minimal enteral feeding or trophic feeding, or breast milk through a tube, or alternative methods.

16. Medical personnel must inform mothers about the behavior and development of children with low birth weight, promote positive psycho-emotional relationships in the mother–child pairs, demonstrate experience of women who nursed their babies by “Kangaroo”, help monitor the status of the child during method “Kangaroo Mother Care”.

17. You should constantly improve mothers’ knowledge at nursing with the method “Kangaroo Mother Care”, hold classes on hygiene measures, features of feeding, neurological development, observation, inform and teach mothers about the critical condition of the child so that mother could be confident at home after the discharge and have the ability of satisfying all needs of her child.

18. There are signs that threaten the child and if they are detected a mother has to call a nurse, and she must call a doctor:

- inadequate and irregular breathing, apnea episodes;
- reducing the activity of the child, depression or anxiety, seizures;
- decreased appetite;
- the refusal of food;
- diarrhea;
- frequent regurgitation.

Complications and mistakes:

- assign method for unstable child in serious condition which needs an urgent assistance;

- deprivation of the child’s possibility of contact with the mother, the underestimation of possibilities of the method;
- lack of education of mother or her indifferent attitude to the child’s needs.

37. Methods of hearing screening in newborns

Indications:

- preterm children (especially children with very low and extremely low birth weight) after stabilization of the baby before the discharge from the neonatology department;
- newborns with a family history of hereditary deafness;
- infants with birth defects (especially defects and abnormalities of ears, asymmetrical and low-lying ear shells, parotid papillomas, ear and parotid fistula);
- infants with the signs of congenital syphilis, cytomegaloviral infection and rubella embryopathy;
- infants with genetic disorders, the presence of stigmas of disembryogenesis;
- newborns of rough neurologic symptoms (microcephaly, intracranial calcifications, seizures, periventricular leukomalacia, etc.) and ophthalmologic disorders (chorioretinitis with optic atrophy, etc.);
- infants with acute respiratory diseases with otitis, meningoencephalitis;
- newborns exposed to ototoxic medicines in the pre- and postnatal period;
- newborns who were in neonatal intensive care unit, especially during mechanical ventilation more than 96 hours;
- birth trauma;
- newborns with perinatal pathology;
- newborns from mothers with complicated pregnancy (toxicosis, preeclampsia, threatened abortion, infectious diseases, pharmacotherapy during pregnancy);

– newborns who are in perinatal centre/lying-in hospital before discharge if a portable system for registration of evoked otoacoustic emissions is present.

The method is insensitive to retrocochlear pathology.

For its exclusion you should conduct registering short-latent hearing induced potentials in a specialized surdological centre.

Contraindications: do not exist.

In severe, unstable condition of the child you must limit all unnecessary studies; in this case postponed hearing screening is possible. **A hearing screening should be made to a 3-month old baby** before discharge from neonatal department (perinatal center) and, if necessary, refer patients to advanced audiological diagnosis for early rehabilitation that will prevent severe disability and deaf since childhood.

Required equipment:

– portable system for registration of evoked otoacoustic emissions;

– a set of nozzles for the probe, which is inserted in the external auditory canal;

– 70 % alcohol solution;

– cotton swabs.

Methodics:

A newborn hearing screening can be conducted by evoked otoacoustic emissions (EOAE) and its variety – transient evoked otoacoustic emissions (TEOAE).

EOAE is sufficiently reliable and simple objective method of screening newborn's auditory function, the essence of which is that a healthy human ear in a few milliseconds after the brief perception of a sound generated another one, which is registered by device. EOAE is the result of biochemical activity of structures within cochlea. TEOAE is produced by a healthy newborn ear in response to a click stimulus. TEOAE method is more informative, therefore it is preferred as a method of screening newborns. TEOAE method is so sensitive that it can be used to fix even

minor deviations in auditory analyzer function; it has early diagnostic value, even at the first level of hearing loss.

Research methodology takes not more than 5–15 minutes.

Before the hearing screening:

1. Refer in details to the manuals for the system of registration EOAE and TEOAE.

2. Check the battery charge (turn on the device, after auto inspection of the battery in case of sufficient charge device starts calibration, in case of low charge displays the inscription “change the battery”, turn off the device).

3. Check the permeability of the probe entered into the external auditory canal.

In the ward of the newborn:

1. The newborn must be at rest in bed or on the mother’s hands (best measurements are made during sleep).

2. An employee who performs research should wash hands thoroughly and dry them.

3. Ensure access to the ear canal on one side (untie the cap, turn the child on the opposite to measurement side).

4. Choose a nozzle of desired thickness and diameter to achieve sealing when administering probe.

5. A nozzle of the probe must be treated with a cotton swab moistened with 70 % alcohol, give it to dry and put the nozzle on the probe.

6. Enter a tube with a nozzle deep in the external auditory canal along its length, lock it and remove the hand.

7. Turn on the device: the calibration starts if the nozzle is chosen of correct size that ensures sealing the ear canal, the measurement begins, which can last from a few seconds to 3 minutes depending on the functional activity of hair cells.

A probe contains a miniature phone and a microphone. In a newborn screening you should use stimulation with broadband acoustic clicking and flat acoustics character in the range from 500 Hz to 5.6 kHz with frequency of 20–50 seconds, ensuring

adequate response from area of speech frequencies. The signal that occurs in response to stimulation is recognized by the microphone, amplified and sent to the fixing device through an analog-digital converter.

8. The result of measurement is displayed on the device:

- the child passed the screening (disease absent);
- the measurement failed (unstable position of the probe through the trouble of a child, the presence of background noise, inability to seal due to wrong size of a nozzle for probe);
- the child did not pass the screening (negative result).

9. A negative result can be a really-negative (i.e. there are pathological changes in the inner ear) or false-negative.

A child with a negative result should be re-screened after 1–2 weeks, but no later than the discharge from the neonatal department (perinatal centre). Age of a child at the time of re-examination should be under 3 months. If in the child of 3 months of life the result remains negative, you need to send an infant to an extended audiological diagnostics to a specialized surdological centre. Investigations of evoked otoacoustic emissions in surdological centre should be undertaken as soon as possible, but previously 6 months of age for early rehabilitation that will prevent severe disability and deafness since childhood.



Figure 134 – The entering of the probe to the external auditory canal of a newborn, who is in the hands of a mother



Figure 135 – The measurement should be performed when a baby is calm or sleeping



Figure 136 – The result of the measurement: a child passed the screening (the perception of sound by hair cells of the inner ear is sufficient)

False-negative results may occur for the following conditions:

- Incorrect position of the probe in the ear canal.
- The presence of earwax in the ear canal and/or when the probe clogging by earwax (probe must be examined before and after each measurement and clean, if necessary).
- The presence of mesenchymal tissue in the middle ear of extremely low birth weight newborns, which resolves to 1 year and may be classified as immaturity at the time of research, but it can be confirmed only by an otolaryngologist. All premature babies with a negative result before the discharge from the

neonatal department should be directed to advanced audiological examination in a specialized surdological centre.

10. Positive result indicates normal functioning of peripheral auditory analyzer, but does not exclude the auditory nerve lesions and/or parts of the central nervous system, responsible for auditory function. If there are mother's complaints to inappropriate response of the child on quiet sounds (poor hearing) more tests of EOAЕ should recommend in a surdological centre.

11. Hearing screening of the other ear is conducted similarly: probe checked for the absence of earwax, the probe tip is cleaned by cotton swab with 70 % alcohol, the child is turned to the other side and the research is conducted according to the abovementioned algorithm.

Complications: absent.

Mistakes:

- violation of measurement methods;
- anxious child, intense ambient noise;
- violation of safety technique, incorrect execution of the instruction manual of the device.

38. Providing of intravascular venous access

Indications:

- restoring blood volume in case of blood loss, shock;
- early energy supply of a newborn with low birth weight in case of low glucose levels and the inability to provide enteral nutrition;
- conduct parenteral (full or partial) feeding;
- constant infusion of sympathomimetics to support hemodynamics;
- conduct intravenous administration of solutions, electrolytes, antibiotics, painkillers and other drugs.
- administration of blood components, immunoglobulins, and vitamins;
- the operation of exchange blood transfusion;

– collecting blood for laboratory studies.

Contraindications:

– infection of the skin at the access area (choose another vein or an other type of access);

– injection of drugs with high osmolarity.

Select the type of access:

Depending on the purpose of the establishment, type of solution for infusion, duration of needs in a catheter, this is defined by a child condition and qualifications of the person who make intravascular access.

Types of access, duration of use:

– Peripheral venous catheter (vasofix, venflon, cannula) is set if it is necessary to provide infusion therapy, prolonged parenteral nutrition, continuous inotropic support and injection of medicines in moderate volume. The average duration of the use of such catheters is 2–5 days but you should not routinely change the catheter. Duration is limited by functioning of the catheter. In case of occlusion or complications it should be removed immediately. There aren't any recommendations for removal of normally functioning catheter in newborns. Thus, modern polyurethane vasofix according to the instructions may stay in vein up to 30 days with proper care.

– Peripheral venous needle butterfly or conventional needle can be used for short-term blood sampling for research or a single administration of the drug, unless absent catheterized vein is absent (such as, till the neonatologist arrival infusion of glucose should be established but a duty nurse was unable to establish vasofix). The duration of the use of butterfly needles – up to the day. Each venipuncture is a painful procedure for the child, and should not be used routinely this kind of access! Most blood tests, that require monitoring, are currently available transcutaneously or with micromethod of capillary blood, if it is possible to use them. If you need frequent sampling of venous blood for research you can take blood from the central catheter or make separate peripheral access, through which infusion is not being made and

use the “lock”.

– Catheter is set in an umbilical vein and used for primary resuscitation in the delivery room, intensive care for the child in the first 2–3 days after birth, the operation of exchange blood transfusion. The duration of use of umbilical catheter in different countries defined differently, 3–5–7 days, but because of the greater frequency of complications (necrotizing enterocolitis, osteomyelitis, sepsis) such access should not be more than a week.

– Central venous catheters (subclavian, jugular, femoral access) are set for 10–15 days, because even with proper care there is a high risk of catheter-associated sepsis, or the possibility of air embolism. It enables to provide all types of infusions, including parenteral feeding with lipid administration, regular blood sampling for research, measurement of central venous pressure. More often it is used in newborns in surgical departments to prepare for the surgery and in the postoperative period.

– Central venous catheter is set through peripheral access – the best choice in the care of preterm and sick newborns; it is set if infusions are lasting more than 10 days. It has fewer complications unlike conventional central venous catheter. Duration of its indwelling also depends on skills and care of the staff and functioning of the catheter that must be replaced only with clogging or suspected complications. Manufacturers of modern central catheters with peripheral access indicate about possibility of their use during 30–40 days.

Required equipment:

- warm room, radiant heat source, extra lighting;
- skin antiseptic (70 % alcohol, chlorhexidine gluconate, povidone-iodine), cotton balls and gauze, wipes, sterile napkin;
- medicines for local or general anesthesia;
- sterile gloves without talc;
- 0.9 % NaCl solution is necessary to fill and wash the catheter;

- sterile disposable syringes;
- individual protection for personnel from the patient's blood: the screen or mask for a face and goggles, a gown, a cap;
- a three-way stopcock;
- sterile semi-permeable fixing film, adhesive tape for fixing.

Depending on the type of access that will be installed:

- peripheral venous catheter № 24 (usually yellow, for babies);
- central venous catheter made of polyurethane or silicone, radiographic, with hydrophilic surface and centimeter markings, № 24 or 1F, 2F, 3F with puncture needle for injection; or silicone tube diameter G 25–27 and butterfly needle with proper (№ 24) and larger size (№ 18), sterile instruments: tweezers, scissors;
- set for vein catheterization with “conductor” by Seldinger technique.

Splints or napkin for fixing limb if bending of joints can lead to removing or fracture of catheter or puncturing of the vein.

For the prevention of venous complications such as thrombosis, thromboembolism, irritation and damage of the vessel wall in place of the catheter standing you should always use the smallest available catheters. Clots are formed not due to small clearance and small speed in the catheter, but because of the small distance between the catheter and the wall of the vessel that cause poor blood flow, blood clots are formed outside of the catheter, and disturbed blood flow in the vein worsens distribution of solutions which affects endothelium of vessels.

The maximum speed for input of solutions through a neonatal peripheral catheter is 22 ml/min, this speed is not needed in neonatology, because it will not withstand the newborn blood vessels, so it is not necessary to enter the thick catheters. Using catheters of smaller diameter also reduces mechanical damage and pain, less traumatic for vessel during prolonged standing and allows greater physical activity of the patient due to the greater flexibility of the catheter.

Preparation of the patient:

1. Before procedure calm a child, feed if possible.
2. For local anesthesia for 15–20 minutes before the procedure put in place of intervention anesthetic cream or other form of lidocaine with local action according with the instructions.
3. 1–2 minutes before the procedure give oral 30 % glucose solution.
4. For additional analgesia ask the mother to keep the baby with both hands, enveloping maximal possible surface of the body, talk with the child during the procedure with a quiet voice, comforting the child.
5. If necessary, provide general anesthesia of the patient.
6. The procedure is performed directly in the ward, in couveuse or under a source of radiant heat. Small directional light lamps (LED, halogen) are used for better light interference; you should direct light on the child's limb with darkening the face.
7. During the procedure observe a child's condition, constant pulse oximetry is desired, but not on the limb, where the manipulation was carried out.

Preparation:

Before the procedure is carried out evaluate the condition of the venous system and select the place for access. When selecting peripheral veins for access, primarily you should choose distal part of veins, because in case of thrombosis, damage of the same proximal vein, distal parts can no longer be used also. The following vein puncture should be carried out proximal to the previous place of puncture. Choose vessels with maximum possible diameter, sufficient capillary filling, well palpable. First, we should give preference to the veins in the hand, then – on the inferior limbs and the scalp. It is unacceptable to choose for puncture the veins that are below the growth line of hair on the head. The procedure is made by 2 persons, assistant cleans the future place of puncture, pinches the limb in case of peripheral access (usually imposition of the tourniquet isn't necessary in

infants), provides the necessary tools, syringes, fixes the catheter and may exercise pressure on the plunger of the syringe if necessary.

Methodics:

Peripheral vein:

1. Choose the vein and provide local anesthesia. To establish peripheral venous access use:

- dorsum of hand (dorsal arch);
- forearm (median vein of the forearm), cubital vein is used for blood sampling for the investigations;
- foot (dorsal arch), large and small ankle veins;
- scalp (eyebrow, superficial temporal or rear ear vein).

To select a vein, pinch it slightly above the place of possible puncture and palpate its content, evaluate its diameter and outflow after releasing of the vein.

2. Both operators must clean hands, wear gloves: the person who will set access – uses sterile gloves, assistant – not sterile gloves.

3. Perform processing of puncture areas and around it with 70 % alcohol or other antiseptic, starting circular motion from the inside to outward. Wait for complete drying, repeat procedure again. Processing plot must correspond to size of the sterile patch that will fix the catheter.

4. Assistant pinches limb by his own hand or tourniquet above the place of puncture.

5. Take the port or wings of the needle by one hand and pull the skin over place of puncture by the other hand to fix a vein.

6. Next steps depend on the goals and tools:

– To puncture a vein with a **needle for blood sampling** you should keep up the needle cut, puncture the skin and introduce a needle into a vein under angle of 45 %. After the appearance of blood in the needle collect the required number of leaking blood to the test tube or attach it to the aseptic tube container (VACUTAINER) with valve without contact with air (without risk for staff), or carefully attach the syringe and take the

minimal required amount of blood and then remove the tourniquet or stop pressing, remove the needle and squeeze the puncture site for several minutes to stop bleeding.

– To puncture vein with a **needle for a single administration** of the medicines, made above mentioned puncture of the vein, after the appearance of blood attached needle to a syringe filled with medication, remove the tourniquet or stop pressing and slow (2–3 ml per minute) impose a solution, and then remove the needle and squeeze the puncture site for several minutes to stop bleeding.

– To establish **needle-butterfly** for administration of infusion solutions if you cannot establish a peripheral catheter, needle extension should be filled with sterile saline till the appearance of liquid at the end of “butterfly”. Pulling the skin, stabilize the vein and hold the needle at wings, puncture the skin. Push the needle at 2–3 mm along the veins, and then puncture the vein and promote the butterfly to the appearance of blood in the needle chamber. Remove the tourniquet. Gently pull the syringe plunger to check presence of blood, and immediately wash the needle with saline, carefully looking for the vessel. If you puncture through a vein or in case of subcutaneous needle position, swelling of the skin or bruising may occur.

– To establish **peripheral venous catheter** on the needle-conductor (vasofix, venflon, cannula), first of all prepare separately a syringe with sterile saline. To facilitate the introduction of polyurethane catheter that at body temperature or the nearest one (in couveuse, under radiant heat source, summer heat) becomes soft, plastic, causes less irritation of the vein, but is difficult to set in case of the aforementioned conditions, you should store it in the cold or put in the fridge for 1–3 minutes before the administration.

Pulling the skin, stabilize the vein and hold the catheter on the needle at wings, puncture the skin at a slight angle and then – skin. When the needle punctures a vein, blood will appear in the chamber. Then you must slightly push the needle forward reduce

the angle and slowly push only catheter, but the needle slowly pulls out the catheter. You can not push the needle back to the catheter. Before removing the needle you should lightly press the vein with your finger just above the tip of the cannula, pull out the needle and immediately attach three-way stopcock and a syringe with normal saline. Gently rinse the cannula with saline, carefully looking for the vessel. If you puncture through a vein or in case of extra-vascular catheter position, swelling of the skin or bruising (hematoma, infiltration) may occur.



Figure 137 – Catheters without port are recommended in newborn



Figure 138 – Peripheral access – the skin puncture



Figure 139 – Vein puncture by the catheter on the needle



Figure 140 – Catheter entered to the vein, the needle is fixed



Figure 141 – Rinsing the catheter with saline



Figure 142 – Introduction of drugs before connecting to intravenous drip system

7. After the installation verify the access of the skin that again must be treated with antiseptic around the puncture site and after its complete drying impose a sterile transparent – a permeable plaster that keeps sterility of the skin and provides moisture evaporation that stands out the skin. If povidone-iodine was used as an antiseptic before the surgery, after the procedure its remains should be rinsed with sterile distilled water or saline, and before the fixation also treat with alcohol.

8. Evaluate the general condition of the child, the pulse, the skin colour, the temperature.

9. Foreign researchers do not recommend the use of peripheral catheters with additional ports in newborns because of the risk of “water hammer” of vein due to the drop pressure associated with the opening of the port. To reduce the episodes of

removing and attaching of the infusion line you should use a three-way stopcock, if necessary.

10. By using the three-way stopcock, disconnect the syringe and connect a filled infusion system to the three-way stopcock, start the infusion. To input several different solutions through a single vascular access you should use multiple series-connected three-way stopcocks. After using the input should be closed by a sterile cap.

11. In the absence of the sterile transparent – permeable plaster it is permissible to impose on the puncture a dry sterile cloth and secure it with thin strips of adhesive plaster. This bandage should be changed every day.

Central venous access through a peripheral vein:

1. Choose a place for vein puncture, provide local anesthesia of certain area. In case of establishing a central venous access through a peripheral vein the tip of the catheter is located at vena cava superior or axillary vein (possible) (with the access from the upper extremity or external jugular vein) or vena cava inferior (with the access from the lower limbs). To ensure such access a basilar or cubital vein on the forearm, a large subcutaneous vein in the leg, axillary and external jugular vein and other veins of the extremities with sufficient diameter are usually used. The veins of the head are not used.

2. Measure with a tape the distance from the puncture to the intended location of the internal catheter tip. For the upper limb length of the catheter the distance is from the access point in case of outstretched hand to the head of the humerus plus the distance from the head of the humerus to 2–3 intercostal space after midclavicular line. For the lower limb the distance is from the access point to the appropriate inguinal folds plus the distance from the inguinal folds to the umbilicus.

3. Ensure the child is additionally sedated to local anesthesia or general anesthesia.

4. To prevent air embolism the child must lie directly, the limb undergoing the procedure must be below the heart. For full-

term baby is recommended Trendelenburg position about 5–10° (dangerous for premature due to intraventricular hemorrhage).

5. Both operators must clean hands, wear gloves: the person who will set the access must use sterile gloves, the assistant – not sterile gloves.

6. Perform processing of puncture areas and around it with 70 % alcohol or other antiseptic, starting circular motion from the inside to outward. Wait for complete drying, repeat the procedure again. Processing plot must correspond to the size of the sterile patch that will fix the catheter.

7. In aseptic conditions without removing the catheter from the package fill the catheter with a sterile 0.9 % solution of NaCl (the assistant opens the package, from which the operator takes a sterile syringe, the assistant holds a bottle of saline to prevent the contamination of operator's gloves).

8. Make vein puncture as described above, using the needle that comes with a catheter or the butterfly with such needle diameter that the catheter is passed through it easily.

9. Make sure the needle is in the vein, then using sterile tweezers enter gently into the needle a filled with saline infusion line to the desired depth (measured as specified in para. 2).

10. To facilitate the access of the catheter from a peripheral vein to a central vein, you can slightly scroll the catheter, enter it according to the liquid stream, gently pressing the plunger with saline; sometimes light stroking of the skin along the vein or changing the position of the limb may help.

11. Upon reaching the desired depth check the location of the catheter by the syringe. Watch the patient, make auscultation of the lungs and heart.

12. After introducing the catheter to the desired depth, the needle is carefully removed without moving the catheter (fix it by a finger through the vein below the needle). The needle is removed from the vein, a special needle from the puncture set is divided in half lengthwise; the butterfly either is removed from the tube or, if the catheter with the port is used, remains on the

residual part of the tube. If the butterfly is removed from the tube another sterile butterfly G 24–27 is inserted and further serves as the infusion port.

13. After establishing access and verify its efficiency, the skin around the puncture site should be cleaned again with antiseptic. After complete drying of antiseptic remained part of the catheter is fold by the rings near the site of the puncture and placed under transparent permeable sterile bandage that keeps sterility and provides skin evaporation. If povidone-iodine as an antiseptic before the procedure is used (recommended in this case), after the procedure its remains should be rinsed with sterile distilled water or saline and alcohol and after drying fix as described above.

14. Check the location of the catheter radiographically. Alternatively, ultrasound control of the passage of the catheter through the veins is possible.



Figure 143 – Three-way stopcocks

Complications:

- pneumothorax, hemothorax, hydrothorax;
- occlusion gap, fracture and migration catheter;
- thrombosis due to poor blood flow in too large catheter, prolonged standing catheter;
- perforation, rupture of blood vessels, organs;
- cardiac tamponade if the tip of the catheter is entered to the heart cavity;

- cardiac arrhythmia;
 - hematoma due to violation of the integrity of the veins and blood falling to the surrounding tissues. For prevention you should not puncture the skin and the vessel immediately, after removing the catheter to squeeze the puncture site during a few minutes;
 - infiltration due to partial fluid ingress to the surrounding tissues;
 - circulatory disorders, ischemia of the limbs due to spasm, thrombosis, hematoma, embolism;
 - thromboembolism as a final result of the separation of thrombus from distal veins and enter of clots to the heart and lungs;
 - to prevent trombosis of the catheter, it should not be left without infusion, the constant movement of fluid in the catheter reduces fixing of fibrin on the walls. To prevent embolism you should choose thinner catheter, do not wash the catheter in case of obturation, but remove it immediately and install a new catheter elsewhere;
 - air embolism when air gets into a vein due to violations of technics of medicines administration or creation negative pressure in the central catheter. For prevention stopcocks should be always used and do not hold the limb with an established peripheral access to the central vein above the heart level during manipulation. Removing the central catheter should be done only during expiration of the patient;
 - phlebitis due to mechanical, chemical and infectious lesions;
 - endocarditis;
 - sepsis.
- Mistakes:
- wrong choice of a place for vein puncture, using primarily large veins as cubital, femoral;
 - improper installation of the catheter;

- prolonged break in using peripheral catheter without heparin lock;
- nursing established through peripheral access central catheters with the open method or covering them with occlusive bandages that prevent removal of moisture, weeping and promote infection;
- fitting the cuff to measure blood pressure on the limb with established venous access;
- infusion through peripheral vein of glucose solution with a concentration above 12 %, amino acid solutions with concentration above 5 %, pH of solution < 5 and > 9.

39. Umbilical vein catheterization in newborns

Indications:

- vascular access for medicines administration during primary resuscitation;
- carrying out exchange blood transfusion;
- venous access for parenteral nutrition;
- venous access for administration of medicines, sympathomimetic drugs and blood in the first 3–5 days of life, if you cannot establish peripheral access.

Catheterization of umbilical vein is an available method of obtaining central access in early neonatal period.

Contraindications:

- infection in the settlement area (omphalitis);
- the presence of symptoms or suspicion of necrotizing enterocolitis, peritonitis;
- age of the child over 5 days.

Required equipment:

- equipment for own protection (sterile gown, cap, clean and sterile gloves, protective screen or mask and goggles);
- 70 % alcohol or chlorhexidine solution;
- sterile diapers, cotton balls, gauze swabs and wipes;
- sterile instruments: surgical forceps without teeth, scalpel or scissors, small clip or capitate probe;

- sterile silk thread or tape for fixing (2 pieces);
- sterile disposable umbilical catheters 3.5F, 5F, № 6–10;
- at three-way stopcock;
- a solution of 0.9 % NaCl;
- sterile, disposable syringes;
- plasters.



Figure 144 – A ligature is tightening after input of the catheter on desired depth



Figure 145 – After cutting umbilical cord stump you should determine vessel for catheterization



Figure 146 – Vein is wide, with blood; two arteries lie side by side, in the form of “papillae”

Preparation of the patient:

1. Warm conditions under the radiant heat source, children weighing less than 1500 g must have extra protection – food foil or plastic bag. In this case, the film is cut above the intervention area to provide access to the umbilical region.

2. The patient should be connected to a cardio-respiratory monitor (pulse oximeter).

3. Umbilical vein catheterization doesn't usually require anesthesia.

4. A newborn must lie in the position on his back under the source of radiant heat; if necessary emergency care is held simultaneously the chest compressions and ventilation.

Determination of the depth of the catheter setting in the umbilical vein:

During primary resuscitation in the delivery room with a goal of entering emergency medical supplies catheter is inserted to a depth of 1 cm away from the place in which a good blood flow is received. The end of the catheter is placed in the vein of the umbilical cord to the place of confluence with a venous duct. It is about 4 cm after umbilical ring in full term newborns and 2–3 cm in preterm ones. Such location of the catheter makes impossible the infusion of hyperosmolar solution to prevent fall them into the portal blood vessels, which can cause liver necrosis.

Some foreign authors propose to establish a catheter at the same distance (2–4 cm) for blood exchange operations, also, if necessary input isotonic solution only and remove the catheter after the procedure.

After emergency care catheter, which is set in the delivery room, removed in aseptic conditions, an experienced assistant establishes a new one or other venous access.

For a long-term catheter use its end should be located above the diaphragm, but below the right atrium. To calculate the depth of catheter standing use standard tables, depending on the distance between the umbilical residue and shoulder (Fig. 147).

To determine the depth of introducing the catheter the formula can be also used:

– The distance between the umbilicus and interclavicular line multiplied by 0.6.

– The distance from the xiphoid process to the umbilicus plus 1 cm.

Methodics:

1. Treat hands with antiseptic.
2. Treat umbilical cord residue and the front wall of the abdomen with antiseptic, allow drying.
3. Wear sterile gloves.
4. Following aseptic conditions without removing the catheter from the package fill the catheter with sterile 0.9 % NaCl solution. An assistant opens the packages, an operator takes sterile syringe from one of them; the assistant holds a bottle of saline so that the operator does not contaminate gloves. After putting saline in the syringe, the operator attaches a sterile transition valve to it and before it the port of the catheter. Catheter's package is opened so that you can attach a syringe and fill the catheter with a solution.
5. In case of using transitional crane you should close it till the location of the catheter in the vein.
6. Impose sterile diapers on the skin around the treated area.

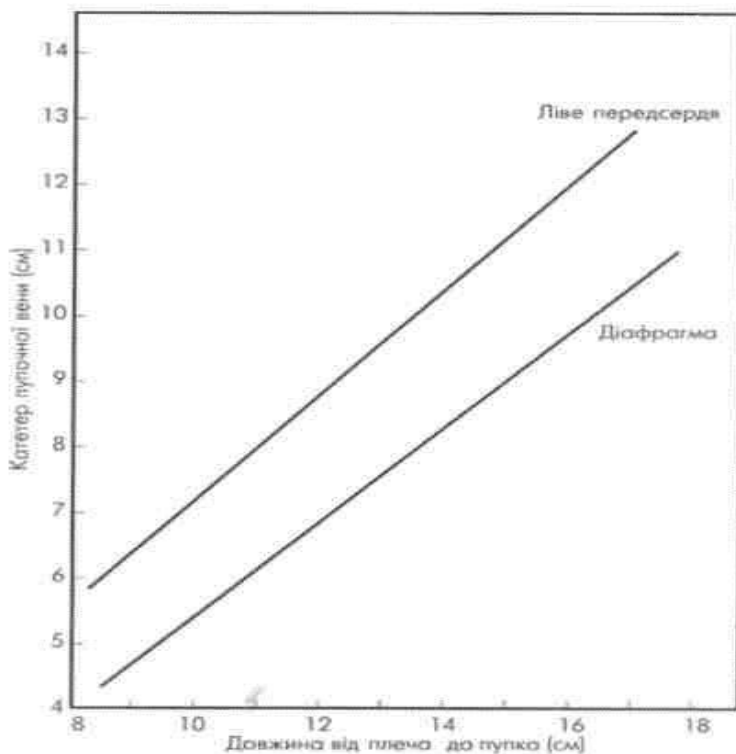


Figure 147 – Determination of the depth of the catheter introduction in the umbilical vein

7. Apply a sterile ligature of suture silk or ribbon around the base of umbilical cord stump for hemostasis and for fixing the catheter after the procedure.

8. Using a scalpel (scissors) cut the umbilical cord horizontally approximately 1.5–2 cm above the skin of the anterior abdominal wall.



Figure 148 – The dry sterile diapers applied after treatment of skin with antiseptic



Figure 149 – Fixation of the catheter to the base of the umbilical cord



Figure 150 – After receiving a reverse blood flow, a vein is washed with saline

9. Umbilical vein may continue to bleed. The bleeding from the artery is not observed usually due to vasospasm. If bleeding occurs you should pull ring of ligation for hemostasis.

10. On section you must identify one vein and two arteries. Umbilical vein is commonly located at position 11–12 hours, but its torsion in the umbilical cord is possible.

11. The arteries are usually thinner, but have thicker walls and a rounded shape on the cut. The vein is wider, has a thinner wall and a flattened oval shape.

12. Using a compression with sterile cloth and the clamp remove blood clots from the veins and expand the vein with a thin clamp.

13. Check the absence of air before entering the catheter to prevent ingress of air into the lumen of the catheter.

14. Carefully holding the catheter with forceps, begin to enter it in the lumen of vein directing its end towards the child's head.

15. If at the beginning of input resistance is felt, it is necessary to loosen the knot ligation on umbilical residue or change the angle of entry of catheter (horizontally under the skin of the abdomen). Do not apply force when entering a catheter, pressing on the plunger of the syringe to direct the catheter after the “liquid” is permissible; do light rotating movements that make catheter harder.

16. For a long-term use of umbilical catheter it should be located above the venous duct in the lower vena cava below the right atrium. This arrangement corresponds to the central venous catheter, which allows monitoring of the central venous pressure and input of hyperosmolar solutions.

17. After setting the catheter treat the umbilical residue and skin around it with antiseptic.

18. Fix the catheter to prevent it from shifting and bleeding using sterile ligatures tightly fixed to the catheter and tied around the umbilical cord, sometimes impose purse-string suture on the cord. Further catheter is fixed with a plaster around the umbilicus.

19. Wharton's jelly is rapidly shrinking, providing protection against infection, so it is allowed open care of umbilical cord stump after catheterization.

20. The use of antiseptics after catheterization of umbilical vessels and the use of bandages is debatable. Do not impose airtight bandage and other coatings, which can mask the possible bleeding or displacement of the catheter.

21. It is allowed to use dry thin gauze that lets umbilical cord to breathe and soak quickly if there are problems or bleeding. When such coverage is used the napkin should be changed every day, while treating the skin around the umbilicus with antiseptic.

22. It is allowed to use sterile semi-permeable patches that provide access of air and moisture removal. Transparent labels can observe the place of standing; you should not change them for 3 days.

23. The location of the catheter can be confirmed radiographically. The end of it shall be at the diaphragm level or 1 cm above the diaphragm (not reaching the right atrium).

24. It is not allowed to hit venous catheter in the beginning of hepatic vessels, in gate vein and right atrium.

25. If manipulation with the sterile catheter is over, pull it slight back, but in any case do not push forward.

26. If roentgenological control was not made only the input of isotonic solutions through catheters is allowed, as in the peripheral access.

27. Using a three-way stopcock, attach the infusion system. Never leave the catheter open to atmospheric air, negative intrathoracic pressure can cause an air embolism.

28. Place of indwelling should remain dry and clean. Dirty skin around the umbilical cord should be cleaned and treated with skin antiseptic.

Removal of the catheter:

1. Remove the catheter preferably within 7 days of life.
2. Eliminating catheter, cut the suture close to the skin, avoid cutting the catheter. Apply a new ligature to the umbilical cord.

3. Take out the catheter slowly and remove it fully on “expiration”, press the umbilicus and tighten the ligature to

prevent the development of embolism during extraction of the catheter.

Complications:

- infection;
- bleeding;
- thromboembolism;
- pericardial effusion;
- hydrothorax;
- thrombotic endocarditis;
- perforation of vessels;
- formation of wrong way in the lumen of the umbilical

cord;

- abscess or necrosis of the liver;
- air embolism;
- embolism of the catheter tip;
- arrhythmia and perforation or tamponade of pericardium

(if catheter is entered to the heart);

- necrotizing enterocolitis;
- obstruction of pulmonary venous circulation;
- portal hypertension.

40. Care of intravenous catheters

Indications:

- the presence of any vascular access in a newborn.

Contraindications: do not exist.

Required equipment:

- equipment for own protection (sterile gown, cap, clean and sterile gloves, protective screen or mask and goggles);
- sterile diapers, cotton balls, gauze swabs and wipes;
- skin antiseptic (70 % alcohol, 2 % chlorhexidine);
- sterile semi-permeable fixing film, adhesive tape for fixing.

Methodics:

1. The infection can get to the bloodstream as through a catheter from contaminated infusion solution and directly into the

vessel along the outer walls of the catheter from the patient's skin. Treatment of setting place and care for the catheter, protection of the puncture area with sterile semi-permeable film are main methods of prevention of endogenous catheter-associated infections.

2. Before any manipulation with the catheters and blood vessels, including the replacement of syringe infusion pumps, carefully clean the hands, wear gloves. It is allowed to use clean gloves when working with peripheral catheters. Do not touch the sterile places of connections (ports), the inner surface of caps (plugs) and catheter, tip of the syringe and infusion solution even with "sterile" gloves. Blood, lymph, condensate, which may be under the bandage, are biological fluids and staff is protected by gloves.

3. For the skin treatment during establishment of venous access and care for the catheters the most effective is the solution of chlorhexidine gluconate with mandatory compliance of exposure time. When setting the central catheter via peripheral access the treatment of the skin should be carried out twice, waiting for drying of antiseptic. After installing the catheter you should repeat cleaning of puncture area and future plaster position with antiseptic.

4. After complete drying of antiseptic the remained part of the catheter is fold by the rings near the site of the puncture and placed under transparent permeable sterile bandage that keeps sterility and provides skin evaporation. In the absence of sterile transparent – a permeable plaster, it is permissible to impose on the puncture a dry sterile cloth and secure it with thin strips of adhesive plaster.



Figure 151 – Sterile transparent – permeable T-shaped sticker for the catheter with a port (in infants port is not used)



Figure 152 – Connecting via three-way stopcock allows to enter into a catheter several solutions simultaneously



Figure 153 – A peripheral catheter on the hand fixed with an improvised splint from the diapers

5. Replacement of bandages is carried out:
- if there is moisture, signs of infection and skin irritation, bleeding, leakage of the infusion solution;
 - every day for dry gauze bandages and central catheters, every 48 hours for peripheral access;
 - if it is dirty, wet from the outside;
 - every 5–7 days sterile transparent-permeable films of central catheters and every 3 days of peripheral catheters.

While changing the bandage treat a place of indwelling with antiseptic, after drying impose a new bandage.

All vascular accesses should be examined periodically. Places of establishing of the central venous access – every 8 hours, peripheral accesses of the central catheters and peripheral catheters – every 12–24 hours. Examine the skin through the transparent patches during each input of medication.

7. If there are signs of swelling, changes in skin color or structure – gently palpate the area around the location of the catheter. If the suspicion is confirmed and there are signs of infection or bleeding, carefully remove the catheter. Palpation of the puncture area and surrounding tissues is carried through the film or before skin treatment with antiseptics in the puncture area, but not after it.

8. Evaluate the possible formation of blood clots in the three-way stopcocks, infusion tubes and connections. In case of the formation of a blood clot, of the feeling of the resistance in the catheter or when infusion pump indicates occlusion – do not try to wash the catheter. You can try to remove the clot from the line, pulling the plunger of the syringe “towards themselves”. If managed to do this – collect all clots in the syringe and rinse the catheter with saline and heparin (0.5 U/ml). In case of failure – remove the catheter, if necessary you should establish venous access elsewhere.

9. Catheters with normal function should not be replaced! Catheter is removed only in case of its blockage, signs of infection

(other than umbilical, which should be replaced after 3 days as soon as possible). Normal functioning catheter is removed when it is no longer necessary.

10. Do not use prophylactic treatment with antibiotics after establishment of central or peripheral catheter; the risk of formation of multiresistant strains of microorganisms exceeds unproven benefit of such appointment.

11. Change of central catheters “through the conductor” can be dangerous if previous catheter is removed due to suspected infection or blood clots. Set another catheter elsewhere.

41. Methodics of parenteral nutrition

Indications:

- inability of effective enteral feeding;
- severe condition of the newborn (severe CNS affections, sepsis, severe and moderate respiratory disorders and heart failure);
- diseases of the gastrointestinal tract (necrotizing enterocolitis, malabsorption syndrome, persistent diarrhea, congenital malformations, which require surgical correction, meconial and paralytic ileus, short bowel syndrome);
- very low and extremely low birth weight (make partial parenteral nutrition).

Parenteral nutrition (PN) should begin after stabilization of parameters of gas exchange, hemodynamics, hemostasis, after correction of metabolic disorders.

The purpose of parenteral nutrition is to provide revenues sufficient amount of nutrients to prevent negative balance of energy and protein, as well as deficiency of essential fatty acids and support the normal growth rate, corresponding to utero ones.

Contraindications:

The ability meets the child’s needs enterally.

Required equipment:

- sterile solutions for parenteral nutrition;
- established venous access;

- infusion pumps (syringe pumps);
- extension line for infusion.

Methodics:

Types of parenteral nutrition:

1. Total parenteral nutrition (TPN) – the whole volume of necessary nutrients is entered intravenously.
2. Partial parenteral nutrition (PPN) – a part of the necessary nutrients is entered enterally, the other one – intravenously.

Ways of parenteral nutrition:

1. Peripheral vein – short-term PN (5–7 days) is provided.
2. Central vein (usually v. cava) – prolonged PN (more than 7–10 days) is provided, when entering concentrated solutions of glucose (over 12.5 %), fat emulsions or the inability to secure peripheral venous access.

Preference should be given to central vein catheter with peripheral access (subcutaneous veins of the legs, anterior cubital vein, and jugular vein).

Entering of medicines, blood, plasma, or collecting blood for tests through the catheter for PN is not recommended.

The calculation of PN programme:

1. The calculation of the fluid need.
2. The calculation of the number of electrolytes.
3. The calculation of the required dose of amino acids.
4. The calculation of the volume of fat emulsion.
5. The calculation of fluid entered with medicines.
6. The determination of the amount of glucose solution by the formula:

$$V_{\text{glucose}} = V_{\text{general fluid}} - V_{\text{electrolytes}} - V_{\text{fats}} - V_{\text{amino acids}} - V_{\text{fluid entered with medicines}}$$

The demand for liquid is determined for each child individually according to gestational and postnatal age, disease type, volume of enteral nutrition, fluid loss with perspiration,

feces, urine, gastric contents, and change of the body weight per day.

The initial amount of liquid is 60–80 ml/kg/day, increasing every day by 10 ml/kg/day (if diuresis is more than 2 ml/kg/hour) to 150–180 ml/kg/day (see the table):

Physiological need for liquid during 1 month of the child's life *			
Birth weight, g	Demand of liquid, ml		
	1–2 day	3–7 day	8–30 day
< 750	100–200+	150–200+	120–180
750–1000	80–150	100–150	120–180
1001–1500	60–100	80–100	120–180
> 1500	60–80	100–150	120–180
* Indices of minimal and maximal need			

Reducing the need for fluid is observed in children with respiratory distress-syndrome, broncho-pulmonary dysplasia, heart failure, patent ductus arteriosus.

Energy needs:

Full parenteral nutrition (FPN) must meet the needs of basic exchange (50 kcal/kg/day) and the expenditure on motor activity, cold stress, growth, stress (disease).

PN should provide the minimum energy intake for full term infants such as 90–100 kcal/kg/day, preterm infants 100–110 kcal/kg/day, and newborns who have normal temperature and receive sedation or muscle relaxation – 80–100 kcal/kg/day.

Rising energy demand is observed in case of the body temperature increasing, cardiac and respiratory disorders; sepsis, necrotizing enterocolitis, delayed fetal growth.

Carbohydrates:

Recycling 1 g glucose solution provides 3.4 calories of energy; energy value of 10 % glucose solution is 0.34 kcal/ml. The number of non-protein energy resulting from the utilization of glucose should be 40–60 % of the total energy needs.

Isoosmolar is a 5 % glucose solution, which has 278 mOsm, 10 % – 555 mOsm solution, 20 % solution – 1110 mOsm.

The rate of glucose administration:

Glucose is appointed to a newborn child depending on the speed of its utilization. In a premature baby the utilization rate is 6–10 mg/kg/min, and in full term – 4–6 mg/kg/min. The glucose dose is gradually increased, depending on its level in blood (> 3 mmol/l, but < 8–9 mmol/l) on 0.5–1 mg/kg/min every day to maximal dose of 10–12 mg/kg/min.

As a starting solution for all babies, regardless of the degree of maturity and body weight, 10 % glucose is recommended.

Fats:

Fats are appointed in cases where it is projected that the child can not absorb enterally 70–80 kcal/kg.

Recycling 1 g lipid provides 9 calories of energy; energy value of 10 % solution of fat emulsion is 1.1 kcal/ml, 20 % solution is 2.0 kcal/ml. Number of non-protein energy resulting from the utilization of lipids should not exceed 40 % of the total energy needs.

Fat emulsion is appointed to a newborn in a dose of 0.5 g/kg/day and increase to 3.0–4.0 g/kg/day. It is not recommended to enter neonatal fat emulsion in doses greater than 4 g/kg/day.

The rate of administration should be increased under control of triglyceride levels which should not exceed 1.5 g/l.

Fat emulsion is entered through a separate catheter or Y-adaptor and do not mix with other solutions and medicines.

Restrictions for the appointment of fat emulsions:

- Hyperbilirubinemia.
- Thrombocytopenia.
- Hypercholesterolemia.
- Pulmonary hypertension.
- Sepsis.

Preparations: Intralipid.

Proteins:

Recycling 1 g of amino acids provides 4 calories of energy. Protein energy should constitute 10–15% of the total energy needs. Recycling 1 g of amino acids is carried out only with simultaneous entering of 10 of non-protein calories.

Amino acids can be entered since the first day of life. The initial dose is 1.0–1.5 g/kg/day. Increase the dose on 0.5 g/kg/day. It is desirable to provide 3.0–4.0 g/kg/day.

Amino acids entered together with glucose, mixing them in sterile bottle.

The peculiarity of amino acid solutions for parenteral nutrition of newborns is greater amount of essential amino acids, and increased concentration of amino acids that are most important for premature infants (taurine, tyrosine, cysteine).

Preparations: Aminoven-Infant

Electrolytes:

– Sodium: the daily need is administered after 24 hours of life, in case of sufficient diuresis.

A full-term healthy baby is 2–3 mmol/kg/day.

A newborn weighing < 1500.0 g during rapid growth is 4–6 mmol/kg/day.

Sodium preparations: 10 % solution of sodium chloride, 1 ml of which contains 1.7 mEq of sodium. 0.9 % solution of sodium chloride in 6.49 ml contains 1 mmol of sodium.

– Potassium: the daily need is administered after 72 hours of life, in case of sufficient diuresis.

A full-term healthy baby is 1–2 mmol/kg/day.

A newborn weighing < 1500.0 g is 2–3 mmol/kg/day.

Preparations of potassium: 7.5 % and 15 % solution of potassium chloride, 1 ml of which contains 1.0 mEq and 2 mEq of potassium.

– Magnesium: the daily need is administered after 24 hours of life at a dose of 0.25 mmol/kg/day or 200–400 mg per day.

Magnesium preparations: 25 % magnesium sulfate solution, 1 ml of which contains 1 mmol of magnesium.

– Calcium: administered in a dose 1.5–2.0 mmol/kg/day (150–200–300 mg/kg/day).

Calcium preparations: 10 % solution of calcium gluconate, 1 ml of which contains 100 mg or 0.2 mmol or 0.46 mEq of calcium. Calcium gluconate is entered through a peripheral venous line, but not both of sodium bicarbonate, digoxin or antibiotics.

Defined dose of electrolytes is entered intravenously evenly throughout the day. Dilution of these drugs in 10–20% glucose solution and slow speed input is mandatory.

Vitamins:

Fat-soluble vitamins are added to fat solution and water-soluble – to a solution of glucose with amino acids.



Figure 154 – Darkening of conventional extension tube by foil when entering medicines

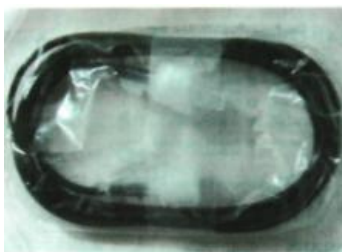


Figure 155 – Opaque extension line



Figure 156 – Opaque syringe for lipids administration

Daily need of vitamins in newborns on full parenteral nutrition		
Vitamins	Full term, per kg	Preterm, per kg
Fat-soluble		
A, mcg	700	500
E, mcg	7	2,8
Д, mcg/MO	10/400	4/160
K, mcg	200	80
Water-soluble		
Ascorbic acid, mg	80	32
Folic acid, mcg	140	56
Cyanocobalamin, mcg	0.8–1	0.4
Thiamine, mg	1.2	0.48
Riboflavin, mg	1.4	0.56
Pyridoxine, mg	1.0	0.4
Niacin, mg	17	6.8
Pantothenic acid, mg	5	20
Preparations: Soluvit (water-soluble vitamins), Vitalipid (fat-soluble vitamins)		

In the absence of multivitamin preparations for parenteral nutrition daily needs can be provided with the appointment of isolated vitamins in appropriate doses.

Daily need of microelements in newborns on full parenteral nutrition, mcg/kg/day		
Microelement	Full term	Preterm
Zinc	250	400
Cooper	20	20
Selenium	2.0	2.0
Chrome	200	200
Manganese	1.0	1.0
Molybdenum	0.25	0.25
Iodine	1.0	1.0

Control over the implementation of parenteral nutrition:

The correctness of infusion therapy in neonates is determined by the dynamics of body weight, hemodynamic and laboratory parameters, clinical symptoms, functional state of organs and systems. Infusion therapy in infants requires clinical and biochemical monitoring of its effectiveness.

1. Violation of water and electrolyte balance, metabolic disorders can be a reason for temporary (24 hours) stoppage of parenteral nutrition.

2. Renal failure may require reducing introduction of amino acids to 0.5–1.0 g/kg/day. You should control the level of residual nitrogen in the blood.

3. The use of amino acids in case of hepatic insufficiency can lead to an imbalance of amino acids in plasma, azotemia, hyperammonemia. In case of significant increase of blood levels of transaminase parenteral nutrition can be stopped.

4. If you suspect sepsis you should use only peripheral veins and access to the central vein may possible after 24–48 hours of antibiotic therapy.

Approximate scheme of monitoring during infusion therapy in newborns	
Index	Frequency of determination
Body weight	Every day
Body length	2–3 times per week
Head circumference	Every day
Diuresis	Every day
Urinalysis	Until stabilization each 8–12 hours, further – every day
Haematocrit	Every 24–48 hours during the 1 st week, further – every week
Clinical blood analysis with formula	1–2 times a week, if indicated
Blood gases	Every week or more often in case of respiratory disorders
Sodium, potassium, chlorine, calcium, residual nitrogen	Every 24–48 hours during the 1 st week, further – 2 times per week
Bilirubin	Every week, in case of jaundice – according to indications
Plasma and urine osmolarity	Every week
Magnesium	Every week
Biochemical blood test (enzymes, general protein, albumin)	Every week
Blood glucose level	Every day or if needed
Plasma triglycerides	Everyday in case of lipids dose increase, further – every week

Complications:

Infection (sepsis, phlebitis, soft tissue lesions). If the patient's condition with sepsis after 48 hours of adequate antibiotic therapy does not improve, you should remove the central venous catheter, through which the FPN is made. Remove immediately if the catheter is intended as a source of infection.

Metabolic (hypo- or hypoglycemia, electrolyte imbalance, vitamin content, hyperammonemia, hypernitrogenemia, hypertriglyceridemia, indirect hyperbilirubinemia, cholestatic jaundice, mineral imbalance, metabolic bone disease).

To prevent hypo- and hyperglycemia change the concentration of glucose in the solution gradually, under the control of blood glucose of the newborn.

Hyperlipidemia in infants with lung disease requires increased oxygen supply. You must provide reduction of fat emulsions.

When you change the composition of FPN always evaluate the condition of water and electrolyte metabolism. Metabolic acidosis is often connected with the increased chloride level. Recalculate amino acids, electrolytes (acetates).

Mechanical:

- tearing of catheter;
- damage of the catheter;
- thrombosis of the catheter;
- thrombophlebitis due to mechanical, chemical irritation;
- hydrothorax.

Liver complications: cholestasis, increased bile acid level, direct bilirubin, fibrosis of portal system due to prolonged administration of amino acids. A few months after stoppage of parenteral nutrition liver function will normalize. In case of syndrome of cholestasis you should exclude copper from parenteral nutrition.

42. Infusion therapy with perfusors

Indications:

- support and restore of fluid balance in the newborn;
- support and restore of electrolyte balance in the newborn;
- medicines administration;
- carrying out partial and total parenteral nutrition;
- entering of blood preparations;
- support for “functioning veins”.

Contraindications:

Ability of per oral meeting the needs of the child and administration of medicines.

Required equipment:

- syringes 20 ml or 50 ml;
- sterile solutions for injection (10 % glucose, 0.9 % NaCl, solutions of amino acids, fats, vitamins and minerals, water for injections as solvent according to the instructions);
- three-fway stopcocks;
- filter for filling solutions under aseptic conditions;
- cotton, gauze balls for processing connections;
- plugs for free inputs (ports) of stopcock;
- 70 % alcohol solution;
- gloves;
- syringe infusion pump with electric power;
- extending systems for transfusion of medicines (tubes, lines) of different diameters, transparent or opaque, tinted by foil for darkening.

Preparation of a patient:

For providing infusion therapy intravenous access should be made.

Properly fixed intravenous catheter does not preclude breastfeeding, nursing premature newborn by “Kangaroo Mother Care”, change of diapers, weighing and examination, etc.

Infusion is carried out in normal conditions of patient's staying (couveuse, table under radiant heat source, heated bed, "Kangaroo Mother").

During infusion therapy you should look after the baby – measure body temperature every 4–6 hours, breathing and heart rate every 3 hours, blood saturation and blood pressure if necessary, physiological functions with mandatory urine control (weighing diapers) after every changing and a newborn weighing 1–2 times a day (depending on the condition, the infusion volume and urine output). The use of urinary catheter for urine output calculation is not recommended.

It should also be observed the state of stomach and digestive system – large volume infusions increase the risk of necrotizing enterocolitis.

Preparation of materials and equipment:

1. In aseptic conditions, after treating hands, in manipulation room the nurse is preparing solutions for intravenous injections and infusions. Glass ampoules should be used immediately after opening and the remains should be disposed. The bottle with rubber stopper after dilution in aseptic conditions and partial selection of the drug may be stored according to manufacturer's instructions. The average duration of storage solutions is 1–2 days in the refrigerator, but some solutions should only be freshly diluted (ampicillin!). So you should always carefully read instructions to the drug.

Bottles should be signed, indicating the date, time and multiplicity of dilution (if there are no standard algorithms, mandatory for all nurses).

2. Solutions for continuous infusion and parenteral nutrition are prepared for 12–24 hours, stored in a cool place, but not in the refrigerator, solution of fats is stored in a dark place or tinted by foil for darkening to prevent lipid oxidation. Solutions of cardiotoxic medicines (dopamine, dobutamine) are diluted just for 12 hours in saline and for 1–2 hours in glucose. Solutions of medicines for a short stream or short drip administration are

prepared immediately before the administration. Bottles with solutions are marked with markers or adhesive tape with the date and time of dilution (production), the names of the patients.

3. Preparations of blood before injection are warmed or defrosted at room temperature; do not use hot water, electrical equipment or microwave ovens. It is allowed to defrost fresh frozen plasma in thermostat or in specific heating devices at a temperature not more than 37 °C (denaturation of proteins starts at higher temperature). You should carry out blood group investigation in a bottle and test for compatibility with blood of the child. Compatible blood preparation is entered through a specific filter for it.

4. Before the infusion a solution is aseptically gained from the bottle through the filter to a sterile disposable syringe (syringes of 20 ml or 50 ml which are compatible with syringe pump are used), for administration of lipids, an opaque syringe or a syringe covered with foil is used. A syringe with a closed needle in a package or a sterile diaper is placed in a couveuse or under radiant heat source to heat (except lipids).

5. After checking the availability and serviceability of electrical power enable turning on of the infusion pump (perfusor or syringe pump) and install the basic parameters of infusion, volume and model of the syringe and previously calculated speed of infusion (in some pump models the size and the model are determined automatically according to a syringe diameter after its connection). If you are not familiar with this device before using it, be sure to read the instructions and get more tips from colleagues familiar with his work.

Methodics:

1. Treat hands; fill a sterile infusion system (tube) with infusion solution or saline (for injections of blood products, immunoglobulins, antibiotics).

Insert the syringe into the pump (take the pump, turn the clamp, insert and secure the plunger in a special section of the pump, turn the clamp into the previous place by pressing on the

syringe), set the model and size of the syringe (if not done earlier), preserving the sterility of line-extensor tip (conduction).

3. Clean the hands, prepare balls with spirits.

4. Treat outside the port of the catheter's three-way stopcock to which the system will be connected and around it where hands can touch.

5. Shut off the valve of a three-way connector, disconnect the syringe or infusion line, or port cover (plug). If you inadvertently touch and cause missing of sterilization of the port, treat the connection place so that the spirits does not get inside. The plug (cover) is thrown away, if necessary, a new one is used later. After entering of the drug do not leave the port opened, in the temporary absence of plug block an entrance with a syringe of 1.0 ml.

6. Carefully, without touching the connections by the hands (even in "sterile" gloves) connect filled line extension to a port, avoiding getting of the air the catheter (the method of "drop"). Open slightly the valve and gently inject the solution by pressing the plunger (if the syringe is not in the pump) or by pressing the button "Run" (if the syringe is already connected to the system). Making sure that the connection is working, insert the syringe to the pump and set the parameters (if not done before).

7. With a "Start" button begin the infusion, monitor the fluid flow in the catheter and vein condition, inspect the place of standing of the catheter and connections. Look after the child's condition; better by monitoring with a pulse oximeter.

8. If necessary provide infusion of several different, incompatible in the same syringe liquids (glucose-electrolyte-amino acid mixture, dopamine and fats), using a serial connection of several three-way stopcocks (as the "track-train"). In this case fat, blood and other viscous liquids are connected closest to the catheter and then sympathomimetic or other medicines, the last valve is connected with the glucose mixture for rinsing and mixing other drugs in the system and the catheter. The side

entrance (port) of this valve is used for entering of antibiotics and other short-term injections.

9. Total liquid quantity received by a child should contain the entire amount of saline solution used for dilution and administration of medicines, for washing the catheters.

10. During the infusion you should monitor the system of the stopcocks and valves catheter patency and exclude leaks etc. Care for intravascular catheter is carried out as usual.

11. Before the liquid ends in the syringe the device gives a warning signal and you should disable alarm, clean the hands and enter the next portion of the solution into a new sterile syringe from the marked bottle checking the patient's name and the date of manufacture of the solution. Do not re-use the syringe, the infusion of which is over due to high risk of infection (in case of full pushing on the plunger the microorganisms from a handle of the plunger transmitted to the inner wall of the syringe, after taking solution in such syringe its contents will be contaminated).

12. After the liquid in the syringe is over, the device gives a signal "replace a syringe", you should disable the alarm, stop input, clean the hands and take sterile balls with spirits, close the valve that simultaneously allows to close the access of fluid from the line to the catheter after the end of the infusion. Replace a syringe to a new one, according to the following steps:

- open the clamp of the pump;
- take out the syringe;
- treat with antiseptic the connection of the syringe with the line;
- disconnect the empty syringe, without touching the tips of line with fingers;
- carefully, avoiding air ingress into the line (the method of "drop, which hangs") connect a new syringe to the line;
- take the pump;
- insert and secure the plunger in a special section of the pump;

– turn the clamp into the previous place by pressing on the syringe.

13. Then, repeat the steps from point 7. If at the end of the next syringe it is necessary to change infusion system, repeat initial steps (from point 2).

Every day, except the lines, you should replace all three way stopcocks. To prevent air embolism, before disconnecting the nearest syringe you should pinch the folded twice catheter by fingers and release only after connecting all systems and a syringe with a solution. During connecting a new system use also a drop that fills the space left in the connection place after separation of the previous system.

14. If you need to enter blood preparations, intravenous immunoglobulins, antibiotics with significant dilution (something that should have exact dosing), the system is filled with saline, attach the syringe with the medicine and gradually displace the solution from the line-extension and then set the syringe into the infusion pump. After the drug in the syringe is over you should set the next sterile syringe with saline, continue infusion at the same rate, controlling the passage of the drug in blood. If solutions do not differ externally (in colour) measure the exact volume required for filling the system line and take more of the drug into the syringe to the appropriate number. Then after emptying the syringe, “extra” amount is left in it.

15. If the infusion is completed or stream injection is made and the infusion of a drug continues through another access – close the valve, disconnect the syringe or the line extension; close the port with a sterile plug.

16. After the transfusion of blood the line extension should be replaced by a clean one, no later than in 12 hours. Maximal duration of using lines for lipids or other viscous liquids administration is the same. The duration of using extension lines, through which liquid preparations that do not contribute to the deposition of fibrin are poured, may be greater – 24–48 hours. For

premature babies with low birth weight you should change the line-infusion system every 24 hours.



Figure 157 – The syringes with potent drugs should be marked because of the risk of speed change during their injection



Figure 158 – “The track-train” provides the mixing of solutions in catheter. Lines with different drugs are marked

17. It is not recommended to make blood transfusion through a peripheral catheter. However, if for health reasons the transfusion of packed red blood cells or fresh frozen plasma was made, you should rinse the catheter with heparin (0.5 U/ml) immediately after the transfusion and observe the vein. In suspicion of thrombosis – remove it and set a venous access elsewhere.

Carrying out parenteral nutrition using lipids is permitted to make via a peripheral vein providing good blood flow,

simultaneously with a solution of glucose with amino acids via a three-way stopcock.

19. To prevent thrombosis of the vein or the catheter daily volume of infusion therapy should be evenly distributed to 24 hours to provide ongoing of the fluid flow through the catheter, which allows not to use heparin “lock”. If the infusion is ended earlier till the doctor’s coming and the calculation of a new infusion, you must set slow entering of saline or 10 % glucose at a speed of 0.5–1 ml/hr or apply heparin “lock” (0.5–1 U/ml).

20. Infusion therapy with plunger pumps should be carried out only through a special connecting system – tubes and lines. It is not allowed to use systems for droppers for this purpose because they are not designed for this! First, a wide tube requires a lot of extra fluid to be filled and a big residue. The elasticity of the tube does not guarantee constant pressure. First of all, the liquid is not moving, the pressure increases, the tube dilates, the pressure increases again (resistance of the tube), during this time clots may form in the vein. Then the fluid “breaks” into the vein that may cause rupture or splitting of intima, thrombus detachment and other complications. The air-dropper containers are especially dangerous for newborns.

21. In case of insufficiency or absence of pumps and immediate need for infusion therapy in newborns it is allowed to use special systems with dosage controller, which allows dosing speed of solution input, approximately in the range of 1–10 ml/hour and more.

Complications:

- catheter-associated infections, thrombophlebitis, and sepsis;
- bleeding from the area of the catheter setting;
- thrombosis, thromboembolism, thrombotic endocarditis;
- air embolism;
- perforation of vessels;
- abscess or necrosis of the liver;
- necrotizing enterocolitis;

- obstruction of pulmonary venous circulation;
- portal hypertension.

43. Determination of the blood group by ABO system erythrocyte antigens

Indications:

– determination of a newborn's blood group by ABO system antigens.

The blood group by ABO system is determined by using the reaction of agglutination. Currently, there are three ways of determining blood groups by ABO system:

- with standard isohemagglutinins sera;
- using monoclonal antibodies (coliclones anti-A and anti-B);
- with standard isohemagglutinins sera and standard erythrocytes (cross-reaction, often carried out in serological laboratories).

Contraindications: The absence of indications.

Determination of the blood group using standard sera

Required reagents:

– standard polyclonal isohemagglutinins sera of groups 0 (I), A (II), B (III) of two different series of each group and the standard serum of group AB (IV). The titer of serum should not be below 1:32 and serum B (III) – not below 1:16. The serum titer means the maximum dilution of it, where agglutination reaction may occur;

- 0.9 % sodium chloride solution.

For the convenience the standard serum of different groups has different colours: 0 (I) – a colorless (gray), A (II) – blue, B (III) – red, AB (IV) – bright yellow. These colours reflect the group membership that's why marking labels of blood and blood preparations are same.

Special equipment, materials:

- white plates or porcelain (enameled) plates;
- glass or plastic sticks;

- pipettes;
- protective gloves.

Technique:

Determination is carried out in a room with sufficient lighting at temperature from +15 to + 25 °C. You can study the whole blood, washed red blood cells, red blood cells in plasma, serum of blood or 0.9 % sodium chloride solution. The cord blood is not used for the study because of the possibility of error associated with maternal erythrocytes hit. Blood of patients with anemia is stabilized with heparin.

1. The plate is marked, putting designation from left to right “0”, “A”, “B”. Apply one large drop (0.1 ml) of each serum of two series under the marks.

2. One small drop (0.01 ml) of a baby’s blood sample (erythrocytes) is applied along with each serum with the ratio to the serum 1:10.

3. Mix every drop of blood (red blood cells) with the appropriate serum with the help of separate glass sticks.

4. After mixing all drops, shake the plate, then let it wait for 1–2 min. and shake again. Although agglutination begins within the first 10–30 seconds, monitoring of the operations is carried out for at least 5 min., because late agglutination is possible, i.e. with erythrocytes of group A2.

5. After 3–4 min. to drops with the serum and the erythrocytes mixture, where agglutination took place, add 1 drop (0.05 ml) of 0.9 % sodium chloride and wait for 5 min. with periodic shaking of plate.

In case of a positive reaction in the mix there appear visible small red granules (agglutinates), consisting of glued erythrocytes that can group into larger flakes. The serum is colourless.

In case of negative reaction during all the time (5 min) liquid is evenly coloured and grains (agglutinates) are not observed.

The results of responses in both drops of sera of the same group (two different series) must match. When you receive agglutination in all three pairs of drops, carry out additional studies with serum AB (IV) to exclude non-specific agglutination (according to the same scheme during 5 minutes).

Interpretation of the results:

As a result of research we can get four different combinations of positive and negative reactions * (see the table):

Blood group	Serum			
	0 (anti-A, anti-B)	A (anti-B)	B (anti-A)	AB (without antibodies)
0 (anti-A, anti-B)	–	–	–	–
A (anti-B)	+	–	+	–
B (anti-A)	+	+	–	–
AB	+	+	+	–

* (–) – absence of agglutination, (+) – presence of agglutination

– if there is no agglutination in all drops – it is the blood of the group 0 (I);

– agglutination in the first and third drops and its absence in the second one group A (II);

– the presence of agglutination in the first and second drops in the absence in the third group B (III);

– agglutination in the first, second and third drops and absence in serum of AB (IV) – AB (IV) blood group.

Possible errors:

– incorrect ratio of blood and serum (normally 1:10);

– not enough time for monitoring of the reaction (normally at least 5 min);

– high temperature (normally not more than 25 °C);

– lack of control reactions with serum group AB (IV);

– use of wet pipettes, plates, contaminated sticks;

– use of insufficiently active serum (old serum).

Note:

– difficulties can arise in case of changes of blood properties in the children with various pathological conditions (autoimmune anemia, purulent-septic conditions, necrotizing enterocolitis, leukemia). Determination of blood group should be carried out in the laboratory using standard sera with high activity;

– if blood contains weak subtypes of A2 antigen, the agglutination test with groups 0 (I) and B (III) serums begins later (on average 3–4 minutes). To clarify the appropriate results additional reaction with an anti-A reagent in a specialized laboratory is necessary (reagent contains only anti-A antibodies and is made from the seeds of plant *Dolichos bitforis*).

Blood group determination with monoclonal antibodies

Method of determining blood groups using coliclones allows eliminating the donors whose blood is used for the preparation of standard sera. At the same time, a narrow range of coliclones' specificity and immaturity of antigenic determinant on the erythrocyte membrane of a newborn baby increases the number of false results in newborns.

Required reagents:

Standard monoclonal antibodies (MCA): coliclones anti-A (red colour) and anti-B (blue).

Special equipment, materials:

1. White plates or porcelain (enameled) plates.
2. Glass or plastic sticks.
3. Pipettes.

Technique:

1. Definition is carried out in a room with sufficient lighting at temperatures from + 15 to + 25 °C.

2. Coliclones anti-A and anti-B is put on a white plate in one large drop (0.1 ml) under the relevant inscriptions: anti-A or anti-B.

3. Along with the drops of antibody one small drop (0.01 ml) of the studied blood is applied. A ratio is 1:10.

4. Mix with glass sticks every drop of blood (red blood cells) with the corresponding coliclones.

5. Shake the plate, then wait for 1–2 min. and shake again. Coliclones agglutination of anti-A and anti-B begins in the first 3–5 seconds, the monitoring of the operation is carried out for 2.5 min.

6. A positive result is confirmed by the presence of agglutination, the appearance of small red grains that quickly form plates. If the result is negative, there is no agglutination, the drop is coloured in red.

Interpretation of results:

– if there is no agglutination in all drops – blood 0 (I) group;

– the presence of agglutination with anti-A coliclones and the absence with anti-B coliclones – blood A (II) group, because its erythrocytes have only antigen A;

– the presence of agglutination with coliclones anti-B and the absence with anti-A coliclones – blood B (III) group;

– the presence of agglutination with coliclones anti-A and anti-B – blood belongs to AB (IV) group, red blood cells contain both antigens A and B.

Tested blood group	Coliclones	
	Anti-B	Anti-A
0 (I)	–	–
A (II)	–	+
B (III)	+	–
AB (IV)	+	+

(–) – absence of agglutination , (+) – presence of agglutination

Possible errors:

- high temperature (normally not more than 25 °C);
- use of wet pipettes, plates, contaminated sticks;
- use of insufficiently active agents (monitor the terms of use of the reagents, reagent storage conditions);

- low quality of reagents (monitor external look of reagents – transparency, films, flakes, rotting smell etc.);
- technical error (not followed instructions);
- features of examined blood;
- a narrow range of coliclones specificity and immaturity of antigenic determinant on the erythrocyte membrane of a newborn baby increases the number of false results in newborns.

Determination of a blood group with standard serum and standard erythrocytes (cross-reaction)

This method of determining blood groups gives full serological characterization of blood. The method is most often used in serological laboratories. The method consists of determining the presence or absence in the examined blood of antigens A and B using standard sera and group's antibodies using standard erythrocytes.

Required reagents:

- standard serum;
- standard erythrocytes of three blood groups 0 (I), A (II), B (III);
- 0.9 % sodium chloride solution.

Special equipment, materials:

- white plates or porcelain (enameled) plates;
- glass or plastic sticks;
- pipettes;
- protective gloves.

Technique of reactions:

1. Standard red blood cells prepared from the blood of donors with a blood group known in advance, stored at 4–8 °C. The term of their use is 2–3 days.

2. Blood samples taken from a vein in dry test tube, centrifuged or left for 20–30 minutes for separation of serum and red blood cells.

3. On a marked plate with a pipette put in each of six cells one big drop of serum from test tube (0.1 ml) and next to them –

one small drop (0.01 ml) standard erythrocytes of groups 0 (I), A (II), B (III) (two series).

4. Further measures are carried out using a method similar to the standard serum: corresponding drops mixed with a glass sticks, shaking a plate, watching for 5 min, add isotonic solution of sodium chloride to the drops of agglutination and then evaluate the results.

5. Reaction with standard sera is made as described above parallel to reaction with standard erythrocytes.



Figure 159 – Preparation for determination: a plate with blood, coliclones



Figure 160 – The ratio of blood and reagent should be 1:10

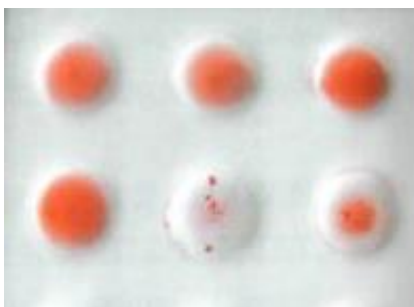


Figure 161 – Interpretation: agglutination in line 2 – 2nd, 3rd drop – B (III) Rh⁺, the first line – no agglutination, 0 (I) Rh⁻

Evaluation of the results:

1. In analyzing the results the data obtained during both reactions with standard sera and standard erythrocytes are evaluated.

2. Red blood cells of group 0 (I) are control in a reaction with standard erythrocytes.

3. Result of cross method considered reliable if the reactions with standard sera and with standard erythrocytes are the same. If they are not, both reactions should be re-made.

Note:

– At the clinical blood studies a doctor determines a blood group using standard serum or coliclones. After this the blood examples are sent to the laboratory for serological testing for the group with a cross method.

– If it is necessary to determine a blood group in an emergency in case of urgent blood transfusion, a doctor determines the group by himself, and confirming laboratory testing are carried post factum.

44. Exchange blood transfusion

Indications:

– acute development of hemolytic disease of the newborn (Rh-isoimmunization, AB0-conflict) with intensive jaundice and other clinical symptoms;

- the level of total bilirubin in cord blood > 80 $\mu\text{mol/l}$ in full term newborns;
- the concentration of total bilirubin in accordance with a range when it is necessary to carry out exchange blood transfusion (EBT) by nomograms according to №255 Order of Ministry of Health of Ukraine from 27.04.2006;
- if phototherapy fails for 4–6 hours, if the level of serum total bilirubin corresponds to the levels of exchange blood transfusion;
- if there is an hourly increase of bilirubin (while making phototherapy) such as:
 - incompatibility by ABO system > 7 $\mu\text{mol/l}$;
 - incompatibility by Rh-factor > 10 $\mu\text{mol/l}$.
- anemia on the first day (despite the level of bilirubin) with Hb < 100 g/l, Ht < 35%.
- ratio of total serum bilirubin levels ($\mu\text{mol/l}$) and albumin (g/l) if it was determined, depending on the weight of a child:

1250.0 g	6.8
1250.0–1499.0 g	8.8
1500.0–1999.0 g	10.2
2000.0–2500.0 g	11.6
> 2500.0 g	12.2

Exchange blood transfusion (EBT) – is acute detoxification method, which aims at removing bilirubin and its toxic metabolites, free Rh or ABO antibodies and hemolyzed red blood cells from the blood of newborn with hyperbilirubinemia.

Required equipment:

- the source of radiant heat (a couveuse or a table with heating);
- equipment for respiratory therapy and reanimation (oxygen, reanimation bag and adrenaline solution);

- monitors for control of the respiratory, cardiovascular system (pulse oximeter with a monitor to control blood pressure and heart activity);

- a nasogastric (orogastric) tube for evacuation of stomach contents before the EBT.

A set of tools:

- sterile syringes with the capacity of 10.0 ml and 20.0 ml (2–3);
- sterile syringes with the capacity of 5.0 ml – 2, 2.0 ml – 1;
- disposable system for blood transfusion – 1;
- tweezers – 2;
- umbilical catheters, for babies weighing less than 2000 g – 5F, and for babies weighing more than 2000 g – 8F;
- capitate probe;
- sterile scissors, needles, sterile silk;
- scalpel;
- 3 sterile glasses;
- 96 % spirits solution;
- 2 % iodine solution;
- 3 sterile test tubes for blood collection;
- sterile diapers;
- sterile cotton and bandage.
- water bath with controlled heating to warm the blood (up to 37 °C).
- thermometer.

The blood or plasma. In case of Rh-incompatibility we should use Rh-negative blood of the same blood group as the child's or Rh-negative erythrocytes of 0 (I) group in plasma of AB (IV) group.

In case of blood incompatibility according to ABO system the same as the child's Rh-factor packed erythrocytes of 0 (I) group in plasma AB (IV) are used.

When exchange blood transfusion is performed, the volume for a full-term newborn is 160–190 ml/kg (2 blood volumes).

In case of reconstituted blood transfusion calculation packed erythrocytes and plasma is made as follows:

$$\text{Amount of packed erythrocytes (ml)} = \frac{\text{General volume for EBT} \times 0.5 (\text{desirable Ht})}{0.7 (\text{Ht of packed erythrocytes})}$$

Amount of plasma = General volume for EBT – volume of packed erythrocytes

Technique:

1. Before the exchange blood transfusion a child's blood is transported immediately to the laboratory for re-determination of blood group and Rh-factor and carrying out tests for compatibility.

2. You should use only the blood prepared within the last 3 days. In exceptional cases, you can use blood, prepared 5 days ago.

3. Blood should be examined for the presence of pathogens of hepatitis B and C, HIV, syphilis, CMV.

4. The level of hematocrit of blood for transfusion should be 45–50 %.

5. The temperature of blood for transfusion should be 37 °C.

6. The child must be weighed.

In case of uncomplicated hyperbilirubinemia EBT is carried out with 2 volumes of blood circulation.

The child lies on his back, arms and legs should be firmly, but not tightly fixed. The contents of the stomach should be removed using the tube. Tube is left in the stomach for decompression, prevention of regurgitation and aspiration.

Wash hands, wear sterile gloves, make catheterization of umbilical vein. Operating field (umbilical cord stump and skin of the abdomen) is treated with 96 % solution of spirits and 2 % iodine solution. Restore the cut of umbilical cord stump, but so that it remains not less than 1.0–1.5 cm from the umbilical ring. Enter the filled with isotonic sodium chloride catheter in the vein to a depth equal to the distance from the xiphoid process to umbilical ring + 1.5–2.0 cm.

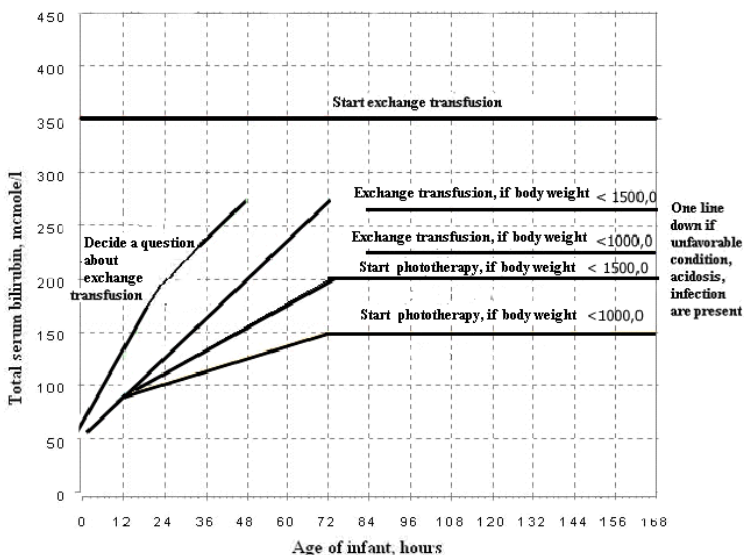


Figure 162 – Nomogram of exchange blood transfusion

The operation starts with the blood collection in an amount of 8–10 ml, then enter 10–12 ml of blood. Taking and input is done with the speed of 3–4 ml/min. to prevent the sudden increase or decrease of the pressure in the bloodstream. After each blood collection the syringe is rinsed with isotonic sodium chloride solution and sodium citrate. After each 100 ml of blood transfusion enter 2.0 ml of 10% solution of calcium gluconate. Last 10 ml of the derived blood should be used for laboratory investigations to determine the levels of hemoglobin, red blood cells, bilirubin and fractions, blood glucose and protein fractions, enzymes, electrolytes. The operation lasts for at least 3 hours, usually – 100 ml/hour (10 ml output and entering 10 ml – 3 minutes, 10 ml of blood exchange – 6 minutes, replacing 100 ml of blood – 60 minutes or 1 hour). During the operation a child receives 40 % oxygen.

Complications:

- infection;

- vascular complications (embolism, thrombosis, spasm of the arteries of the lower limb, infarctions of vital organs);
- coagulopathy (blood clotting or thrombocytopenia due to deficiency in clotting factors);
- electrolytes metabolism disorder (hyperkalemia, hypocalcemia);
- metabolic acidosis;
- metabolic alkalosis (due to the slow utilization of citrate in liver);
- necrotizing enterocolitis.

Additional measures:

1. Before and after FBI it is necessary to take blood sampling to determine the levels of hemoglobin, hematocrit, bilirubin, platelets, leukocytes and leukocyte formula and electrolytes.
2. After EBT it is recommended to do blood cultures.
3. Make urinalysis after EBT.
4. After EBT it is advisable to start or continue phototherapy.
5. Monitoring of bilirubin is made after 2, 4, 6 hours after EBT and then every 6 hours.
6. If the child received antibacterial therapy, repeat the dose of antibiotics after EBT.
7. Monitor heart rate, saturation, blood pressure in children.
8. After EBT it is recommended to start the antibiotic therapy with an individual approach.
9. In case when children after EBT do not require infusion therapy, remove the catheter and apply pressing bandage to umbilical cord stump.

45. Phototherapy

Indications:

– jaundice that appeared in the first 24 hours of life (start phototherapy and make laboratory control of bilirubin levels in blood);

– the presence of “dangerous” jaundice. When symptoms of “dangerous” jaundice appear you should immediately initiate phototherapy, without waiting for the result of total bilirubin level in blood serum;

– total bilirubin levels that are within the range for phototherapy in nomogram according to gestational age and perinatal period.

Criteria of “dangerous” jaundice in newborns (WHO, 2003 ISBN 92 4154622 0)		
Age of the child (hours)	Localization of jaundice	Conclusion
24	Any part of the body	“Dangerous” jaundice
24–48	Limbs	
> 48	Feet, wrists	

Contraindications:

Direct bilirubin level is 20 % of the total bilirubin or above.

Relative contraindications for phototherapy:

- acute renal failure;
- severe heart failure;
- birth trauma with convulsions.

Phototherapy – is a treatment of hyperbilirubinemia based on photooxidation of indirect bilirubin with forming biliverdin, dipirols and configuration of its molecules, forming non-toxic and water-soluble isomers that are excreted with urine and feces and do not require the process of conjugation.

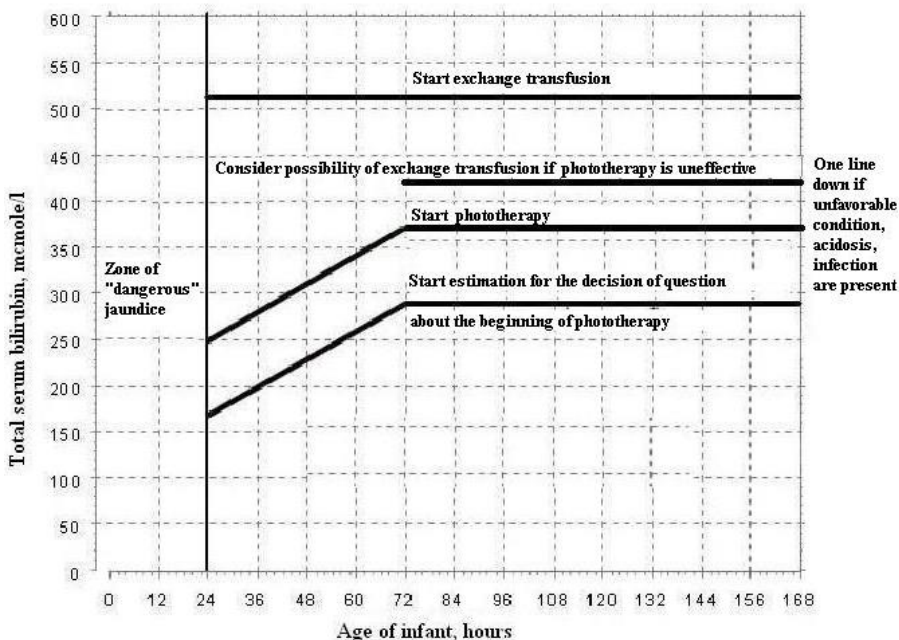


Figure 163 – Indications to phototherapy depending on the level of total bilirubin in the blood serum

Methods of phototherapy in a newborn:

1. In case of satisfactory clinical condition of a child the phototherapy should be made under joint stay of a mother and a child.

2. There are the following methods of phototherapy:

- classic phototherapy using battery lamps;
- fiber-optic phototherapy using diapers or mattress;
- the using of LED lamps for phototherapy;
- “intensive” phototherapy using multiple light sources;
- “spotted” phototherapy using halogen light sources.

High-brightness LEDs are the most secure type of radiation as they completely exclude the ultraviolet and infrared part of the spectrum, reducing the risk of burns, erythema and

intangible loss of fluid.



Figure 164 – Intensive phototherapy using two lamps



Figure 165 – Phototherapy with LED lamp in couveuse



Figure 166 – Protection of the child's eyes during phototherapy



Figure 167 – Phototherapy of the child in open reanimation system

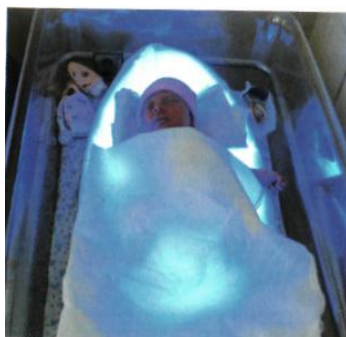


Figure 168 – Phototherapy in bed-mattress. Baby in diaper, and covered above

3. Practical aspects of phototherapy:

- lamps for phototherapy are installed close to a child (according to the manufacture's instructions);
- the child must be completely naked. Do not cover the boys' scrotum with lightproof bandage;
- during the phototherapy protect the child's eyes with glasses or a light-impermeable bandage;
- when using a single light source it is advisable to change the position of the child's body (preferably after each feeding) to irradiate maximal surface of a newborn's body;
- to obtain the effect from the phototherapy, it should be made continuously except the periods of feeding, child's care and manipulations;
- in case of severe hyperbilirubinemia an intensive phototherapy is advisable using at least two light sources: lamp for phototherapy and a photo mattress;
- to increase the intensity of irradiation close the sidewalls of crib or incubator with foil or white cloth;
- if during the phototherapy a child is not getting enough breast milk, it is advisable to make additional feeding with expressed breast milk;
- considering that during phototherapy the intangible fluid loss increases, it is advisable to increase the volume of liquid in

case of parenteral nutrition for 5–10 % of the daily requirement or to 0.5–1.0 ml/kg/h;

– during the phototherapy you should continue the treatment of basic or concomitant diseases.

Monitoring during the phototherapy:

– evaluation of the clinical condition of a newborn with jaundice should be made at least 3 times a day;

– the colour of skin does not reproduce the existing level of hyperbilirubinemia during phototherapy and 24 hours after its termination;

– it is recommended to maintain the body temperature of the child within 36.5–37.5 °C and implement its controls every three hours;

– monitor the child's weight at least 1 time per day;

– breastfeeding continues on demand without night breaks at least 8–12 times a day;

– phototherapy must be accompanied with the decrease of serum total bilirubin by 20–35 $\mu\text{mol/l}$ or decrease intensity of its growth below the level requiring exchange transfusion within 4–6 hours from the start of phototherapy. Otherwise, consider the inefficiency of phototherapy and go to intensive phototherapy or exchange blood transfusion.

Complications and side effects of phototherapy:

– the increased compared with conventional, intangible fluid loss;

– the tendency to thrombocytopenia;

– reducing of the growth rate at the time of phototherapy;

– syndrome of “bronze child”. It occurs in children with high level of bilirubindiglucuronid and liver damage. The skin gets normal colour within a few weeks;

– the frequency of persisting fetal circulation of blood may increase in preterm newborns with extremely low birth weight;

– diarrhea that has green colour, not required treatment;

– transient skin rash, slight lethargy. Therapy is not needed;

- increasing of the body temperature.



Figure 169 – During the phototherapy a child has to be naked to enlarge the area of influence of the rays

Mistakes:

- carrying out unnecessary interruptions (pauses) in phototherapy;
- absence of the protection of the child's eyes, changing the distance between the lamp and the child, failure to follow manufacturer's instructions of the device, etc.;
- absence of the covering of a couveuse from scattering of rays during phototherapy;
- untimely appointment of phototherapy or change of the treatment tactics of jaundice;
- cancel of breastfeeding only due to the jaundice, routine infusion of solutions and full parenteral nutrition.

46. Calculation and interpretation of erythrocyte indices

Indications:

All newborns which require blood investigations.

Contraindications: The absence of indications.

Required equipment:

- clean disposable gloves for each patient;
- sterile disposable scarifiers;
- equipment for collecting and transporting of blood (test tubes, capillaries, monovette, microvette, vacutainer);

– modern hematological analyzer which allows large spectrum of research in small amount of blood (0.2–0.5 ml).

The clinical interpretation of key indicators of red blood in newborns is obtained by hematological analyzer.

MCV (mean corpuscular volume) – is the average volume of red blood cells. Determined in cubic micrometers: $1 \text{ mcm}^3 = 1 \text{ femtoliter (fl)} = 10^{-15} \text{ l}$.

This index is obtained by hematology analyzer or calculated according the formula:

$$\text{MCV} = (\text{Ht} \cdot 10) : \text{RBC}$$

Example: Ht = 34 %; RBC = $3.3 \cdot 10^{12}/\text{l}$;
MCV = $(34 \cdot 10) : 3.3 = 340 : 3.3 = 103 \text{ fl}$

In a newborn the level of MCV less than 94 fl is considered as microcytosis.

Focusing on the MCV indicator, there are three groups of anemia by morphological characteristics:

– microcytic anemia, characterized by the presence of small in size red blood cells (MCV less than 80 fl). This group includes iron deficiency, anemia, hyperthyroidism, anemia associated with blood loss and others;

– normocytic anemia characterized by the presence of normal in size red blood cells (MCV in the normal range). It is observed in case of chronic renal failure, chronic iron deficiency anemia, and secondary anemia in case of somatic disease;

– macrocytic anemia characterized by the presence of large in size red blood cells (MCV over 95 fl). This type is occurred due to isolated or combined deficiency of vitamin B₁₂ and folic acid (megaloblastic anemia).

MCH (mean corpuscular hemoglobin) – is an average content of hemoglobin in one erythrocyte. Determined in picograms, 1 picogram (pg) = 10^{-12} g .

This index is obtained by hematology analyzer or calculated according to the formula:

$$\text{MCH} = \text{Hb (g/l)} : \text{RBC (} 10^{12}/\text{l)}$$

Example: Hb = 125 g/l; RBC = $3.6 \cdot 10^{12}/\text{l}$;
MCH = $125 : 3.6 = 34.7$ pg

Reducing MCH below 30 pg is considered in infants as hypochromia of red blood cells and along with their transformation to microcytes helps to suspect iron deficiency anemia.

MCHC (mean corpuscular hemoglobin concentration) shows the average concentration of Hb in a given volume of red blood cells and is defined as a percentage (%).

This index is obtained by hematology analyzer or calculated by the formula:

$$\text{MCHC} = (\text{Hb (g/dl)} : \text{Ht} \cdot 100$$

Example: Hb = 12.5 g/dl; Ht = 33 %;
MCHC $(12.5 : 33) \cdot 100 = 37.9$ %.

The increase of MCHC indicates the presence of spherocytes (hereditary microspherocytosis, Rh- and ABO-conflict and disseminated intravascular coagulation syndrom).

RDW (index of anisocytosis) – reflects distribution of red blood cells by size (%). Its normal range is 11.6–15 %.

Using key red blood cell indices allows you to differentiate anemia:

– hemolytic: normal values of MCH, MCV in combination with low Hb, RBC;

– macrocytic: high values of MCH, MCV in combination with low Hb, RBC;

– iron deficiency: low values of MCV, MCH, and Hb, but normal values of RBC.

Laboratory tests for verification of anemia:

1. Before the drug administration:

Complete blood count of the number of erythrocytes, reticulocytes, platelets, hemoglobin level, hematocrit.

2. During treatment:

Complete blood count of the number of reticulocytes, platelets, hemoglobin level, hematocrit – once in 1–2 weeks.

3. After the termination of EPO entering:

Complete blood count of the number of erythrocytes, reticulocytes, platelets, hemoglobin level, hematocrit and (preferably) the concentration of iron and ferritin in serum.

4. Apt test (Apt-Downey test) for the presence of fetal hemoglobin:

The Apt test can be used if the newborn has bloody vomiting or active bleeding from the nasogastric tube. It is necessary for differentiation of the child's own blood from the maternal blood, which was swallowed. **Fetal** hemoglobin is relatively resistant to denaturation with alkali, compared to adult hemoglobin.

Methodics:

Child gastric contents is mixed with water at a ratio of 1:1. The mixture, which should be pink, is centrifuged to collect supernatant. Add 1 ml of 1 % NaOH to 5 ml of the liquid. If liquid contains HbA, colour changes to yellow-brown in the first 2 minutes that indicates the presence of maternal blood. If the fluid is still pink for more than 2 minutes, it indicates the presence of the child's blood (HbF).

5. Coombs test:

The direct Coombs test is used for differential diagnosis of hemolytic anemia of immune and non-immune origin (positive when there is isoimmune and autoimmune hemolysis). The direct Coombs test is used to detect antibodies or complement components that are fixed on the surface of red blood cells. It reveals the incomplete (non agglutinating) IgG class antibodies on the surface of red blood cells using antiglobulin serum (used

polyclonal, monoclonal variations and serum against factors of complement).

During the direct Coombs test red blood cells of a newborn are studied. This survey is aimed at identifying antibodies that have appeared in the body due to isosensibilization and fixed on blood cells. The molecule of antiglobulin connects molecules of incomplete agglutinins, fixed on two different red blood cells, resulting in agglutination.

Locating on red blood cells, they are unable to call direct and immediate agglutination and blocking effect and only adding of antiglobulin serum binds red blood cells to agglutinates.

The methodology: the red blood cells of a newborn pre-washed from its own plasma, serum is added to the sample Coombs. If red blood cells are sensitized in vivo, their agglutination occurs.

Evaluation of the results: no agglutination the test is negative, if present the agglutination test is positive and indicates the sensitization of erythrocytes.

The indirect Coombs test is used only to identify the parent antibodies, which are in a free state in blood serum and provides the information about the state of sensitization of a mother (in case of hemolytic disease of the newborn), or made as a test for compatibility during blood transfusions when it is necessary to estimate the impact of serum of a recipient on donor's red blood cells.

The methodology: the test is made in two stages – preliminary sensitization of red blood cells in vitro and then the actual reaction with serum samples for Coombs test.

Evaluation of the results: the positive indirect Coombs test indicates the presence of incomplete antibodies in the serum of a mother, when there is evidence of hemolysis in children.

A question of specificity of these antibodies is established by comparing the results of direct Coombs test; the antibody activity is determined by titration.

47. Gastric lavage

Indications:

- gastric stasis with pathological impurities (bile, meconium, old blood);
- repeated episodes of vomiting;
- erroneous entry of medicines, large volume of meals into the stomach.

Contraindications:

- the presence of bleeding from the stomach, fresh blood;
- diaphragmatic hernia, gastroschisis, omphalocele, etc., when increasing the pressure and volume of the stomach can worsen the general condition of the child.

The presence of old blood/hemorrhagic content (if the indication that it is maternal blood is absent) requires individual approach to the evaluation of possible risk and expected benefits of the procedure. In case of esophageal/gastric bleeding during washing you can remove the clot and restore/trigger massive bleeding, on the other hand, the cautious entering of saline solution in the volume of the stomach with further passive leakage of gastric contents through the open tube can help set the massive bleeding.

Required equipment:

- sterile disposable stomach tubes № 6–10 Fr;
- sterile 0.9 % solution of NaCl, with temperature 25–30 °C;
- sterile syringe 20 ml;
- the reservoir for draining washing masses;
- pulse oximeter, stethoscope for evaluation of the child's condition during the procedure.

Preparation of a child:

1. In warm conditions on a flat horizontal surface, on the right side or on the back.
2. Physiological pain treatment by fixing with the diaper or mother's hands.

3. Connect the pulse oximeter for monitoring the condition of the child during the procedure.

4. Technique:

1. Wash hands, wear gloves.

2. Set a sterile tube or check the depth of the tube if it has been set earlier. For this with the same clean tube, without removing it from the sterile package, measure the distance from the nose to the ear lobe plus from the ear lobe to the xiphoid process, check the mark and compare to the mark near the lip on the outer end of the fixed tube.

3. Check the depth of the newly or previously set tube is also possible with auscultation entering the air through a tube with 0.5–1 ml sterile syringe, while auscultate noises above the stomach.

4. Connect the tube to an empty sterile syringe and easily remove gastric contents by pulling the plunger and disconnect the syringe.

5. Connect the tube to the sterile syringe funnel (without plunger) with the desired amount of saline solution that meets the physiological stomach volume depending on the weight, age and gestational age of the child (5–20 ml). You should lift syringe above, wait till the liquid starts to pass free into the stomach and empty the syringe.

6. If moving of the fluid is absent, you can carefully connect the syringe plunger. Easily pushing the plunger enter the liquid slowly to the stomach and then pinch a probe with fingers and remove the plunger, lifting syringe above. After complete emptying of a syringe (input of full fluid volume, which corresponds to the volume of the stomach) lower the syringe below the stomach of the child.

7. If there is no knowledge of working with the funnel without a plunger, after a slow emptying of a syringe disconnect it and place the tube below the stomach of the child. This method has more complications due to possible hyperextension, injury of

stomach and difficulties in determination whether all the liquid has left the stomach.

8. To enable the fluid drain slowly from the stomach to the syringe-funnel or reservoir, if the syringe is disconnected. This is a physiological way of emptying the stomach, it does not injure the mucosa, does not provoke reflux.

9. After leakage of liquid, the amount of which is equal to the entered one the liquid from a syringe-funnel, is poured into the reservoir, fill the syringe with a new portion of saline solution. It is desirable that the liquid flows to the stomach itself, without forcing the plunger.

10. Repeat the procedure till clean washing water, considering the condition of the child.

11. If during some time the return of the fluid from the stomach is absent and observations show that the stomach still has plenty of fluid, carefully connect the plunger to the syringe or other syringe with the plunger and remove the gastric contents, slowly pulling the plunger for preventing injury of the gastric mucosa.

12. The tube set for gastric lavage may be removed after the procedure, if it is not necessary to control stasis.

Complications:

– apnea and bradycardia (control the condition of the child);

– regurgitation followed with aspiration due to hyperextension of the stomach and stimulation of the vomiting centre;

– irritation of the esophagus, the posterior wall of the pharynx, stomach, pain sensation in a child;

– injury of mucosa and cardia, perforation of the esophagus, stomach or duodenum;

– infection.

Mistakes:

– routine gastric lavage in case of meconial waters;

– aggressive fluid insertion or extraction with creation of high pressure by a plunger, the use of large (not physiological) volumes.

48. Methodics of cleansing enema in newborns

Indications:

– cleaning the intestine from the intestinal contents if self-emptying is absent and the symptoms of worsening general condition of the child (bloating, regurgitation, vomiting, and intoxication) are present;

– delayed discharge of meconium in the first 24–36 hours of life;

– cleaning the colon in case of rectal administration of medications.

An alternative to cleansing enema at a delay of intestinal contents can also be rectal administration $\frac{1}{2}$ – $\frac{1}{4}$ of glycerol candles.

Contraindications:

– suspected “acute abdomen”;

– bleeding from the intestine;

– prolapsus of rectal mucosa;

– necrotizing enterocolitis of III–IV degree.

Required equipment:

– clean warm surface (table) under radiant heat source (possible in couveuse through the window);

– disposable absorbing diapers on the waterproof basis or several layers on the oilcloth;

– disposable clean rubber or plastic gloves;

– individual disposable rubber balloon or sterile disposable tube-catheter with a sterile syringe of 20 ml;

– vaseline oil or vegetable oil;

– sterile saline (0.9 % NaCl) or distilled water (depending on the patient’s condition) with a temperature of 26–32 °C.

Preparation of the patient:

A newborn baby lies on the left side, bending at the hips or position on the back with raised bent legs. Ensure adequate temperature. Physiological anesthesia ask the mother to cover a trunk of a child with one hand and to hold legs with another, talk with a child gently and quietly, after the procedure, soothe it in the arms or feed.

Methodics:

1. Clean the hands, wear clean disposable rubber/plastic gloves.

2. Take into a syringe 25–30 ml of fluid that has the temperature of 26–32 °C. Connect the syringe to the catheter to fill it with liquid.

3. The tip of a catheter before entering is lubricated with liquid grease/vegetable oil (using a sterile swab or pouring a little of oil in a separate container, do not immerse the tip to the bottle that is planned to use). Evacuating air, gently enter the tip of the tube into the anus without added effort:

– the container is first sent ahead, and then, after passing external and internal anal sphincters, slightly back, entering the end of the container to the depth of 3–5 cm. Then slowly clench the container and take it out holding the buttocks of the child with one hand, so that the liquid would not come out ahead of time;

– when entering the catheter be careful that the tube doesn't curl vials and passes by the sphincters, then enter slowly the liquid and let it flow out slowly, then entering may be repeated. For one entry for a newborn use 15–25 ml of fluid, for the whole procedure – 80–160 ml of fluid (in case of appropriate leakage).

It is necessary to control the volume of entered and flowed out fluid! After the procedure the tube is left for 5–10 minutes at the level of surface, where the child lies, for leaking of fluids and final discharge of gases. Avoid hypothermia!

Note: peristalsis is increased due to mechanical irritation of the bowel by water and temperature, so in case of atonic

constipation enter the liquid with a lower temperature and in spastic – with higher. You can add glycerin or vegetable oil to the liquid to increase peristalsis (1–2 g per 25–50 ml).

Nowadays the number of indications for cleansing enema is reduced. In order to accelerate peristalsis lactulose can be used. Problems with excessive flatus in the intestine that causes colic in children are common. Help in solving them can be done not only with cleansing enema or gas discharging tube but also with preparations – “defoamers” as dimethicone, simethicone. Dimethicone reduces the surface tension of gas bubbles in the intestine, which helps to reduce intracolonic pressure and remove gas.

Complications:

- perforation of the intestine, trauma of the mucosa and underlying tissues;
- irritation of the intestines;
- “water intoxication” after using warm water;
- hypothermia of a child caused by air or liquid.

Mistakes:

- neglecting contraindications – making procedure in case of suspected “acute abdomen”, intestinal bleeding, symptoms of necrotizing enterocolitis of III–IV degree;
- active removal of intestine content with the plunger into the syringe;
- too large entered fluid volume, the lack of control of its leaking;
- use of cold or hot water;
- using force for entering the catheter/container (pear).

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Навчальний посібник
(Англійською мовою)

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