MINISTRY OF PUBLIC HEALTH OF UKRAINE
O.O. BOHOMOLETS NATIONAL MEDICAL UNIVERSITY

"Approved"
at the methodical meeting
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GUIDELINES

For Independent students work

Academic discipline	**Pediatrics with children's infectious diseases**
Module 1	**Pediatrics**
Semantic module 1.	Differential diagnosis of the most common diseases of the respiratory system in children. Emergency care.
Topic 4	**Methods of respiratory support of children** (CPAP, oxygen therapy).
Course	6
Faculty	Medical

Kyiv 2024

1. Specific goals:

- To determine the etiological and pathogenic factors of a respiratory disorders syndrome, respiratory failure in newborns and children of different age.
- Classify and analyze the typical clinical picture of a respiratory disorders syndrome of newborns, respiratory failure.
- Diagnose and provide emergency care in case of respiratory failure.
- To carry out differential diagnosis of a respiratory disorder's syndrome of newborns and other diseases that are followed by respiratory failure.
- To determine the methods of respiratory support in children.
- Have the technique of oxygen therapy.
- Be able to provide emergency care to children with respiratory failure in case of coronavirus infection.
- To make a prognosis for life in respiratory disorders syndrome of newborns, respiratory failure in children.
- Demonstrate mastery of moral and deontological principles of a medical specialist and the principles of professional subordination in pediatrics.

2. Basic level of training:

Previous disciplines	Acquired skills
Normal anatomy	Knowledge of the anatomical features of the respiratory tract: a) the nasal part of the pharynx; b) larynx, trachea, bronchi; c) the structure of the chest, the type of breathing; d) the structure of lung tissue, pleura
Normal physiology	Knowledge of the physiological peculiarities of the respiratory system: a) an effect 0f regulation in the respiratory center and the cerebral cortex; b) drainage function of the bronchial tree; c) gas exchange process in the lungs
Biology and genetics	The importance of genetic factors for the growth and development of the child
Basics of child care	Carrying of the respiratory system organs in a healthy and sick child
Histology	Knowledge of the histological structure of the respiratory tract
Propaedeutic of therapy	Knowledge of appropriate methods
Propaedeutic of pediatrics	Knowledge of anatomical and physiological features of the respiratory system in newborns and children of different age, semiotics of diseases of the respiratory system in children
Pediatrics	Pathogenesis and clinical signs of respiratory failure, principles of treatment of respiratory failure in children
Obstetrics	Features of premature birth, prevention of respiratory distress syndrome
Children's infectious diseases	Airborne infections

Abbreviation

FiO_2	the fraction of inspired oxygen
SpO_2	blood oxygen saturation
PaO_2	partial pressure of oxygen in blood
$PaCO_2$	partial pressure of carbon dioxide in blood
PCO_2	partial pressure of carbon dioxide in exhaled air
V_T	volume of gas that moves in and out of the lungs in one breath

T_I	duration of inhalation
T_E	duration of exhalation
PIP	peak inspiratory pressure
NIV	non-invasive ventilation
PEEP	positive end-expiratory pressure
SBCH	self-breathing with constant hypertension in the airways
CPAP	continuous positive airway pressure

3. Organization of educational material content.

Relevance of the topic. Respiratory pathology occupies a prominent place in the structure of morbidity and mortality of children. Acute respiratory diseases (ARD) such as acute laryngotracheobronchitis (LTB), COVID-19 infection, obstructive bronchitis, pneumonia, bronchial asthma and hereditary or acquired chronic bronchopulmonary diseases are mainly severe due to developing of respiratory failure syndrome. Nowadays, huge importance is attached to the peculiarities of COVID-19 in children, methods of diagnosis and emergency care in case of respiratory failure (RF). Therefore, knowledge of the causes and mechanisms of RF in children, methods of respiratory support and the ability to use methods for diagnostics of RF and algorithms of oxygen therapy in primary care for children are needed by pediatricians and family doctors.

Content of educational material

Respiratory support - is a mechanical method or set of methods designed to partially or completely replace external respiration to achieve the desired levels of alveolar ventilation, gas exchange process and ventilation-perfusion balance in the lungs.

Respiratory therapy includes oxygen therapy, non-invasive ventilation (NIV) and mechanical ventilation (MV).

Acute respiratory failure (ARF) - is a pathological condition when the normal gas composition of the blood is not maintained, or it is achieved because of external respiratory system and heart more intensive work.

Various pathological conditions and diseases may lead to ARF. Among newborns, ARF mainly occurs in premature infants and children with congenital heart and lung defects. In children aged 1-2 years, the most common causes of ARF are respiratory infections and heart disease, and in children 7-12 years - bronchial asthma.

Factors contributing to developing of ARF are anatomical - physiological features of the respiratory organs in children (expiratory structure of the chest, low absolute values of tidal volume, physiological tachypnea, narrow airways, weakness of the respiratory muscles, less surfactant activity).

There are three pathogenic stages development of ARF:

I stage (compensated) - gas exchange disorders are absent due to compensatory increase of breathing and blood circulation. SpO2 90-94% (PaO2 - 60-79 mm Hg).

II stage (subcompensated) – appearance of clinical and laboratory signs of sub compensation in the form of symptoms of hypocapnia and hypoxia: shortness of breath, prolonged inhalation or exhalation with a change in the ratio between them, tachycardia, hypertension, pale skin. SaO2 89-75% (PaO2 - 40-59 mm Hg).

III stage (decompensated) - mixed of metabolic and respiratory acidosis, neurological disorders because of cerebral edema, cardiovascular failure. Clinical signs include bradyarrhythmia, pathological types of breathing, and signs of damage to the respiratory center, cyanosis, sticky sweat, motor and mental anxiety of the child or inhibition. SaO2 <74% (PaO2 - <40 mm Hg).

There are three types of ARF: hypoxemic, hypercapnic and mixed.

Hypoxemic ARF (shunt-diffusion) is characterized by insufficient oxygenation of the blood with relatively adequate ventilation: there is low PaO2 in combination with normal or slightly reduced PaCO2. The main is a violation of alveolar-capillary perfusion with intrapulmonary blood shunting without changing alveolar ventilation. The alveolar-capillary oxygen gradient is increased. This is caused by intrapulmonary blood shunting because of filling or collapse of the air space (for

example pulmonary edema due to left ventricular failure, acute respiratory distress syndrome) or blood shunting from left to right into the heart.

Hypercapnic ARF (ventilation) is characterized by decreasing PaO2 with increasing PaCO2 because of primary hyperventilation, followed by a sharp decrease in ventilation and severe hypercapnia. The main mechanism is a violation of ventilation-perfusion relations with acute alveolar hypoventilation.

The most common causes of hypercapnic ARF are obstructive, restrictive and neuroregulatory disorders. Obstructive type of ventilation disorder is characterized by obstruction in the airways, which leads to impaired ventilation of the alveoli. Restrictive type of ventilation disorder is characterized by obstacles to stretching the lungs, which leads to a decrease in the gas exchange surface.

Mixed ARF is manifested by hyperventilation and increase of the alveolar-capillary gradient. Hypoxemia is less pronounced as in case of hypoxemic ARF.

Clinical signs of ARF depends on its cause and the impact of violations of the gas composition in the blood to the target organs. There are no specific symptoms of ARF.

Common symptoms include weakness, sweating; symptoms of the respiratory system include tachypnea or bradypnea, weakening or absence of respiratory noises, cyanosis, paradoxical breathing, swelling of the wings of the nose, "creaking" exhalations, wheezing. Cardiovascular signs include tachy- or bradycardia, hyper- or hypotension, arrhythmia, paradoxical pulse, cardiac arrest. Injury of the central nervous system (CNS) may be accompanied by swelling of the optic disc, encephalopathy, tremor, coma.

The main criteria for the diagnosis of ARF in children:

I. Clinical: tachypnea or bradypnea, apnea; paradoxical pulse; reduction or absence of respiratory noise; stridor, wheezing, severe retraction of the chest compliant areas and participation of the accessory respiratory muscles in the breathing; cyanosis when breathing a mixture containing 40% oxygen (exclude congenital heart disease); disturbance of consciousness of various degree.

II. Laboratory-instrumental: PaO2 <60 mm Hg. when breathing a mixture containing 60% oxygen (exclude congenital heart disease); PaCO2> 60 mm Hg; pH <7.3; vital capacity (VC) <15 ml/kg; maximum inspiratory pressure <25 cm of wat. art.

ARF can cause by respiratory tract obstruction because of congenital and acquired lung diseases and injuries. Congenital one include ligament stenosis, membrane, cyst, laryngocele, tumor, laryngomalacia, laryngotracheoesophageal membrane, tracheomalacia, tracheoesophageal fistula; external compression and damage: vascular ring, cystohygroma; birth trauma; neurological disorders; anomalies of the craniofacial region; hypocalcemia.

Following acquired disease, injuries and infections which can provoke ARF include stenotic laryngotracheitis, epiglottitis, pharyngeal abscess, Ludwig's angina, fungal infection, paratonsillar abscess, diphtheria, bacterial tracheitis; postintubation edema, posttracheostomy stenosis; respiratory burns (thermal or chemical); aspiration of foreign bodies; systemic disorders; tumors; neurological injuries; chronic upper respiratory obstruction; hypertrophic tonsillitis and adenoiditis.

The most often reasons of lower airway obstruction are bronchial asthma, acute or chronic obstructive bronchitis, bronchiolitis, heart failure, pneumonia, tracheobronchial tree tumors, poisoning of organophosphorus compounds.

General principles of treatment of acute airway obstruction in children have aims to restore patency of the upper respiratory tract, elimination of bronchial obstruction, correction of metabolic disorders, antibacterial therapy, if it’s necessary - tracheal intubation and mechanical ventilation.

The most common cause of high airway obstruction in children is acute stenotic laryngotracheobronchitis (LTB, false croup). LTB mainly affects children aged 6 months to 6 years, more often from 6 to 36 months.

LTB is an urgent condition that requires emergency treatment at the prehospital stage (fresh air, emotional calm, suppository of prednisolone per rectum). The effectiveness of antihistamines, bronchodilators and antispasmolitics has not been proven. Glucocorticoids (inhalation of budesonide, i/v of dexamethasone), epinephrine (inhalation), endotracheal intubation are justified as emergency care in case of LTB.

Treatment of ARF include elimination the reason of it. In case of decreasing SpO2 <90% should be provided oxygen therapy.

With the appearance signs of ARF in children, namely:

1). Difficulty breathing;

2). Respiration rate more than age norm (respiratory rate in a child aged 2 months - more than 60/min, 2-11 months - more than 50/min, 1-5 years - more than 40/min, 6 years and older - more than 30/min);

3). SpO2 less than 90% on self-breathing;

4). Central cyanosis, it is necessary to begin oxygen therapy.

Oxygen therapy should be start with oxygen flow rate of 5 l/min and the rate adjusted to SpO2 ≥ 92-95%.

Children with emergency signs of life threatening (difficult or absent breathing, acute respiratory distress syndrome, convulsions, shock, coma) should receive oxygen therapy during resuscitation until the level of SpO2 ≥ 94%, otherwise the target level of SpO2 is ≥ 90%.

It is necessary to use the supply of oxygen through a nasal catheter, mask or face mask with a reservoir bag (flow rate 10-15 l/min, which is usually the minimum flow required to maintain inflation of the bag; FiO2 0.60-0.95).

It is important to recommend for children with severe ARF to ventilate the lungs in a supine position for more than 12 hours a day. But it's safe implementation is possible only with the necessary human resources and experience.

If there is a need for mechanical ventilation may be used the supply of oxygen through the nose with high flow and non-invasive ventilation (). Patients receiving HIV therapy have a high risk of treatment failure. NIV systems can supply 60 l/min of gas flow and Fi O2 up to 1.0. Pediatric regimens usually only work up to 15 l/min and sometimes children need an adult circuit to ensure adequate flow. Compared with standard oxygen therapy, NIV reduces the need for intubation.

Pulse oximetry or peripheral oxygen saturation (SpO2) - determination of the saturation of hemoglobin with blood oxygen. The method of pulse oximetry is based on the spectrometric method-estimating amount of hemoglobin in the blood: indicators of oxygenated and deoxygenated hemoglobin, taking into account the absorption of the red and infrared spectra. Arterial blood saturation rate with oxygen in percent (%): the ratio of oxygenated and deoxygenated hemoglobin. Pulse oximetry is use to determine peripheral blood oxygen saturation (SpO2).

Blood oxygen saturation assess without oxygen partial pressure. Normal oxygen saturation of arterial blood is 95% and above, except for patients with cyanotic congenital heart defects. Although pulse oximetry does not determine PaO2, it provides the most important information about blood oxygen saturation in real time and allows you quickly assess the oxygenation in a critical condition of the child. In addition, pulse oximetry does not directly determine the pressure of CO2, acid-base or bicarbonate.

Pulse oximetry may be use in case of heart or respiratory failure, asthma attacks, asthmatic status, pneumonia.

Indications for pulse oximetry:

- In emergencies, in intensive care units, during anesthesia;
- Newborns in the intensive care unit;
- With signs of respiratory or heart failure, asthmatic status;
- In shock;
- Diagnosis of obstructive sleep apnea syndrome.

Pulse oximetry has no contraindications.

PULSE OXIMETRY IN CHILDREN

Pulse oximetry is a simple, sensitive, non-invasive method of monitoring the oxygenation of patients in the supine position.

Using a pulse oximeter determine two parameters: the first - oxygen saturation of hemoglobin in the blood; the second indicator is the pulse rate for 1 minute.

Three types of pediatric pulse oximeters are used: for toes or hands and depending of age: for newborns, for infants and older children. Wrist pulse oximeters are most often used.

Technique of pulse oxymetry

1. Equipment: pulse oximeter.

2. Turn on the pulse oximeter. Select the appropriate sensor with special attention to the correct size and place of fixation.

3. Carrying out pulse oximetry:

№	Sequence	
1	Install the pulse oximeter sensor on any hand, on any finger - usually the index finger. If fingers too little, then install the sensor on the thumb; if large - on the little finger	To optimize work
2	Make sure that the pulse oximeter display on the sensor is located above the nail plate	To optimize work
3	At the beginning of the measurement, the display visualizes the risks. After 20 seconds, the percentage of blood oxygen saturation and heart rate should appear	Registration of indicators
4	During the measurement the hand of patient should be relaxed	To optimize work
5	If there is no indicator on the display after 20 seconds, it is advisable to check the quality of the sensor attachment or install it on the other finger	To optimize work

4. Completion of the measurement.

Remove the pulse oximeter sensor from the patient's finger. Treat the contact surface of the appliance with alcohol.

Audible pulse oximeter alarms indicate a low saturation rate (hypoxia) - SpO2 <90%, no pulse, low heart rate, tachycardia.

Interpretation of indicators.

Normal saturation of arterial blood with oxygen SpO2 - 95% -100%.

If the saturation rate is below 94%, then the patient has hypoxia and needs emergency care.

Saturation <90% is a critical condition and requires emergency medical care, including respiratory support.

Respiratory support in children

Oxygen therapy - the appointment of oxygen in higher concentrations than in the surrounding air, in order to treat or prevent the symptoms and manifestations of hypoxia. The aim of oxygen therapy is to achieve adequate oxygenation of body tissues without manifestations of oxygen toxicity.

Use:

1. Oxygen therapy at normal atmospheric pressure
2. Oxygen therapy with constant positive hypertension in the airways

Oxygen therapy with normal atmospheric pressure

Inhalation resources:

1. Nasopharyngeal catheter or "mustache".
2. Face mask (nose-moth).
3. through the intubation tube.

Oxygen therapy is performed by humidified oxygen. The rate of oxygen flow during inhalation is 2-3 l/min.

During using nasal and nasopharyngeal catheters, they should be lubricated with glycerin to reduce irritation of the airway mucosa. The nasal catheter is inserted through the lower nasal passage to a distance equal to between the wing of the nose and the earlobe. The high location of the catheter leads to a decrease in oxygen tension in the air on the udder, and low - to aerophagia and distension of the stomach.

Optimal oxygen concentrations. In case of 80% concentration inhalation duration of it should be not more then 2-3 hours; in case of 60% - less than 6-10 hours. If it is necessary to provide longer oxygen therapy, you may use 30-40% oxygen concentration inhalation.

Self-breathing with constant hypertension in the airways

A constant high pressure create in the airways of the child (4-12 cm of water. art.). It helps to straighten microatelectasis, increase the functional capacity of the lungs, normalize the ventilation-blood flow ratio, reduce interstitial edema and exudation in the alveoli, increase surfactant, and reduce intrapulmonary ejection non-oxygenated blood in the arterial circulation.

Indications for self-breathing with constant hypertension (SBCH):

1. Viral pneumonia
2. Aspiration pneumonia.
3. Hemorrhagic syndrome.
4. Disease of hyaline membranes.
5. Bronchiolitis.

Contraindications to SBCH:

1. Pneumothorax.
2. Pneumomediastinum.
3. Peripheral vascular insufficiency with arterial hypotension.

Resources:

1. Intranasal cannulas.
2. Mask.
3. Frame with negative pressure around the baby's chest.

Prerequisite for SBCH is the presence of self-breathing and humidified oxygen.

Oxygen therapy in SBCH is carried out with 80-100% oxygen concentration.

Criteria for the effectiveness of respiratory support are the dynamics of clinical manifestations and the results of pulse oximetry.

Mechanical ventilation during cardiopulmonary resuscitation

After resumption of adequate tissue perfusion, the monitoring of hemoglobin oxygen saturation (SpO2) should exceed 94%.

With adequate tissue perfusion and oxygenation, the oxygen content in the inhalation mixture should be reduced to the required minimum, because hyperoxygenation, as well as hypoxia, has a negative effect on the child's body and can contribute to secondary damage to its tissues.

Respiratory support is performed by using a self-inflating Ambu mask and bag.

Ventilation bag Ambu allows you to achieve normal values of O and CO2, minimizing the risk of respiratory injuries.

First, choose the right Ambu bag (sufficient volume) and the correct size of the mask; the latter should completely cover the baby's mouth and nose, excluding the eyes and chin, be tightly attached to the soft tissues of the face.

The minimum volume of the self-inflating bag for cardiopulmonary resuscitation is 450-500 ml.

The Ambu bag is squeezed with a force that will provide sufficient breathing volume for adequate "inflation" and the appearance of chest excursions.

Respiratory support can be performed correctly using an Ambu bag using the "E-C girth" technique. The thumb and forefinger of the left hand take the shape of the letter "C" and are used to press the mask tightly to the face; the other three fingers of this hand, resembling the letter "E", must bring the jaw, pulling the lower jaw up into the mask.

To perform respiratory support with a mask, using the "technique of EC girth", you must:

- stand near the child's head;
- tilt your head back and place a flat pillow or pillow under the child's head or under the back;

- Assistant immobilizes the neck;
- apply a mask to the patient's face;
- remove the lower jaw with the last three fingers of your other hands;
- place these fingers at an angle to the lower jaw to bring it forward and up (three fingers form the letter "E");
- Removal of the jaw helps to remove the tongue from the back of the pharynx, preventing obstruction of the pharynx by the tongue;
- Place the thumb and forefinger in a "C" shape over the mask and press down.

Provide E-C girth with one hand and holding breathing bag by other hand if you are alone, it is advisable to follow the movements of the chest.

Algorithm and indications for respiratory support patients with COVID-19.

• Begin to supply oxygen through nasal cannulas, low flow, from 2 to 5 liters (depending on the patient's reaction). Nasal cannulas can increase the fraction of oxygen in the respiratory air from 25 to 40%, depending on the flow of oxygen.

• If this does not give the desired effect and the saturation remains <90 %, then you need to switch to a regular mask or a mask with a tank bag. It should be noted that if on an ordinary mask it is possible to reach an oxygen fraction of 40-60%, then with a tank the oxygen fraction in the respiratory mixture can be 60-80%.

• If the SpO2 level does not rise above 90%, then it is necessary to switch to CPAP.

• In the absence of the desired effect from the use of CPAP-helmet and nasal high-flow oxygen therapy (oxygen supply through nasal cannulas at speeds up to 60 l/min), as evidenced by saturation <85%, loss of consciousness, psychomotor agitation, excessive breathing - tachypnea more than 45 breaths/minute with involvement of auxiliary muscles of breath. With such a clinical picture, it is already necessary to intubate and transfer the patient to mechanical ventilation.

• In general, mechanical ventilation is used in extremely severe disease.

The vast majority of patients, who are unable to provide their body with normal levels of SpO2 through self-breathing, are CPAP therapy (CPAP devices or ventilators in CPAP mode).

This algorithm is prescribed in all editions of the protocol of the Ministry of Health № 762 "Provision of medical care for the treatment of coronavirus disease (COVID-19)".

Oxygen therapy in newborns

According to modern recommendations for the use of oxygen in newborns, it is advisable to prescribe it in the case (Haque A., Rizvi M., Arif F., 2016):

- Hypoxemia (paO2 <60 mm Hg, SpO2 <90%);
- Circulatory arrest, cardiopulmonary resuscitation;
- Severe anemia;
- Small cardiac output syndrome;
- Septic shock;
- Severe injury;
- Preoperative period, anesthesia.

Methods of oxygen supply - nasal cannulas, nasal catheter, oxygen tent, mask. **Algorithm for oxygen therapy:**

1) During the period of oxygen therapy, careful monitoring of vital functions of the newborn (respiratory rate, heart rate, SpO2, blood pressure and t° of the child's body) is required.

2) Do not prescribe oxygen unnecessarily!

3) Oxygen should be supplied only through an oxygen-air mixer in a warm (30º-35ºC) and humidified (60-70%) form.

4) Oxygen supply to start stabilization should start with 21-30% and gradually increase. Optimal oxygen concentrations -30-40%.

5) Further increase or decrease in the concentration of O2 is based on the pulse oximeter (SpO2).

6) Use a pulse oximeter to make sure that the child receives adequate oxygen concentration (SpO2 - 86-95%).

7) SpO2 during oxygen therapy should not exceed 95%. More oxygen saturation (> 95%) is toxic to the baby.

8) If SpO2 <86%, give the child a higher concentration of oxygen, then gradually increase the oxygen concentration until SpO2 is abnormal.

9) If the child has SpO2 <86%, even when breathing 70% oxygen for full-term, 50% for premature, it is advisable to switch to CPAP or mechanical ventilation according to the indications (target levels of mechanical ventilation - SpO2 90-95%, PaO2 50-70 mm Hg., PaCO2 40-60 mm Hg.).

10) The duration of oxygen therapy is not limited.

11) If there is no pulse oximeter, watch for the appearance of signs of oxygen saturation, the color of the skin (no cyanosis).

Continuous positive airway pressure (CPAP) - is a method of respiratory support, which creates a positive pressure in the airways during all phases of the respiratory cycle while maintaining spontaneous breathing of the patient.

This method helps to:

• straightening of burnt and unstable alveoli;

• increase lung pliability, decrease in right-left blood shunting;

• CPAP prevents surfactant deficiency;

• Mild respiratory distress syndrome (RDS) treatment is limited to CPAP therapy, without the introduction of surfactant;

• As earlier the CPAP begins, then more likely it is that mechanical ventilation will fail.

NIPPV – nasal intermittent positive pressure ventilation.

CPAP can be performed through:

• endotracheal tubes (during removal from mechanical ventilation)

• binasal cannulas (priority)

• nasal masks

Indications for the use of CPAP in newborns:

• signs of respiratory failure of any etiology: RDS of the newborn; hyaline membrane disease; pulmonary edema; transient nephropathy of newborns; multiple atelectasis; meconium aspiration syndrome; pneumonia;

• Frequent apnea in newborns;

• Early period after extubation;

• Tracheomalacia;

• All newborns with a gestational age of less than 30 weeks, if they have independent breathing;

• Score on the Downs scale - more than 3 points;

• Air force with left-right shunt and increased pulmonary blood flow, atrial and interventricular septal defect;

• Patent ductus arteriosus (prevents collapse of alveoli, reduces shunt and pulmonary edema, due to increased oxygenation stimulates duct closure);

• Omphalocele and gastroschisis (increased lung volume and significantly increased PaO2 without visible changes in PaCO2 and pH);

• In the absence of self-breathing in a premature baby, it is recommended to perform mechanical ventilation with a mask and Ambu bag, only after the restoration of self-breathing - the transition to CPAP.

Criteria for transfer to CPAP:

• If the child on oxygen therapy retains central cyanosis (SpO2 <86%)

• Clinical signs of RDS: tachypnea, retraction of the intercostal spaces, moaning, cyanosis, subsidence of the pliable areas of the chest, swelling of the wings of the nose;

• Frequent recurrent episodes of apnea with desaturation and bradycardia;

• PaO2 less than 50 mm Hg. during breathing 60% O2;

• Radiological picture of restrictive lung diseases.

Algorithm for respiratory support by CPAP:

1. Follow the methods of caring for a child with nasal CPAP:

- Close the child's mouth to prevent possible loss of pressure through the mouth - Avoid frequent suction of contents from the nose.

- Use cannulas as large as possible.

2. Monitoring of the child's condition:

- Clinical picture. Physical examination. Control of blood pressure, respiratory rate, heart rate, body temperature. Oxygenation and ventilation control. X-ray control.

3. Begin with maintenance of constant positive pressure of 5-6 cm water.st.

4. The concentration of oxygen is set at 10-15% more than it was during oxygen therapy.

5. Starting pressure PEEP - 5-6 cm of water.st. If, at the same time, the increase in oxygenation does not occur within 15 minutes, it is necessary to increase the pressure by 1-2 cm. wates.st, up to a maximum of 10 cm of water.st. with nasal CPAP.

6. With improved oxygenation (SpO2-90-95%), gradually reduce the concentration of O2 without reducing PEEP.

7. The smaller the child, the more gradual weaning from SPAP is required.

8. Upon reaching the concentration of O2 - 25-30%, you can gradually reduce the positive pressure to 3-4 cm water.st. and decide to terminate the CPAP.

9. Reduction of CPAP parameters and transfer to independent breathing:

- With a stable clinical picture and laboratory parameters, reduce first FiO2 by 5-10% step by step to less than 30%, then the positive pressure at the end of exhalation (PEEP) by 1-2 cm. water st. to the level of 4-5 cm of water. st. At the same time, the visible work of breath should not increase.

- Abolition of CPAP is carried out with satisfactory oxygenation of the child for 2 hours at FiO2 - 21% and PEEP - 2 cm. water st.

10. After removal from CPAP, some children are transferred to oxygen therapy with mask.

Traditional mechanical ventilation

Mechanical ventilation - is the artificial maintenance of the act of breathing with the help of the device, in the absence and/or reduction of spontaneous breathing, in order to replace or maintain the patient's breathing until it becomes sufficient and/or completely independent.

The aim of mechanical ventilation:

• Support for gas exchange in the lungs;

• Achieve and maintain an arterial blood oxygenation level acceptable in certain clinical circumstances. SaO2 level> 90%, PaO2> 60 mm Hg;

• Increased lung volume;

• Decreased respiratory function.

Clinical indications for mechanical ventilation:

• Apnea or hypopnea;

• RDS with impaired consciousness;

• Clinically visible increase in respiratory function;

• To maintain airway patency during surgery;

• With brain damage;

• With shocks, stupor, coma;

• SpO2 <86% when breathing 70% oxygen (FiO2) on CPAP;

• Respiration rate is more than 2 times higher than normal, 80-120 times per minute;

• Paleness or diffuse cyanosis of the skin;

• Bradypnoe;

• Frequent apnea attacks with bradycardia.

Laboratory indications for ventilation:

- PaO2 <50 mm Hg. when FiO2> 0.7 (if the body weight at birth is less than 1000 gr., When FiO2> 0.5);

- PaCO2> 55-60 mm Hg. ;
- increase PaCO2 by more than 10 mm Hg. for 1 hour
- pH <7.2 (increase in metabolic or mixed acidosis).

Initial parameters of mechanical ventilation:

1. respiratory rate 50 per minute.
2. PIP 20 cm water st.
3. PEEP 5 cm water st.
4. FiO2 0.6.
5. Tin 0.4 sec.

4. Additional information
Means for self-control:
Test tasks
Situational tasks

4.1. Test tasks:

1. Indicate which initial mechanical ventilation parameter is correct?
A. Respiratory rate 50 per minute.
B. PIP 30 cm water st.
C. PEEP 10 cm water st.
D. FiO2 0.2.
E. Tin 0.6 sec.

2. Indicate which initial mechanical ventilation parameter is correct?
A. Respiratory rate 70 per minute.
B. PIP 20 cm water st.
C. PEEP 10 cm water st.
D. FiO2 0.2.
E. Tin 0.6 sec.

3. Indicate which initial mechanical ventilation parameter is correct?
A. Respiratory rate 70 per minute.
B. PIP 30 cm water st.
C. PEEP 5 cm water st.
D. FiO2 0.2.
E. Tin 0.6 sec.

4. Indicate which initial mechanical ventilation parameter is correct?
A. Respiratory rate 70 per minute.
B. PIP 30 cm water st.
C. PEEP 10 cm water st.
D. FiO2 0.6.
E. Tin 0.6 sec.

5. Indicate which initial mechanical ventilation parameter is correct?
A. Respiratory rate 30 per minute.
B. PIP 30 cm water st.
C. PEEP 5 cm water st.
D. FiO2 0.6.
E. Tin 0.4 sec.

6. Indicate what level of PaO2 should be provided by effective mechanical ventilation in a newborn with respiratory disorders syndrome (RDS) (mmHg)?
A. 20-30
B. 30-40

C. 40-50
D. 50-70
E. 70-80

7. Indicate what level of PaCO2 should be provided by effective mechanical ventilation in a newborn with respiratory disorders syndrome (RDS) (mmHg)?
A. 20-30
B. 30-40
C. 40-50
D. 50-70
E. 70-80

8. Indicate what level of SpO2 should be provided by effective mechanical ventilation in a newborn with respiratory disorders syndrome (RDS) (%)?
A. 70-75
B. 75-80
C. 80-85
D. 85-90
E. 90-95

9. What should be the color of the cylinder with medical oxygen:
A. gray
B. white
C. green
D. blue

10. The length of the nasal catheter introduction for oxygen therapy:
A. from the tip of the nose to the xiphoid process
B. from the tip of the nose to the lower incisors
C. from the tip of the nose to the earlobe
D. from the tip of the nose to the umbilical region

11. Hyperbaric oxygenation is the introduction of oxygen:
A. through the nasal cannula
B. with an oxygen pillow
C. through nasal catheters
D. in a pressure chamber under pressure

12. A 5-year-old boy got an intravenous infusion of euphyllin 6 mg/kg for 4 hours for a severe asthma attack. Before therapy, heart rate 112/min, respiratory rate 46/min., After - heart rate 148/min., respiratory rate 62/min. The child is asleep, wheezing is gone, breathing noises are reduced. Specify priority MEASURES:
A. Investigate the partial pressure of O2 and CO2 in the blood
B. Radiography of the chest
C. Determine the content of euphyllin in the blood
D. Dynamic determination of BH and heart rate
E. Intravenous infusion of isadrinum

13. A healthy full-term baby age 3 month. What should be the ratio of respiratory rate and pulse rate?
A. 1:01
B. 1:02
C. 1:03
D. 1:04

E. 1:05

14. The asphyxia phase of asthmatic status is characterized by all the signs except:
A. Tympanic sound during lung percussion
B. Respiratory failure of 3 degrees
C. Absence of respiratory noises
D. Hypoxic encephalopathy
E. Breathing with prolonged exhalation, wheezing

4.2. Situational tasks.

Task 1. A 3,6 year old boy is admitted to the pediatric ward with complaints of abdominal pain during breathing, shortness of breath, cough, lethargy, irritability, and fever. During previously week, he received symptomatic treatment at home for acute respiratory viral infection and simple bronchitis. During the last 3 days, the condition worsened: the temperature rose to febrile numbers, shortness of breath appeared, cough became more frequent. Doctor diagnosed with lower right pneumonia. He did not receive antibacterial therapy. During the last day, there was abdominal pain, vomiting, "it became difficult and painful to breathe."

On objective examination: the condition is severe; the child is cranky, somewhat lethargic, lying on his right side, legs bent at the knees. Body temperature 39ºC. Cough "painful", short. Breathes with a creek, shallowly, cannot breathe deeply because of pain in the right side. Shortness of breath of a mixed nature. Respiratory rate -48 for 1 minute. Skin rash, cyanosis of the nasolabial triangle, acrocyanosis. Muscle tone is normal. Heart rate - 132 for 1 minute. Blood pressure - 100/65 mm Hg. Heart tones are muted. On the right in the subscapular-axillary area is determined by a significant shortening of the percussion sound, which turns into a dull in the lower parts of the right lung. Breathing during auscultation is significantly weakened and is not heard over the area of dull percussion tone. Palpation of the abdomen reveals tension in the right half. Liver +3 cm. There was no defecation for 2 days. Diuresis is normal.

According to the study of blood gas composition: PaO2 is 68 mm Hg. Art., PaCO2 - 66 mm Hg. Art.

Task:
1. What complication develop in this case?
2. Name and justify the degree of RF.
3. What urgent measures do you intend to take? Do you recommend mechanical ventilation?

Task 2

A 2 year old girl was taken to the hospital in a serious condition due to symptoms of respiratory failure, shortness of breath, and general intoxication. The child is ill for two days. The disease began with a rise in body temperature to 38 ° C, decreased appetite, "barking" cough without sputum. The child received paracetamol and ambroxol on an outpatient basis. In two days - a condition without improvement; rapid breathing, general restlessness. On objective examination: the general condition of the child is severe, reacts negatively to the examination, is worried. The skin is clean, pale, dry, with reduced elasticity, perioral and acrocyanosis. The mucous membrane of the oropharynx is pink, the tongue is dry, the tonsils are not enlarged, without plaque. Peripheral lymph nodes are not enlarged. Respiratory rate - 50/min., Breathing loud, stridor, difficulty breathing, the participation of auxiliary muscles in the act of breathing. Breathing through the nose is free. The voice is hoarse, crying is quiet. At percussion - the sound is clear pulmonary, auscultation - the weakened breath, rales are not listened; Heart rate - 140/min., Rhythmic heart sounds, muted. The abdomen is palpable, the liver is 1 cm below the costal arch, the spleen is not palpable. Defecation without features; free urination.

Task:
1. Determine the tactics of treatment.

Task 3

A 14-year-old boy was taken to the hospital by an ambulance in an extremely serious condition without consciousness. Suffers from bronchial asthma from 3 years of age. The last attack began 10 hours ago. Taking euphyllin and prednisolone had no effect. On examination: the skin is diffuse-cyanotic, covered with cold sweat. Pupils dilated, react sluggishly to light. The chest is sharply swollen. Breathing is not listened to.

Task:

1. Which method of oxygen therapy is the most reasonable in this case?

4.3. Control questions:

1. Etiological and pathogenic factors of the respiratory disorders syndrome in newborns.
2. Etiological and pathogenic factors of respiratory failure in children of different ages.
3. Classification, clinical picture of the respiratory disorders syndrome in newborns.
4. Diagnostic criteria for respiratory failure.
5. Differential diagnosis of the respiratory disorders syndrome in newborn, other diseases accompanied by respiratory failure.
6. Providing emergency care for respiratory failure.
7. Methods of respiratory support in children.
8. Technique of oxygen therapy.
9. Providing emergency care to children with respiratory failure with coronavirus infection.
10. Prognosis for life in case of respiratory disorders syndrome in newborns, respiratory failure in children.

Correct answers to test tasks:

1	A	8	E
2	B	9	D
3	C	10	C
4	D	11	D
5	E	12	E
6	D	13	C
7	C	14	C

Correct answers to situational tasks:

Task 1:

Answer:

1. About exudative costal-diaphragmatic right-sided pleurisy.
2. RF 2 st. Cyanosis, shortness of breath at rest, increased blood pressure, tachycardia. There are signs of CNS disorders (lethargy, irritability), but there is no inhibition, muscle tone is normal. Diuresis is normal. PO2-65 mm Hg.
3. Oxygen therapy. Analgesics (non-narcotic analgesics). Pleural puncture. Mechanical ventilation - only in acute RF, severe.

Task 2

Answer: Inhalation of humidified oxygen; glucocorticoids.

Task 3

Answer: mechanical ventilation.

Literature:

Main

1. NelsonTextbookofPediatrics [Text]/R. M. Kliegman [et al.]; ed. R. E. Behrman. - 21th ed. - Edinburgh [etc.] : Elsevier, 2020.

2. Основи педіатрії за Нельсоном: у 2 томах. Том 1/Карен Дж. Маркданте, Роберт М. Клігман; переклад 8-го англ. видання. Наукові редактори перекладу В.С. Березенко, Т.В. Починок. Київ: ВСВ «Медицина», 2019. Т1-378с., Т2- 426 с.

3. Педіатрія: підручник для студ. вищих навч. закладів IVрівняакредит/ за ред. проф.О.В. Тяжкої.- Вид. 5-те виправ. та допов.- Вінниця: Нова Книга, 2018. -1152 с:
4. Неонатологія: національний підручник: у 2 томах /За ред. проф.Є.Є. Шунько.- К., 2014.-Т.1.960 с.
5.Неонатологія: національний підручник: у 2 томах /За ред. проф.Є.Є. Шунько. - К., 2015.-Т.2.640 с.
6. Неонатологія; навчальнийпосібник /За ред. Т.К.Знаменської.-Київ, 2012.-980с.
7. Наказ МОЗ України від 28.03.2014р. № 225«Початкова, реанімаційна і після реанімаційна допомога новонародженим в Україні»).
5. Наказ МОЗ України від 21.08.2008р. № 484 «Про затвердження клінічного протоколу надання медичної допомоги новонародженим з дихальними розладами».
6. Наказ МОЗ України 17.07.2015 N 438 «Про внесення змін до наказу Міністерства охорони здоров'я України» від 21.08.2008р. № 484до «Клінічного протоколу надання Допомоги новонародженій дитині з дихальними розладами».
7. Наказ МОЗ України від 2.04.2020р. № 762 «Про затвердження протоколу «Надання медичної допомоги для лікування коронавірусної хвороби (COVID-19)».

Additional

1. Волосовець О.П., Снісарь В.І. Рекомендації з серцево-легеневої реанімації у дітей. Методичний посібник. – Дніпропетровськ, АРТ-ПРЕС. – 2015. – 48 с
2. Педіатрія.Навч. посібник: у 2-х томах. /М.Л. Аряєв, Н.В. Котова, О.О. Зелінський, Н.Ю. Горностаєва; - Одеса: ОНМедУ. Том 1. Неонатологія. Гематологія. Ендокринологія.- 2014. – 155 с.
3.Практичний посібник з неонатології / За ред. С. Езутачана, Д. Добрянського: Пер.з англ. - Львів-Детройт, 2002. 344 с.
4. https://www.youtube.com/watch?v=kcytHfT9gmo
5. https://www.youtube.com/watch?v=1tic3rMVBMs
6.https://emedicine.medscape.com/article/976034-overview