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Radiological Evaluation of Pneumonia in Young Children Depending on the Gestational Age

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Abstract: The article discusses the main properties associated with imperfect diagnostics of the disease, the accuracy and completeness of which determine the therapeutic strategy and prognosis of the disease. The lack of radiological control also does not allow objectifying the clinical picture of the disease. Modern specialized literature and relevant scientific information were systematically studied. The information served as the basis for our observation in the follow-up of children born with signs of SDR, in dynamics up to 3 years of age. continuing signs of immaturity in premature babies and up to 3-4 years of age, the opportunity to study the presence of these signs in pneumonia in young children depending on the gestational age was used.

Key words: Pneumonia, SDR, follow-up, X-ray picture, gestational age, early age.

Respiratory disorders in young children are one of the most serious problems in pediatrics and neonatology, as they are the leading cause of death in early childhood and especially in the perinatal period [26,30,33]. An alarming trend in modern neonatology is the almost universal increase in the number of births of children with respiratory disorders, the most common causes of which are respiratory distress syndrome and pneumonia of newborns [26,37,83].

The consequences of unfavorable factors of the perinatal period can manifest themselves throughout early childhood [55,59,84]. In children born prematurely, signs of immaturity of the lung tissue persist for a long time, and children with a weight of less than 1,500 continue to have frequent respiratory diseases, especially before 2 years. In the period from 3 months to 3 years, children experience intensive growth in the volume of lung lobes and segments, and the early onset of the disease leaves its mark on the process of further development of respiratory tract diseases in children, which has an adverse effect on the final differentiation of the bronchopulmonary system, observed at the age of 4 to 7 years [48,60,77].

Pathology associated with the relative functional immaturity of the most important body systems occupies a significant place in the structure of neonatal morbidity and mortality. Immaturity underlies such frequent and formidable conditions as respiratory distress syndrome (RDS), edema syndrome, conjugated hyperbilirubinemia, adrenal insufficiency syndrome, and others [43,56,83].

It should be noted that in recent years, respiratory disorders in newborns have begun to attract much attention from researchers, since their outcome is often chronic respiratory failure, broncho-obstructive syndrome, and bronchopulmonary dysplasia in older children [24,45,65,77].

In-depth studies on the identification of risk factors and mechanisms of formation of the pathological process in the lungs, objective early diagnostic methods, pathogenetically substantiated methods of therapy and prevention of secondary lesions of lung tissue in young children have not yet been finally resolved [93,95,99].

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The expected reduction in mortality in newborns and young children and especially complications of SDS has not occurred in the last 10 years. First of all, this can be associated with imperfect diagnostics of the disease, the accuracy and completeness of which determine the therapeutic strategy and prognosis of the disease. The lack of the possibility of radiological control also does not allow objectifying the clinical picture of the disease [18,80,81,83].

This information served as the basis for our follow-up observation of children born with signs of SDR, in dynamics up to 3 years of age. Guided by the opinion [26,80,81,83]continuing signs of immaturity in premature infants and up to 3-4 years of age, the opportunity was used to study the presence of these signs in pneumonia in young children depending on the gestational age.

One of the significant factors influencing the nature and outcome treatment measures, is a complete and timely diagnosis of various diseases in children. This is especially important in the early stages of the disease, when adequate therapy can significantly affect the nature of the development of the pathological process [17,21,35,30]

The timeliness of assessing the condition of the respiratory organs in newborns and especially premature infants, as well as the presence of signs of morphological immaturity in RDS, requires the widespread use of well-known examination methods, in particular, this concerns timely X-ray examination [18,19,20].

X-ray examination of young children with modern advanced X-ray technology remains the leading and most accessible method for diagnosing respiratory diseases in newborns [18,19,20].

Unfortunately, against the background of rapid growth and development of new technologies, attention to X-ray diagnostics is weakening, little covered in the literature available to us over the past 10-15 years. The works of leading radiologists, especially on neonatal X-ray diagnostics in the 70-80s of the last century, have not lost their relevance. In the diagnosis of acute inflammatory lung diseases in children, traditional survey chest X-ray in standard positions is most often used. This is accompanied by a small radiation load, accessible and informative. With the help of X-ray, dynamic monitoring of the pathological process in the lungs is also carried out [52,55].

The purpose of the study: to establish the nature - radiological assessment pneumonia in young children depending on the gestational age.

Material and methods. We were monitoring 120 children with pneumonia (60 newborns and 60 young children) were examined using chest X-ray.

To accomplish the task, 60 newborns and 60 young children with pneumonia were radiologically examined. The patients were hospitalized at stage II of the pathology of newborns in the regional neonatology department of the regional Children's Multidisciplinary Clinical Hospital.

"Tabletsa"2.1". Observation of sick newborns was carried out in compliance with the rules of clinical-laboratory monitoring, which mainly included: observation of the patient in dynamics, familiarization with the anamnesis, with an emphasis on the obstetric anamnesis and the health of the mother, examination of the newborn with an assessment of the gestational age of the child based on a set of morphological criteria, palpation, percussion, auscultation, taking into account the dynamics of body weight, recording body temperature, signs of SDR according to the Silverman scale.

The distribution of the examined newborns was carried out into groups, taking into account the gestational age and state of maturity, as well as the time of the study: upon admission - 1-3 days, during treatment - 5-7 days and at discharge - 7-10 days.

Depending on the gestational age and birth weight, the following groups were formed:

A - full-term newborns, of which:

Group A1 - full-term newborns, without signs of IUGR;

Group A2 - full-term newborns with signs of IUGR - hypotrophic variant;

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*B - premature newborns*with a gestational age of 32 to 37 weeks, with low birth weight 1,500 –2500 g, of which:

Group B1 – premature newborns with a gestational age of 35-37 weeks and a birth weight of 2,000 – 2,500 g.;

Group B2 – premature newborns with a gestational age of 32-34 weeks and a birth weight of 1,500 – 2,000 g.

Table 2.1. The scope of clinical and radiological examination of newborns

Groups of those surveyed	In hospital
Group A1	20
Group A2	20
Group B1	10
Group B2	10
Total	60

Clinical manifestations of the pathopulmonological process in the observed newborns were characterized by a complex of symptoms and damage to various organs and systems of the body. Pneumonia in newborns occurred against the background of SDR. Of the examined newborns: 8.8% of newborns were admitted to the hospital in a moderate condition, 91.2% of patients were in a severe condition. Acute onset of the disease in 17.6%, symptoms appeared gradually in 76.5% of newborns.

On examination of sick newborns: fever - in 11.8%, in 79.4% - pale skin, cyanosis or acrocyanosis - in 61.8%, adynamia - in 5.9%, weak cry - in 55.9%, hypertonia - in 58.8%, hyporeflexia - in 85.3%, chin tremor - in 32.4%, limb tremor - in 38.2%, convulsive syndrome - in 2.9%, apnea attacks - in 2.9%, shortness of breath - in 82.4%, cough - in 17.6%, flaring of the wings of the nose - in 5.9%, foamy discharge from the mouth - in 8.8%, recession of the sternum - in 50% of patients, retraction of the intercostal spaces - in 61.8%, edema stop - at 2.9%.

Percussion revealed dullness of the pulmonary sound in 26.5%, shortening of the pulmonary sound in 14.7%; during auscultation, weakened breathing was detected in 79.4%, harsh breathing was detected in 5.9%, and isolated moist rales were heard in 32.4%.

On the part of the heart, the borders are enlarged in 2.9%, auscultation reveals muffled heart sounds in 97.1%, with systolic murmur at the apex in 8.8%. The liver is enlarged in 41.2% of newborns.

Upon admission to inpatient treatment, the general blood test parameters had the following range: hemoglobin level 70 g/l - 140 g/l; red blood cell count 3.5*1012/l - 4.4*1012/l; color index 0.8-0.9; white blood cell count 3.3*109/l - 10.0*109/l; band 1*109/l -16*109/l; segmented 25*109/l - 68*109/l; eosinophils 1.0*109/l -2.0*109/l; lymphocytes 20*109/l - 58*109/l; monocytes 3*109/l - 10*109/l; ESR 1-2 mm/h.

General urine analysis and general stool analysis of the examined newborns were unremarkable.

In the formation of the risk of developing a pathopulmonary process in newborns, priority belongs to a complicated obstetric history in the mother, in particular, the presence of a focus of chronic infection (24%), with a long anhydrous interval being especially highlighted (14.7%).

Of the examined newborns, 20% were born from the first pregnancy, 11% from the second, and 69% from the third or more pregnancies. The medical history showed that 91.2% of mothers had anemia, labor was induced in 55.9% of cases, multiple pregnancies were in 26.5%, premature rupture of membranes were in 14.7%, prolonged gestosis of pregnant women were in 25% of mothers, threatened miscarriage was in 9%, bleeding and infectious diseases during pregnancy were in 11%, umbilical cord entanglement was in 2%, placenta previa was in 2%, breech presentation was in 1%,

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polyhydramnios was in 2%, oligohydramnios was in 2%, cesarean section was planned in 18%, and emergency in 6%. A combination of factors was detected in 72% of observations.

Upon admission, sick children underwent a full clinical examination, anthropometry, chest X-ray, microflora culture and antibiotic sensitivity from blood, urine, throat, general blood, urine, and stool tests.

The presented thorough analysis of clinical and anamnestic features of the examined newborns indicates a close connection between the observed pathopulmonological process in the newborn and the health of the mother, the course of pregnancy and childbirth. The stages of development of this process require close attention not only from clinicians, but also the need for objective informative functional, in particular, radiological criteria.

RESULTS AND DISCUSSION. Radiological assessment of the severity of respiratory disorders in pneumonia in newborns. Based on our own observations based on a combination of radiological symptoms, in comparison with well-known radiological classifications of the stages of inflammatory bowel disease, we identified our own version of radiological verification of changes according to the severity of the inflammatory process against the background of immaturity of the lung tissue “Table 3.2”.

The distribution of newborn children with pneumonia depending on the severity of the disease is graphically presented in “Fig. 3.23”.

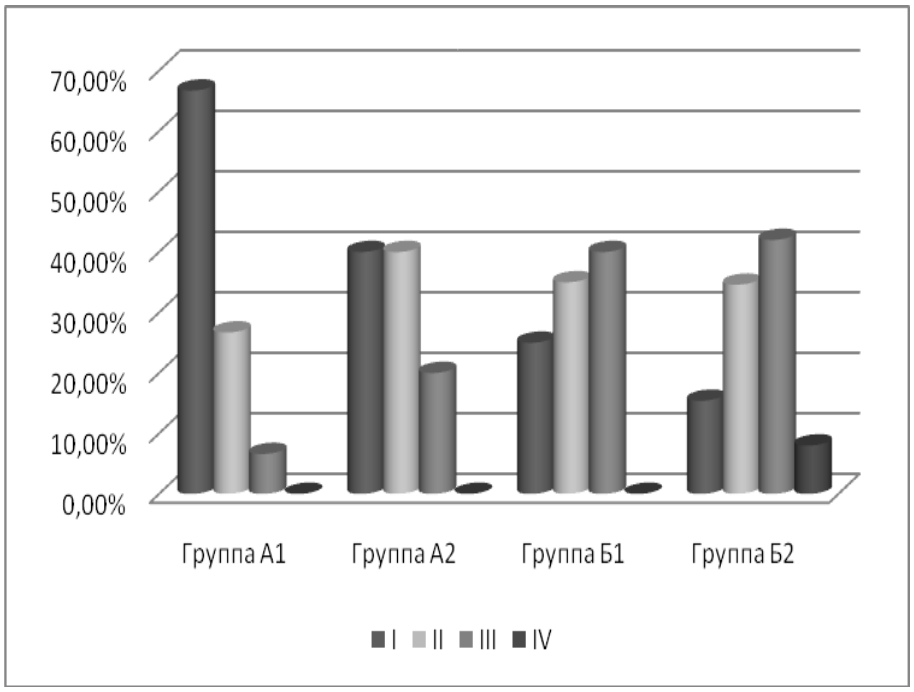

Fig. 3.23. Distribution of newborn children with pneumonia by severity of SDR.

Thus, in the group of full-term newborns with pneumonia without signs of IUGR (group A1), the changes characteristic mainly of the first degree of severity of RDS prevailed, namely, miliary spotting, limited low-intensity non-homogeneous darkening, a vague nodular-reticular network, and a distinguishable "air bronchogram". It should be remembered that even in completely healthy premature infants without clinical respiratory disorders, radiologically, the presence of scattered atelectatic areas can be detected. In the genesis of scattered atelectasis, not only the relative deficiency of surfactant is important, but also the absence or weak straightening of pulmonary arterioles.

Table 3.2. Severity of radiographic signs of SDR in pneumonia in newborns depending on signs of immaturity

Severity levels of SDR	Radiographic manifestations	Group A1	Group A2	Group B1	Group B2
I	-Moderate decrease in pneumatization -Miliary spotting -Limited low intensity shadows - Nodose-reticular network (blurred) - "Air bronchogram" is visible	66.7%	40%	25%	15.4%
II	-Reduction of pneumatization - Coarse, randomly scattered areas of compaction of lung tissue - Nodose-reticular network - "Air bronchograms"	26.7%	40%	35%	34.6%
III	- Marked reduction in pneumatization ("ground glass") - Smoothing of the pulmonary-diaphragmatic and pulmonary-cardiac border (symptom of the "silhouette") - "Air bronchograms"	6.6%	20%	40%	42%
IV	"White Lungs"	-	-	-	8%

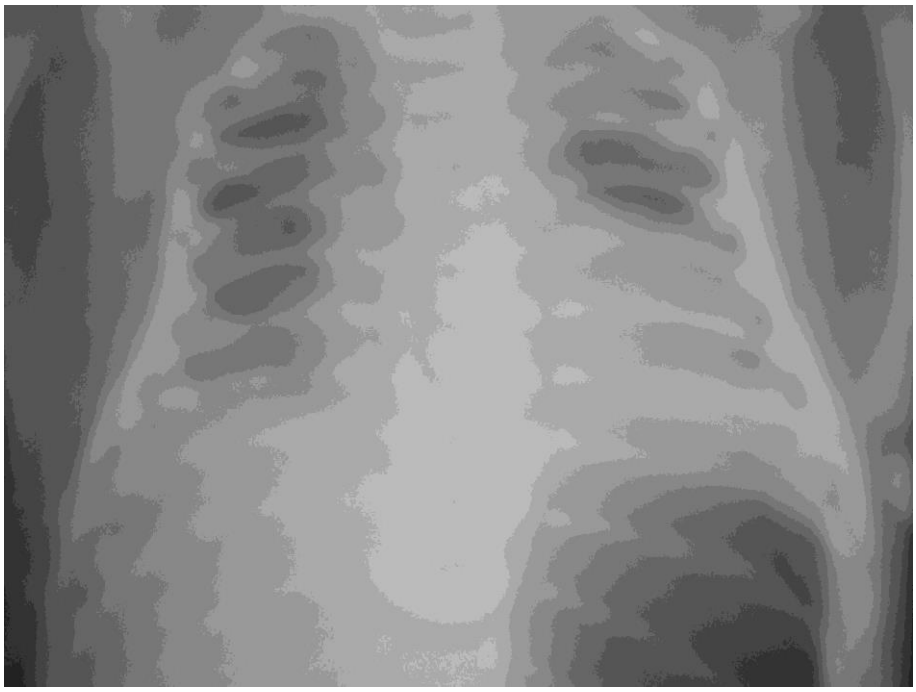

Figure 3.24. Radiograph of child Sh. upon admission, 3 days old. Gestation period 36-37 weeks. Polysegmental pneumonia. Hypoventilation of the lungs. Heterogeneous limited darkening in the middle zones. "Air bronchogram" symptom on the left. Reticulate deformation of the pulmonary pattern. Limited areas of hyperairiness on both sides.

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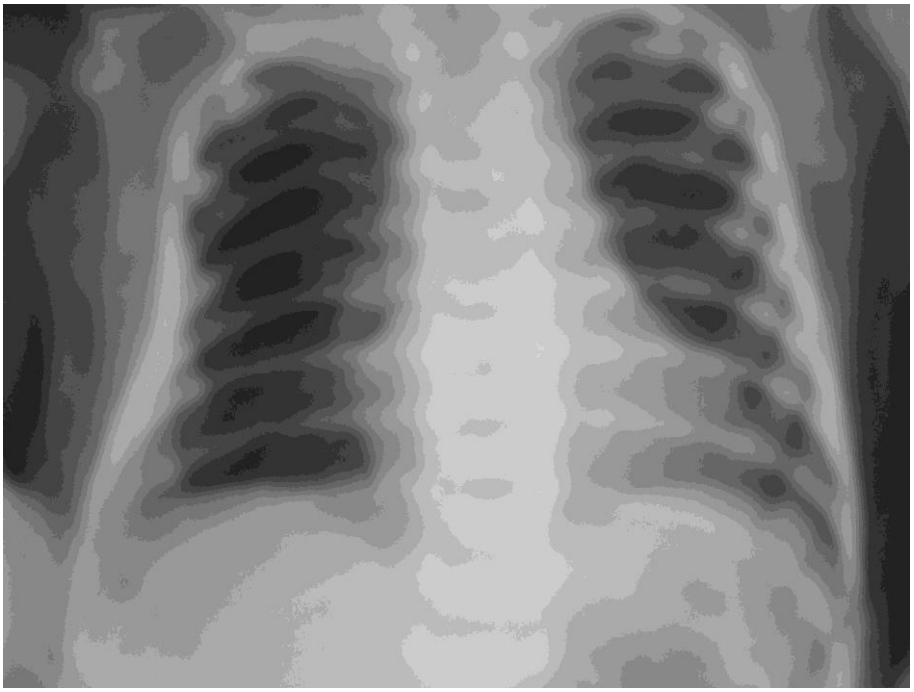

Figure 3.25. Radiograph of child Sh. during treatment dynamics, 17 days. Residual effects after polysegmental pneumonia. Airy lung fields. Nodose-reticular mesh in limited areas in the middle zones. Single widespread small-focal shadows. "Air bronchogram" symptom.

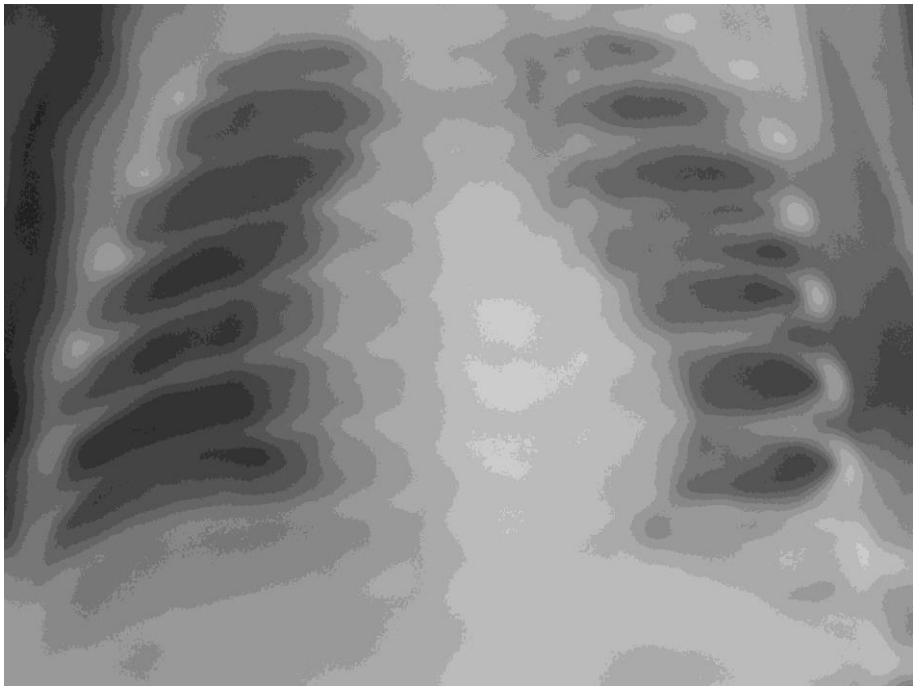

Fig. 3.26. Radiograph of child A. at discharge, 14 days. Gestation period 33 weeks. Residual effects after atelectatic pneumonia. Airy lung fields. Nodose-reticular mesh in the root zones. Enlarged cardiac shadow.

In full-term newborns with signs of IUGR (group A2), changes characteristic of I and II degrees of severity of RBD prevailed in equal proportions, i.e. decreased pneumatization, rough randomly scattered areas of compaction of lung tissue and "air bronchograms". In dynamics, a tendency to transition to I degree of severity of RBD was observed "Fig. 3.24", "Fig. 3.25", "Fig. 3.26".

In our observations of premature infants, depending on the depth of prematurity, and possibly also due to the short-term clinically asymptomatic onset upon admission, in most cases, grades II and III of RDS severity were observed: a marked decrease in pneumatization ("ground glass"), smoothing of

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the pulmonary-diaphragmatic and pulmonary-cardiac border (positive "silhouette" symptom), air bronchograms. It should be noted that in group B2, relative to group B1, manifestations of grade III RDS severity somewhat prevailed.

When comparing the airiness of the lung fields (Fig. 3.27), the majority of those examined with normal birth weight (group A1) had relatively satisfactory ventilation parameters, which was not typical for the other groups of examined newborns, who had particularly clear symptoms of ventilation disorders of varying severity depending on the degree of immaturity. Darkening of the "ground glass" type in combination with a positive "silhouette" symptom was mainly expressed in immature children (groups A2, B1 and B2) and was not observed in full-term newborns with normal birth weight. And "white lungs" were visualized only in group B2.

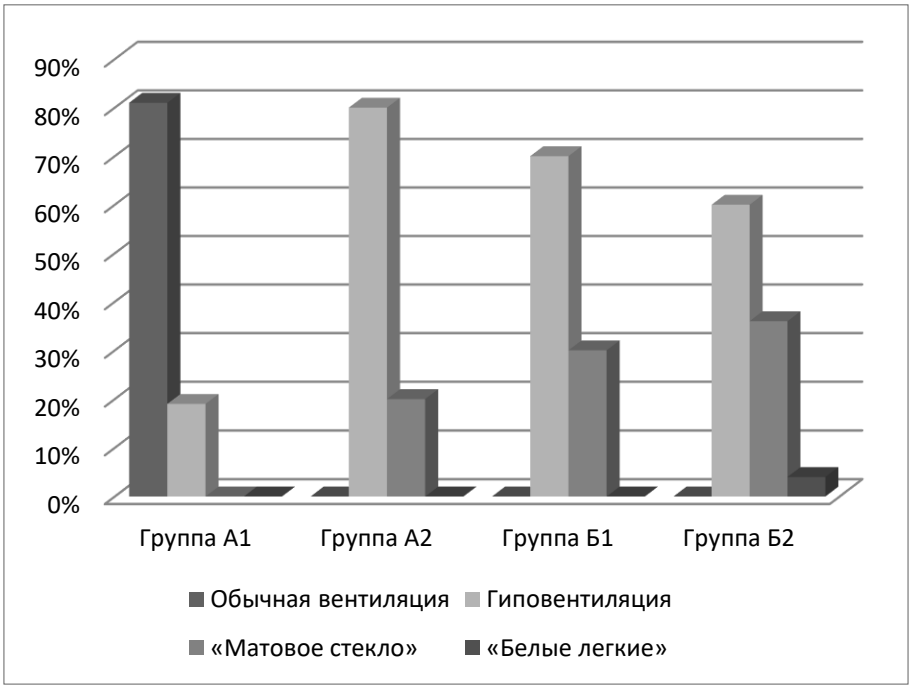

Fig. 3.27. Radiographic parameters of lung field ventilation.

As for the assessment of the prevalence of opacities, areas of limited opacities on radiographs were more often detected in groups A1 and A2. Our radiological observations noted selective localization of the inflammatory process in individual, lung segments that are delayed in their development. According to our observations, these are the 1st, 2nd, 7th, 9th, 10th segments of the right lung and the 1st, 2nd, 4th, 5th, 9th, 10th segments of the left lung. Radiological analysis showed that diffusely widespread small-focal shadows, as one of the manifestations of SDR, were relatively more often observed in newborns from groups B1 and B2 (Fig. 3.28).

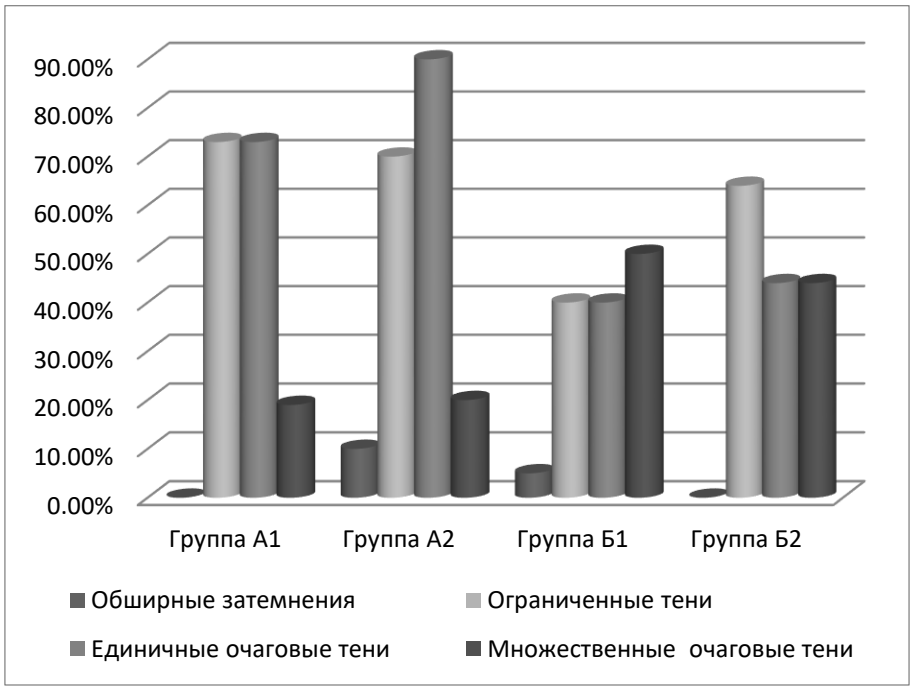

Fig. 3.28. Prevalence of opacities on radiographs.

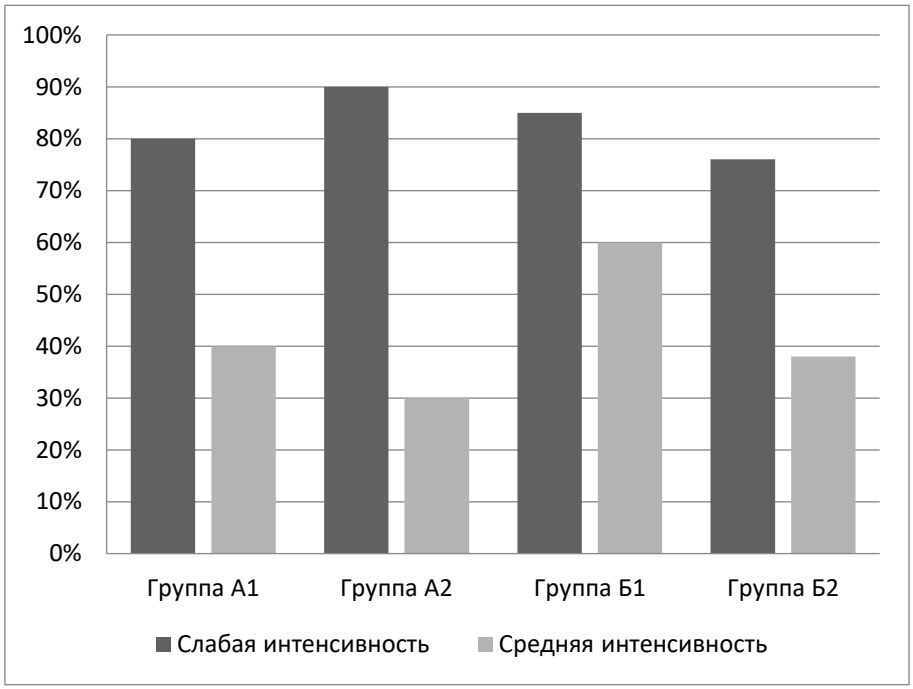

Fig. 3.29. Intensity of darkening

Diffusely distributed small focal opacities tended to merge and were combined with multifocal swellings. Focal shadows varied not only in size but also in intensity, which indicates that they arose at different times and were located at different depths. A combination of inflammatory foci with high-intensity focal-like shadows of blood vessels and atelectatic lobules was noted. Therefore, both weak and medium intensity shadows were simultaneously visualized on radiographs (Fig. 3.29).

The analysis of the X-ray picture of the pulmonary pattern revealed that the impoverishment of the vascular pattern due to its immaturity prevailed in newborns from groups A2, B1 and B2. The symptom of increased vascular pattern, characteristic of the inflammatory process, did not manifest itself in the groups of premature infants examined by us, but prevailed in mature newborns. In premature infants, its enrichment by the type of nodular-reticular network was very clearly visible, having different lengths and revealed in most observations.The frequency of air bronchogram

registration on images directly correlated with the worsening of the newborn's condition, closely associated with the immaturity of the lungs (Fig. 3.30).

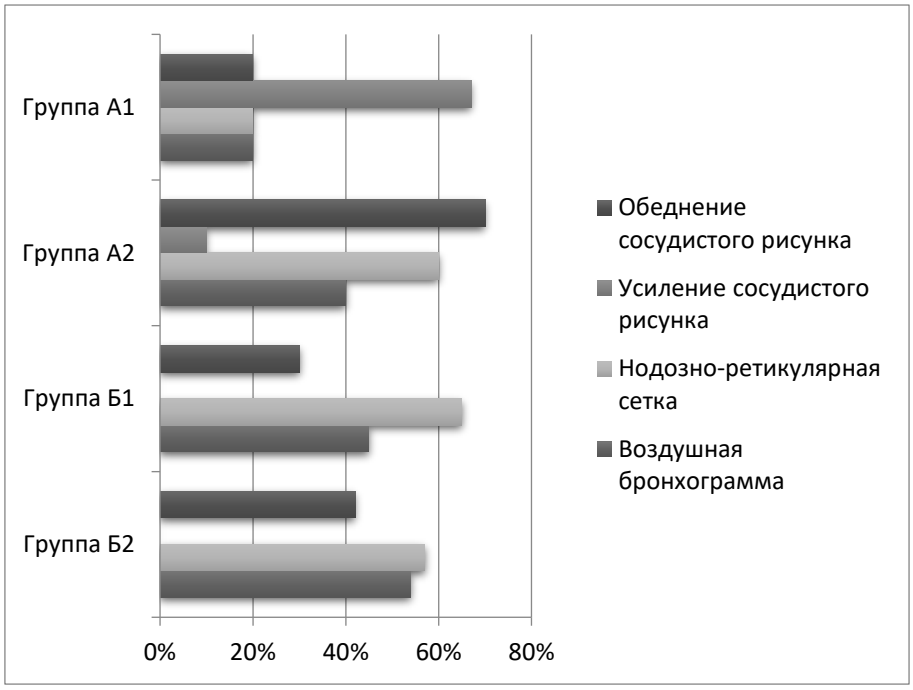

Fig. 3.30. State of the pulmonary pattern.

Taking into account the rapid dynamics of pathological processes in the lungs of premature infants, as well as the great similarity of clinical and radiological changes in RDS and congenital pneumonia in premature infants in the first 24 hours of life, the final differential diagnosis between these pathological conditions should be made on the basis of a repeated radiological examination in the dynamics of treatment. The appearance of fine-point shadows against the background of delicate reticulation of the pulmonary pattern, thin or undifferentiated roots, pronounced or undetectable air bronchogram, indicates the presence of RDS. Congenital pneumonia is indicated by the appearance of large- and small-focal shadows against the background of coarse reticulation, thickening of the pulmonary pattern in the root zones, moderate increase in airiness of the bronchogram. Blurred pulmonary pattern with thickening in the root zones, formation of wide, non-structural roots, the appearance of small- and medium-focal shadows indicate the development of pneumonia.

CONCLUSIONS:

1. In full-term newborns born with normal weight, up to 67% of cases of pneumonia are dominated by radiological signs of grade I severity of SDR.
2. In full-term newborns with low birth weight, radiographic signs of grades I and II of severity of SDS are observed equally (40% each).
3. In premature infants, radiological signs of grade II (35%) and grade III severity of RDS (42%) predominate.
4. The formation of appropriate degrees of severity of radiological signs of SDR in newborns depending on the signs of immaturity allows for the verification of the pathological process in the early stages of the disease.
5. The appearance of fine-point shadows against the background of hypoventilation and delicate meshwork of the pulmonary pattern, thin or undifferentiated roots, pronounced or undetectable air bronchogram, indicates the presence of SDR.

6. Congenital pneumonia is indicated by the appearance of large and small focal shadows against the background of coarse reticulation, thickening of the pulmonary pattern in the root zones, and a moderate increase in the airiness of the bronchogram.
7. Long-term signs of immaturity of lung tissue in children born prematurely leave their mark on the process of further development of respiratory tract diseases in young children.

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