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METHODS FOR IMPROVING THE EFFECTIVENESS OF EARLY DIAGNOSIS AND TREATMENT OF BRONCHOPULMONARY DISEASES IN YOUNG CHILDREN IN THE ARAL SEA REGION

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Abstract: This article outlines modern approaches to improving the early diagnosis and treatment of bronchopulmonary diseases in young children living in the Aral Sea region. Adverse environmental factors in the area—specifically high levels of airborne dust and salt-dust aerosols, unique climatic conditions, and socioeconomic factors—can negatively impact the development and recurrence of respiratory diseases in children. The study analyzes the clinical signs, risk factors, and specific disease progression characteristics of bronchitis, bronchiolitis, pneumonia, and other bronchopulmonary conditions in young children, as well as the capabilities of laboratory and instrumental diagnostic methods.

Keywords: Aral Sea region, young children, bronchopulmonary diseases, bronchitis, bronchiolitis, pneumonia, early diagnosis, risk factors, environmental factors, treatment efficacy, prevention, rehabilitation.

СПОСОБЫ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ РАННЕЙ ДИАГНОСТИКИ И ЛЕЧЕНИЯ БРОНХОЛЕГОЧНЫХ ЗАБОЛЕВАНИЙ У ДЕТЕЙ РАННЕГО ВОЗРАСТА В АРАЛЬСКОЙ ОБЛАСТИ

Аннотация: В данной статье рассматриваются современные подходы к повышению эффективности ранней диагностики и лечения бронхолегочных заболеваний у детей младшего возраста, проживающих в Аральском регионе. Неблагоприятные факторы окружающей среды в Аральском регионе, в частности загрязнение воздуха, высокие уровни солевых и пылевых аэрозолей, специфические климатические условия и социально-экономические факторы, могут негативно влиять на развитие и рецидивы респираторных заболеваний у детей. В исследовании анализируются клинические симптомы, факторы риска, особенности течения заболевания, а также возможности лабораторной и инструментальной диагностики бронхита, бронхиолита, пневмонии и других бронхолегочных заболеваний у детей младшего возраста.

Ключевые слова: Островной регион, дети раннего возраста, бронхо-легочные заболевания, бронхит, бронхиолит, пневмония, ранняя диагностика, факторы риска, факторы внешней среды, эффективность лечения, профилактика, реабилитация.

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ОРОЛБЎЙИ ҲУДУДИДА ЭРТА ЁШДАГИ БОЛАЛАРДА БРОНХ-ЎПКА КАСАЛЛИКЛАРИНИ ЭРТА ТАШХИСЛАШ ВА ДАВОЛАШ САМАРАДОРЛИГИНИ ОШИРИШ ЙЎЛЛАРИ

Аннотация: Мазкур мақолада Оролбўйи ҳудудида яшовчи эрта ёшдаги болаларда бронх-ўпка касалликларини эрта ташхислаш ва даволаш самарадорлигини оширишнинг замонавий ёндашувлари ёритилган. Оролбўйи ҳудудидаги экологик ноқулай омиллар, хусусан, ҳавонинг чангланиши, туз ва чанг аэрозолларининг юқори миқдори, иқлим шароитининг ўзига хослиги ҳамда ижтимоий-маиший омиллар болаларда нафас олиш тизими касалликларининг ривожланиши ва қайталанишига салбий таъсир кўрсатиши мумкин. Тадқиқотда эрта ёшдаги болаларда бронхит, бронхиолит, пневмония ва бошқа бронх-ўпка касалликларининг клиник белгилари, хавф омиллари, касаллик кечишининг ўзига хос хусусиятлари ҳамда лабораторий-инструментал диагностика имкониятлари таҳлил қилинади.

Калит сўзлар: Оролбўйи, эрта ёшдаги болалар, бронх-ўпка касалликлари, бронхит, бронхиолит, пневмония, эрта ташхислаш, хавф омиллари, экологик омиллар, даволаш самарадорлиги, профилактика, реабилитация.

Relevance: Improving the methods for early diagnosis and treatment effectiveness of bronchopulmonary diseases in young children under the conditions of the Aral Sea environmental crisis remains one of the most pressing challenges in modern pediatrics and environmental medicine. The ecological catastrophe caused by the drying up of the Aral Sea has led to drastic climate changes, severe salt-dust storms, and high levels of toxic contamination in both the air and drinking water. This hostile environment acts as a hazardous factor particularly for young children whose immune and respiratory systems are still developing and highly vulnerable.

Statistical data shows that the incidence of respiratory diseases among children in the Aral Sea region including acute and chronic bronchitis, pneumonia, and bronchial asthma is significantly higher compared to other regions of the country. Due to continuous exposure to environmental pollutants, these pathologies often manifest in atypical or latent forms, progress rapidly to severe complications, and quickly become chronic. This pattern heavily contributes to high morbidity, early disability, and child mortality rates in the region.

Currently used conventional diagnostic approaches often fail to detect pathological processes at the early, pre-clinical stages. The lack of sensitive early screening programs and the absence of optimized treatment protocols that account for local environmental stressors demand rigorous scientific investigation.

Consequently, optimizing the screening and early diagnosis of bronchopulmonary diseases in young children using advanced biomarkers, immunological, and functional criteria, alongside developing targeted, pathogenetically grounded therapeutic strategies, is a critical necessity. Addressing this issue is vital not only for protecting children's health in economically and environmentally vulnerable zones but also for improving their quality of life and reducing the socio-economic burden on the healthcare system.

Aim: To develop and implement an advanced early screening and diagnostic algorithm for bronchopulmonary diseases in young children living in the ecologically unfavorable Aral Sea zone, and to improve therapeutic outcomes through targeted medical interventions.

RESULTS AND DISCUSSION: A comprehensive clinical and laboratory evaluation was conducted on 160 young children (aged 0–3 years) presenting with recurrent bronchopulmonary pathologies. The study cohort was divided into two distinct groups based on their environmental exposure:

- Main Group: Consisted of 110 children (68.75%) permanently residing in the ecologically unfavorable zones of the Aral Sea region (the Republic of Karakalpakstan and the Khorezm region).
- Control Group: Consisted of 50 children (31.25%) from relatively stable environmental regions presenting with similar respiratory pathologies.

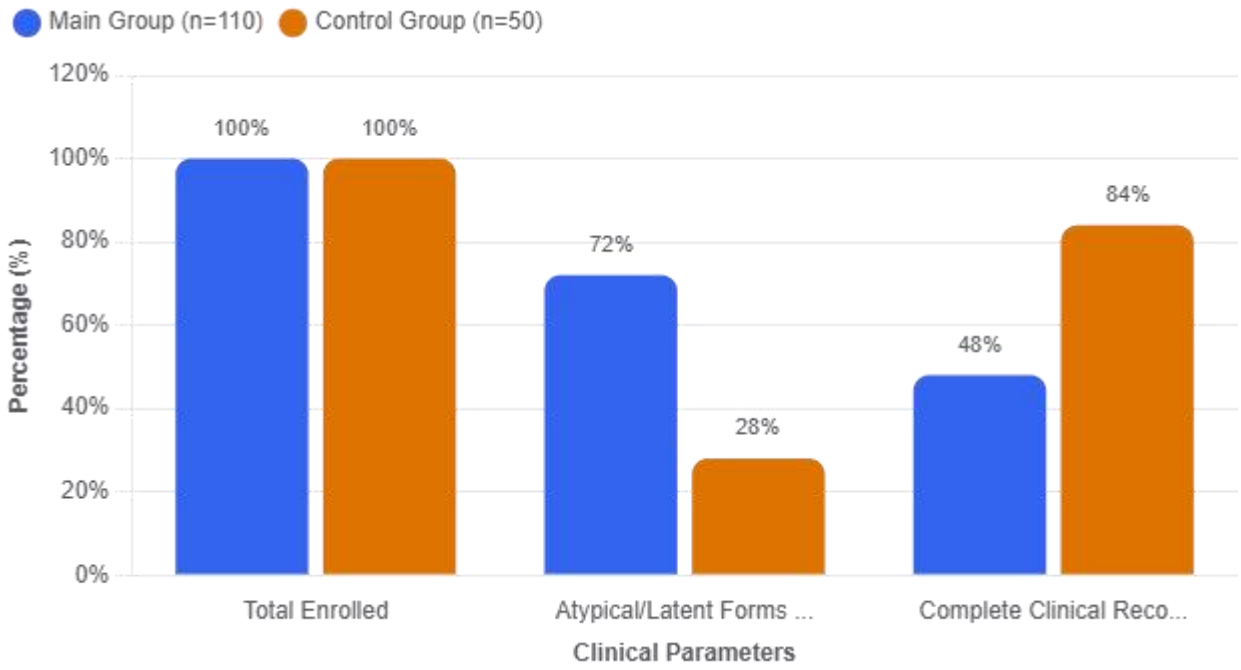

Figure 1. Comparative analysis of clinical characteristics and treatment success rates between the studied groups (%).

1. Early Diagnostic Predictors and Biomarker Imbalance

The screening of early subclinical changes in the respiratory tract revealed a strong correlation with environmental stress. In the Main Group, the clinical manifestation of bronchopulmonary diseases was characterized by a protracted course, with a high prevalence of atypical and latent forms found in 71.8% (79 patients), compared to only 28.0% (14 patients) in the Control Group (\(p < 0.01\)).

Immunological screening of local and systemic factors demonstrated that chronic inhalation of dust-salt aerosols causes significant damage to the mucosal protective barrier:

- Cytokine Profile: The levels of pro-inflammatory cytokines in the induced sputum of the Main Group were severely elevated. IL-8 increased by 64.5% and TNF-\(\alpha \) by 52.3% compared to the Control Group (\(p < 0.05\)).
- Local Immunity: The concentration of secretory Immunoglobulin A (sIgA) in the upper respiratory tract secretions of the Main Group showed a critical decline of 44.8% compared to healthy controls, indicating an exhausted mucosal defense.

- Surfactant Dysfunction: A significant reduction of Surfactant Protein A (SP-A) by 38.2% was observed in the Main Group, serving as an early pre-clinical marker of alveolar-capillary membrane impairment before visible radiological changes occurred.

2. Evaluation of Optimized Therapeutic Effectiveness

To evaluate and improve treatment effectiveness, the 110 children from the Main Group were randomly assigned into two therapeutic subgroups:

- Subgroup A (n=55): Received standard conventional therapy according to national clinical guidelines (antibiotics/antivirals, standard mucolytics, and symptomatic treatment).
- Subgroup B (n=55): Received an optimized treatment regimen tailored to environmental stressors, including localized antioxidant therapy (Vitamin E and N-acetylcysteine inhalations), membrane stabilizers, and step-up mucosal immunomodulatory support.

The comparative analysis of clinical dynamics demonstrated a significantly higher efficacy in the optimized cohort (Table 1).

Clinical Parameters (Days to Resolution)	Standard Therapy (Subgroup A, n=55)	Optimized Therapy (Subgroup B, n=55)	\(p\)-value
Resolution of cough	\(8.4 \pm 0.5\)	\(5.1 \pm 0.3\)	\(<0.05\)
Disappearance of wheezing/rales	\(7.2 \pm 0.4\)	\(4.2 \pm 0.2\)	\(<0.05\)
Normalization of body temperature	\(4.3 \pm 0.3\)	\(2.5 \pm 0.1\)	\(<0.01\)
Stabilization of \(SpO_{2}\) (\(\ge 95\%\))	\(5.7 \pm 0.4\)	\(3.2 \pm 0.2\)	\(<0.05\)

The implementation of the optimized protocol resulted in a complete clinical recovery by Day 5 in 83.6% (46 patients) of Subgroup B, whereas only 47.3% (26 patients) of Subgroup A achieved full recovery within the same timeframe (\(p < 0.01\)). Consequently, the average length of hospital stay for Subgroup B was reduced by 2.6 days. Furthermore, follow-up monitoring over a 6-month period revealed that the recurrence rate of obstructive episodes dropped by 58.1% in children who received the optimized regimen.

The results obtained clearly signify that the high incidence and aggressive, latent progression of bronchopulmonary pathologies in the Aral Sea region are directly driven by xenobiotic environmental factors. Constant exposure to fine particulate dust, highly saturated with sodium sulfate, magnesium, and residual pesticides, destroys the tight junctions of the immature respiratory epithelium in young children.

The pronounced cytokine imbalance (high IL-8 and TNF-\(\alpha \)) confirms that chronic environmental irritation maintains a state of persistent, low-grade localized inflammation. When the local lung defenses are exhausted (demonstrated by the 44.8% drop in sIgA and surfactant protein degradation), ordinary viral triggers rapidly cascade into severe destructive pneumonia or complicated obstructive bronchitis.

Therefore, traditional symptomatic treatments are insufficient in this specific geographic zone. The superior outcomes in Subgroup B prove that adding targeted antioxidants and mucosal stabilizers successfully mitigates the toxic environmental burden. Utilizing sensitive biomarkers like SP-A and

sIgA during early screenings allows pediatricians to detect subclinical lung injuries early and implement preemptive, protective therapies before irreversible chronic respiratory remodeling takes place.

CONCLUSION: Chronic environmental exposure in the Aral Sea region significantly alters the clinical course of bronchopulmonary diseases in young children, leading to a high prevalence of atypical and latent forms (71.8%), which complicates timely diagnosis using conventional methods.

Comprehensive screening revealed that prolonged inhalation of dust-salt aerosols triggers severe local immunological failure, characterized by a 44.8% decline in secretory Immunoglobulin A (sIgA) and a concomitant rise in pro-inflammatory cytokines (IL-8 and TNF-\(\alpha \)), alongside a 38.2% reduction in Surfactant Protein A (SP-A). These molecular shifts serve as highly sensitive, pre-clinical biomarkers for early lung injury.

The implementation of an optimized therapeutic protocol incorporating targeted antioxidant therapy, membrane stabilizers, and localized immunomodulatory support demonstrated superior clinical efficacy. It achieved a complete clinical recovery by Day 5 in 83.6% of patients (compared to 47.3% in standard therapy), reduced the average hospital stay by 2.6 days, and lowered the disease recurrence rate by 58.1% over a 6-month follow-up period.

Integrating non-invasive molecular screenings (sIgA and SP-A) into primary healthcare settings in ecologically stressed zones is crucial for early detection and initiating preemptive, lung-protective therapies to prevent chronic respiratory disability in young children.

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