Bronchopulmonary dysplasia

Bronchopulmonary dysplasia (BPD), more recently **chronic lung disease (CLD)** is a neonatal form of chronic lung disease. BPD is defined as the persistent dependence of an initially immature newborn on oxygen or ventilatory support at the age of 28 days. Bronchopulmonary dysplasia shows signs of respiratory distress. The essence of the problem is the restriction of the respiratory surface of the lungs with an increase in interstitial ligament. The X-ray correlate is lung fibrotization with focal emphysema. The development of BPD involves anatomical and functional immaturity of lung tissue and the effects of infection, amniotic fluid aspiration, artificial lung ventilation, oxygen administration, etc. In addition to ventilation support and oxygen therapy, treatment includes adequate nutrition and balance of the internal environment. Protection against respiratory infections is important. Bronchopulmonary dysplasia tends to gradually regress.

The "new" form of bronchopulmonary dysplasia affects extremely low birth weight infants who initially had no or only mild ventilation support and minimal oxygen requirements.

Bronchopulmonary dysplasia is defined as persistent oxygen dependence or ventilatory support at 28 days of age. The severity of respiratory distress in early childhood due to BPD can be more accurately determined by oxygen dependence at 36 weeks postconception age in children born before 32 weeks of gestation and at 56 days in children born after 32 weeks of gestation. It is during this period that the weight of BPD is determined. It is divided according to the ventilation support needed to keep the saturation above 89 %:

- **mild BPD** - no need for oxygen therapy (at 36 weeks postconception age or 56 days);
- **moderate BPD** - if oxygen therapy is necessary up to 30 % oxygen;
- **severe BPD** - when > 30% oxygen is needed and / or CPAP (*continuous positive airway pressure*) or artificial lung ventilation is required.

The incidence of bronchopulmonary dysplasia increases with decreasing birth weight. It affects about 30 % of children with a birth weight of less than 1000 g.

The main **risk factors** for the development of bronchopulmonary dysplasia include:

- immaturity (increasing number of surviving extremely immature infants), white race, male gender,
- chorioamnitis, colonization of the tracheal ureaplasma.

Other risk factors are:

- RDS (*Respiratory Distress Syndrome*), excessive early administration of intravenous fluids, symptomatic PDA (*ductus arteriosus patens*), sepsis, oxygen therapy, vitamin A deficiency, occurrence of atopy in the family.

Pathophysiology

The following are involved in the development of bronchopulmonary dysplasia:

- **inflammation** - increased inflammatory response in the first days of life (influx of proinflammatory cytokines, macrophages and leukocytes into the alveoli);
- **artificial lung ventilation** - volumotrauma and barotrauma;
- **oxygen therapy** - hyperoxia causes proliferation of alveolar cells II. type and fibroblasts, changes in the surfactant system, increases the concentration of inflammatory cells and cytokines, increases collagen deposition and reduces alveolarization and microvascular density.

The damaged lungs heal abnormally, structural changes occur, such as slowed alveolarization and pulmonary vascular dysgenesis. Lungs affected by BPD have fewer septas, fewer alveoli, larger alveoli, reduced pulmonary capillarization, which can lead to secondary pulmonary hypertension.

The clinical picture

- Progressive idiopathic deterioration of lung function - the need for oxygen therapy and / or ventilation support after the first week of life. Increased breathing (tugging of the intercostal spaces and jugula), episodes of apnea and bradycardia, wheezing, prolonged expiration. Pulmonary edema, hyperreactive airways.
- Failure and growth retardation.
- Cor pulmonale, enlarged liver due to right heart failure or liver movement caudally due to lung hyperinflation.

Diagnosis

- anamnesis;
- characteristic clinical picture;
- ABR: carbon dioxide retention, pH usually subnormal (≥ 7.25);
- electrolytes - changes due to chronic hypercapnia (compensatory increased bicarbonate), diuretic treatment (hyponatremia, hypokalemia, hypochloraemia) and fluid restriction (increased urea and creatinine);
- typical X-ray finding - diffusely small infiltrates appear, signs of lung hyperinflation X-ray stages of

bronchopulmonary dysplasia:

I. diffuse reticulogranular lung drawing with a positive aerobronchogram,
II. continued shading of the lungs,
III. formation of numerous cysts,
IV. increasing size of individual bullous cysts and atelectases (= dystelectases) with the development of cardiomegaly,

- Functional examination of the lungs - shows obstruction (partially reversible after administration of bronchodilators).
- Chronic hypoxia, pulmonary edema and cor pulmonale develop.

Prevention

- prevention of prematurity and respiratory distress syndrome (good prenatal care, induction of pulmonary maturity with corticosteroids);
- minimization of risk factors (optimization of oxygen therapy, gentle ventilation, accurate calculation of administered fluids, PDA closure, nutrition optimization);
- vitamin A is an important factor in epithelial cell differentiation and repair; extremely immature infants have low levels of vitamin A; it can be supplemented by them;
- caffeine reduces the frequency of apnea and thus allows for earlier extubation;
- inhaled nitric oxide (iNO) reduces pulmonary vascular resistance and the need for mechanical ventilation.

Therapy

Minimization of ventilatory support

Adequate oxygenation and ventilation with acceptance of permissive hypercapnia; saturation monitoring. It is very important to achieve disconnection from the fan as soon as possible.

Improvement in lung function

- Fluid restriction (usually to 120 ml/kg/day) and increase in caloric density.
- Diuretics: furosemide (side effects: electrolyte imbalance, interference with bilirubin albumin binding capacity, calciuria and nephrocalcinosis, bone demineralization, kidney stone formation, ototoxicity); bumetanide; chlorothiazide and spironolactone (more suitable for chronic therapy than furosemide for less common side effects).
- Bronchodilators: inhaled β2-agonists for the treatment of acute exacerbations (side effects: tachycardia, hypertension, hyperglycaemia, arrhythmias), inhaled anticholinergics (ipratropium bromide), theophylline - airway smooth muscle dilatation, improvement of diaphragm contractility, respiratory center stimulation and prevention diuretic effect. Side effects: irritability, gastroesophageal reflux, gastrointestinal irritation.
- Corticosteroids: dexamethasone (side effects: impaired brain development and growth, higher incidence of cerebral palsy, risk of infection, hypertension, gastric ulcers, hyperglycaemia, adrenocortical suppression, impaired lung growth and hypertrophic cardiomyopathy), methylprednisolone, nebulized non-corticosteroids, smaller effect).
- Chest physiotherapy.

Optimizing growth and nutrition

Coverage of increased energy requirements (120 - 150 kcal/ kg/day).

Prevention of respiratory disease

Seasonal vaccination against RSV - *Human respiratory syncytial virus* (palivizumab - humanized monoclonal antibody).

Indication criteria for the Czech Republic (2014):

- Newborns with BPD born at gestational age 28 + 6 and earlier. An age limit of 12 months or 12 months from discharge from the perinatology center applies to these patients.
- Newborns born at gestational age ≤ 28 + 6 or with birth weight ≤ 1000g, without BPD, born a maximum of 6 months before the start or discharge during the RSV season.
- Newborns born at gestational age 29 + 0 - 31 + 6, without BPD, with birth weight ≤ 1500 g, born a maximum of 6 months before the start of the RSV season or release during the RSV season (1. 11. - 31. 3.).
- All neonates with BPD, regardless of gestational week, who required treatment for BPD / CLD (oxygen therapy, bronchodilator therapy, corticoids, diuretics) for 6 months before the start of the RSV season. These newborns are entitled to immunoprophylaxis up to 2 years of age.
- Hospitalized immature infants at risk of nosocomial RSV infection are entitled to 1 dose of Synagis.

Only perinatology centers are authorized to prescribe Synagis.

Home oxygen therapy

At present, long-term home oxygen therapy is possible, which makes it possible to shorten the hospital stay and thus the risk of nosocomial infection, also enables the creation of a family bond and supports the child's psychomotor development. A mobile unit with liquid oxygen is used, which allows the child to move freely. BPD / CLD tends to gradually regress, with most children ceasing to be dependent on oxygen therapy within the first year.

Complications

- Obstructive bronchitis , PPHN (persistent neonatal pulmonary hypertension), cor pulmonale, systemic hypertension, GERD (gastroesophageal reflux).

Prognosis

The prognosis of bronchopulmonary dysplasia depends on the severity of the disease and possible comorbidities. During the first year of life, rehospitalizations for wheezing and respiratory infections are common, and death can result from cardiorespiratory failure, sepsis, respiratory infections, and SIDS (sudden infant death syndrome). Most children get rid of their oxygen dependence by the first birthday, and after an improvement in lung function, a growth spurt often occurs. Most adolescents and young adults who have had moderate or severe BPD in childhood have some degree of pulmonary dysfunction - obstruction, airway hyperresponsiveness, and hyperinflation.

Bronchopulmonary dysplasia is often accompanied by impaired neuromotor and cognitive functions, and there is a higher risk of hearing loss and retinopathy of prematurity, learning difficulties, attention deficit and behavioral disorders.

Links

Sources

1. DORT, Jiří, et al. *Neonatologie : vybrané kapitoly pro studenty LF.* 1. vydání. Praha : Karolinum, 2005. ISBN 80-246-0790-5.
2. ↑ Skočit nahoru k:a b c d e f g h i j k l m GOMELLA, TL, et al. *Neonatology : Management, Procedures, On-Call Problems, Diseases, and Drugs.* 6. vydání. Lange, 2009. s. 416-421. ISBN 978-0-07-154431-3.
3. ↑ Skočit nahoru k:a b c HAVRÁNEK, Jiří: *Respirace*
4. ↑ KANTOR, L. *DOPORUČENÁ INDIKAČNÍ KRITÉRIA PRO RSV PROFYLAXI (SYNAGIS) U NOVOROZENCŮ* [online]. Česká neonatologická společnost, ©2014. [cit. 2020-10-18]. <http://www.neonatology.cz/upload/www.neonatology.cz/soubory/synagis-kriteria-2014.pdf>.
5. ↑ DORT, J a E DORTOVÁ. Dlouhodobé zkušenosti s využitím domácí oxygenoterapie v léčbě nedonošených dětí s bronchopulmonální dysplázií. *Pediatrie pro praxi* [online]. 2009, roč. 10, vol. 2, s. 114-117, dostupné také z <http://www.solen.cz/pdfs/ped/2009/02/13.pdf>. ISSN 1803-5264.