THE USE OF THE INDIVIDUAL SALINE INHALER „SALTMED®" IN PATIENTS IN CRITICAL CONDITION WITH ACUTE RESPIRATORY FAILURE CASE REPORT

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Key words: haloaerosols, halotherapy, patient in critical condition, acute respiratory failure

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Summary: The authors report the clinical and paraclinical respiratory evolution after the use of the individual saline inhaler „SaltMed" in a patient with acute respiratory failure in septic context, subject to mechanical ventilation and with severe bronchospasm. The in extremis use of this product spectacularly improved the values of O_2 partial pressure (pO_2), the CO_2 partial pressure (pCO_2) and the oxygen saturation of hemoglobin (SO_2) in the arterial blood, as well as the dynamic ventilation parameters (the peak inspiratory pressure - PIP, tidal volume - V_T). The clinical result obtained stimulates and raises the interest in the evaluation of haloaerosol use in the adjuvant therapy of patients in critical condition with acute respiratory failure and severe bronchospasm.

The halotherapy („halos" being the Greek name for salt) represent a therapeutic method that uses an environment with a controlled concentration of salt particles that simulates the natural microclimate of salinas. The speleotherapy (therapy in salinas) is used for many years and it is based on the beneficial effects of dry aerosols in sodium chloride, as well as on the adequate action of this environment from the point of view of temperature, humidity, reduced microbiological load and lack of allergens. Described in 1843 by the Polish Bochowsky, this therapeutic method is difficult to apply because of the reduced number of beds in salinas, as well as because of the need to move the patient in that environment. This is how the halotherapy appeared, which imitates the natural environment in „halochambers", by providing the patients, in rooms covered with salt, with salt aerosols with sizes ranging between 1-5 μ. The positive effects of this therapy were assessed in studies on the various kinds of respiratory failures (asthma, obstructive chronic bronchopneumopathies, bronchiectasis, mucoviscidosis), in which the evolution of the curves volume-pressure, compliance/pulmonary resistance, resistance in the respiratory tract [1,2,3] was analyzed. The positive action mechanisms of the sodium chloride dry particles are not completely clarified. From physical point of view, the salt, in contradiction to all the other crystalline structures, has a unique property: its atomic structure is not molecular, but electric, that is why it is extremely transformable. The sodium chloride aerosols have a significant negative ionic load, while the respiratory tract surface has a minimum positive load, thus the binding of these particles is more stable at the level of the bronchomucus. The sodium chloride aerosol enhances the rheology of the bronchic secretion and stimulates the mucociliary clearance [5, 6, 7]. It was proven that the patients with pseudohypoaldosteronism are not capable of making the resorption of

the liquid at the level of the airway mucus, which leads to the increase of secretions at this level. This observation leads to the conclusion that the sodium has an essential role in regulating the secretion volume at the surface of the airways [4]. On the other hand, the sodium chloride aerosol has bactericide and bacteriostatic effects on the respiratory tract microflora, it stimulates the reactivity of the alveolar macrophages and facilitates phagocytosis at this level [8,9,12]. Besides, the halotherapy leads to a decrease of the IgE levels in patients with asthma [8,13]. Consequently, the therapy with sodium chloride dry aerosols could have mucolytic, antibacterial, anti-inflammatory, immunomodulator and allergen desensitizing effects [8,9,10,11,14].

The literature that studies this subject, not a prolific one, does not mention any device similar to SaltMed, especially for patients in critical condition in the intensive care units.

The patient PE, 24 years old, 48 kg, 164 cm, is hospitalized in our clinic on 04.12.2006, being transferred from the Hematology-Transplant Clinic, with the diagnosis: Severe aplastic anemia. Thrombocytopenia. Immunodepression. Mycotic bronchopneumonia. Pulmonary hemorrhage. Acute respiratory failure. Serious sepsis. Given the immunodepression, the patient under preparation for transplant of stem cells develops a serious acute respiratory failure with fungus pathogen agent (Candida non-albicans).

When taken over in our clinic, the patient suffered from serious apnea, orthopnea, cyanosis, abundant haemoptoe expectoration, under-crepitant and sibilant rales on both lung areas, O_2 peripheral saturation of 82% with oxygenotherapy through mask, average blood pressure 110 mmHg, pulse 135/ min, sinusal rhythm, stimulated diuresis 2700 ml/the previous 24 h, afebrility. Paraclinical : Hematocrit 27%, hemoglobin 8.9 g/l, Leukocyte no. 440/ mm^3, blood platelet no. 31000/mm^3, sodium serum 145 mol/l, potassium serum 4.5 mmol/l, glycemia 152 mg/dl, urea 46,9 mg/dl, creatinine 1.09 mg/dl, GOT 46 u/l, GPT 140 u/l, total bilirubinaemia 1.08 mg/dl, positive urine culture for E.coli and positive bacteriologic expectoration examination for Candida non-albicans, subsequently confirmed by the bronchoscopic aspiration.

The patient has been following for 24 hours a deescalation therapy with Meropenem, Linezolid, Caspofungin and Aciclovir, with massive transfusion of red blood cell mass, thrombocytic concentrate, fresh frozen plasma, cryoprecipitate, with administration of corticotherapy, intravenous immunoglobulin, gastric acid-blockers and factor of leukocyte maturation. After taking over of the patient in our clinic, it was proceeded to the immediate placement of a prosthesis in the respiratory tract and to mechanical ventilation, after sedation with Midazolam and Propofol, to which low, intermittent doses of Fentanyl were added. After the beginning of the mechanical ventilation, we had problems in keeping the blood gasometry stable and optimum ventilatory dynamics. We started a bronchoscopy for the purpose of diagnosis and aspiration of secretions in the upper respiratory tract, with no improvement of the respiratory parameters. The abundant bronchial and sanguinolent secretion made the nursing of this patient extremely difficult.

The blood gasometry conducted on the arterial blood revealed the following values: pH 7.21; pCO_2 84 mmHg; pO_2 151 mmHg; SO_2 88%; HCO_3 32 mmol/l, at inspiratory oxygen concentrations of 100%.

The ventilation parameters in controlled BIPAP mode were: frequency 14/min, peak inspiratory pressure (PIP) of 48 cm H_2O, positive end-expiratory pressure (PEEP) of 7 cm H_2O, as the inspiratory volume was of only 350 ml, even after administration of

muscle relaxants (rocuronium). The oxygenation unsatisfactory parameters required the administration of an inspiratory oxygen fraction of 1. The increased resistance in the upper respiratory tract, obvious in stethacoustic exams as well as through the insufficient ventilatory mechanics, made us administer aerosols with corticoids, with betamimetic, ketamin infusion, and later sevofluran vapors, with no improvement of the bronchospasm and resistance in the respiratory tract.

In such conditions, we decided to insert in the patient's ventilation circuit, between the orotracheal intubation and the bacterial filter, a device for the vaporization of the sodium chloride, by using the SaltMed® cartridge, an external oxygen source with the flow of 2.5 l/min. and a „T" connection.

After approximately 15 minutes since the sodium chloride aerosols were inserted into the circuit, the mechanical ventilation device started the alarm for exceeding the minute-volume set for 8 l for the upper limit. By checking the ventilation parameters, we were surprised to notice that, for the same PIP of 48 cmH_2O, with high risk of barotrauma, in which inspiratory volumes of maximum 350 ml were previously obtained, over 700 ml per inspiration were now administered. The favorable evolution of gas exchanges was also obvious, with a peripheral O_2 saturation of 98-100%, which allowed us to reduce the oxygen inspiratory fraction to 0.8, and then to 0.6, with improvement of hypercapnia and complete disappearance of the sibilant rales.

The values reached 1 hour after the therapy with sodium chloride aerosols was applied were: pH 7.26; pCO_2 58 mmHg; pO_2 158 mmHg; HCO3 27.2 mmol/l, at an oxygen inspiratory fraction of 0.6.

For oxygen inspiratory volumes of approximately 500 ml, the PIP could be set to 35 cmH_2O, and the PEEP at 5 cmH_2O. This clinical condition of oxygenation, decarboxylation and favorable ventilatory mechanics maintained as long as we administered the sodium chloride aerosols. 30 minutes after their administration was stopped, the patient condition worsened as previously, that is why we inserted and continuously maintained the SaltMed® cartridge in the patient's mechanical ventilation circuit.

PARAMETER	**INITIAL**	**1 HOUR AFTER THE SALTMED® THERAPY**
pO_2	151mmHg	158 mmHg
SO_2	88%	100%
pCO_2	84 mmHg	58 mmHg
PIP	48 cmH_2O	35 cmH_2O
PEEP	7 cmH_2O	5 cmH_2O
FiO_2	1	0.6
pO_2/ FiO_2	151	263.3
Inspiratory volume	Approx. 350 ml	Approx.500 ml

Even though the subsequent evolution was toward septic shock with multiple dysfunction of organs and systems and ended by the patient's death, the amazing improvement of the gas exchanges and of the ventilatory mechanics surprised us, as practitioners used to invasive and aggressive therapies adapted to the extreme conditions of patients in critical condition.

We consider that the field of the adjuvant therapy using sodium chloride aerosols is a not explored chapter in patients in critical condition suffering from acute respiratory failure and this first spectacular result makes the initiation of studies in this field compulsory. The establishing of exact indications and contraindications, as well as of an administration protocol of the sodium chloride aerosols in patients in critical condition, according to the type and context of the respiratory failure, requires studies and actual statistic data, which could be a surprising source of clinical benefits, with minimum pharmacologic and economic implications.

Bibliography

1. Chervinskaya AV, Zilber NA. Halotherapy for treatment of respiratory diseases. *J Aerosol Med* 1995;**8**:221-232.
2. Gorbenko P, Adamova IV, Sinitsyna TM. Bronchial hyperreactivity to the inhalation of hypo and hypersomolar aerosols and its correction by Halotherapy. *Ministry of Public Health of the Russian Federation, Russian Pneumological Scientific Society Pulmonology*, 1993; 3.
3. Semochkin E, Silvestrov V, Surovikov V. Halotherapy: Complex treatment in out-patients with breathing (respiratory tract) pathologies. *Kremlin Medicine. Clinical Herald* 1999; 3.
4. Kerem E, Bistritzer T, Hanukoglu A *et al.* pulmonary epitelial sodium-channel disfunction and excess airway liquid in pseudohypoaldosteronism. *N Engl J Med* 1999; **341**: 156-62
5. Sood N, Bennett W, Zenman K *et al*: Incresing Concentration of Inhaled Saline with or without AmilorideInhaled . *Am J Respir Crit Care Med, 2003,* **167**: 158-163
6. Robinson m, Hemming AL, Regnis JA *et al*. Effects of incresing doses of hzpertonic saline on mucociliary clearance in patients with czstic fibrosis. *Thorax* 1997; **52**: 900-903
7. Robinson M, Regnis JA , Bailey DL *et al*. Effect of hypertonic saline, amiloride and cough on mucociliary clearance in patients with cystic fibrosis. *Am J Respir Crit Care Med 1996*; **153**: 1503-1509
8. Gorbenko P.P.,Strschnova O.V. Halotherapy in preventive maintenance and treatment of patients with bronchial asthma . *Pulmonology*, 1993; **2**: 61-65.
9. Chervinskaya A., Alexandrov A., Zilber N., Stepanova N. Effect of halotherapy in patients with bronchial asthma and allergic rhinitis (abstract). *XV International Congress of allergology and clinical immunology, Sweden*, 1994: 175.
10. Chervinskaya A., Alexandrov A., Strashnova O. Effect of dry sodium chloride aerosol in patients with bronchial asthma . *Allergy & Immunology* 1995; **27**: 221.
11. Chervinskaia AV,Kvetnaia AS, Cherniaev AL et al. Effect of halotherapy on resistance parameters of the respiratory tract . *Ter. Arkh*, 2002:48-52.
12. Chervinskaya A. V., Kvetnaya A. S. Therapeutical effects of the dry sodium chloride aerosol on physiological properties of the respiratory mucosa . *Pulmonology. Supplement abstract book: 3-rd Congress of European Region International Union against Tuberculosis and Lung Diseases (IUATLD).* Russia

respiratory Society 14-th National Congress on Lung Diseases, Moscow, 2004. Res. 322.
13. Chervinskaya A. V. Respiratory hygiene with the dry sodium chloride aerosol.*14th Annual Congress of the European Respiratory Society, Glasgow*, September 2004:Ref. 2514.
14. Mokina N. A., Geppe N. A. Alternative methods at bronchial asthma of children. *14th Annual Congress of the European Respiratory Society, Glasgow,* 2004: Ref. 1069.