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RESEARCH ARTICLE

Our Experience Treatment Inhalation Injury in Children in Uzbekistan

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Abstract

Thermal inhalation injury is one of the factors aggravating the course of burn disease and resulting in patient's death. According to literary data, damage to respiratory tract occurs approximately in 30% of cases with severe burn injury. Thermal inhalation injury severity can be determined not so much by airway burns but by toxic inhalation damage to the lungs and whole body with high toxic gaseous and vaporized chemical components of smoke. During a 3 year period 28 children with deep burns of III-IV degree were treated at Burns Department of Republican Scientific Center of Urgent Medical Aid (RSCUMA), Samarkand, Uzbekistan. Contemporary and timely objective evaluation of thermal inhalation damage, active endoscopic management of patients and complex therapy significantly reduce probability of tracheobronchial and pulmonary complications that makes it possible to decrease the rate of unfavorable clinical outcomes of thermic injury, particularly in the group of patients which were earlier considered as having no prospects.

Keywords

Inhalation injury, Pediatrics, Treatment

Introduction

Thermal inhalation injury (TII) makes significant proportion in general structure of burn injuries, the urgency of its study is associated with severity of its clinical course, frequency of infectious complications and high lethal outcome [1-5].

Thermal inhalation injury is one of the factors aggravating the course of burn disease and resulting in patient's death. According to literary data, damage to respiratory tract occurs approximately in 30% of cases with severe burn injury [6-8]. In thermal inhalation injury caused by inhalation of smoke activation of vasoactive mediators takes place with discharge of serotonin, histamine, kinins, prostaglandin which causes constrictions of pulmonary vessels, generalized increase of their permeability. The conditions for interstitial edema of the lungs in normal hydrostatic pressure are arised without development of the left ventricle insufficiency, with high protein content [9-11].

Increase of respiratory insufficiency degree is due to disturbance of alveolar capillary membranes and rapid development of toxic edema in the conditions of increased microcapillary permeability. At that time clearly marked systemic bronchospasm, edema of the respiratory tract mucous membrane and increase of mucous secretion develop. Gradually ventilation of various pulmonary segments is disturbed up to its complete stoppage due to obturation of one or other sections of tracheobronchial tree. Development of interstitial extravasators and decrease of surfactant level lessens pliability of pulmonary tissue, increases the work of respiratory muscles. These changes result in development of atelectasis which reduce the respiratory surface of the lungs [12,13].

Roentgenological diagnostic method for early detection of TII is insufficiently informative as it does not permit to reveal the signs of the respiratory tract damage in the day of getting injury. Bronchoscopy is a more informative method making possible to diagnose the presence of trauma, to determine the extension and severity of damage, to carry out primary medical manipulations [14]. In dynamics bronchoscopy is carried out in order to provide sanation of tracheobronchial tree, receiving of bronchial lavage for cytological and

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Table 1: Distribution of patients by age group.

Patients	Number	Total %
Under 1	3	10.7
1-3	6	21.4
3-5	8	28.6
5-14	11	39.3
Total	28	100%

microbiological studies (perhaps with administration of antibacterial therapy on sensitivity), as well as to reveal the after-effects of damage to the mucus of trachea and bronchi (fibrosis, scar stenosis).

Material and Methods

During a 3 year period 28 children with deep burns of III-IV degree were treated at Burns Department of Republican Scientific Center of Urgent Medical Aid (RSCUMA), Samarkand, Uzbekistan. The age of hospitalized patients was from 8 month to 14 years (Table 1). When the causes of the burns injuries were examined, the most causes of injuries were flame - twenty four (85.7%); and sandal burns - 4 (14.3%) [15]. Mostly patients were hospitalized the first 12 hours. Anamnesis acquisitation in admission of victims is of particular significance. Thus it was possible to choose several groups under such circumstances of getting trauma as: nearness to the focus of flame; the time of staying in the apartment with smoke; hermetization degree of the apartment due to smoke penetration or nearness to the source of the fresh air; presence of protective means for respiratory organs; the way of evacuation from the focus. The G. Frank index was used to determine the severity of a burn injury. Thermal inhalation injury victims complained of pain in swallowing, tickling in throat, pain behind the breastbone, and difficulty of breathing, dry cough with discharge of scanty sputum with soot admixture, hoarse voice and loss of voice.

On examination of victims particular attention was paid on: burns localization on the head and chest; singing of external nasal meatus hair, eyebrows, moustache, i.e., hairy part of the head; presence of soot in the oral cavity, pharynx; on auscultation - on rough breath sounds or relief of breathing in inferior portions, presence of rales. After primary examination of children diagnostic fibrobronchoscopy (diameter of endoscopes is 2.8-4.9 mm) on suspicion to thermal inhalation injury was carried out in first 24 hours after getting trauma or after transference from other in-patient departments. The aims of fibrobronchoscopy in burned patients were: - diagnosis of the spread and extent of respiratory tract damage, - restoration of patency of the tracheobronchial tree.

In 11 children (39.3%) were diagnosed with upper respiratory tract burns (from the nasal passages to the larynx and 17 children (60.7%) had lower respiratory burn. Among the victims there were 18 boys (64.3%) and 10 girls (35.7%). Endoscopic classification of the severity of airway damage was based on the presence, severity, and prevalence of signs such as hyperemia, mucosal edema, erosion, fibrin overlays, and soot.

In all cases damage to respiratory tract combined with skin burns from 8% to 70%. Bronchoscopies were performed daily until the soot was completely sanitized, and then daily or every other day, depending on the nature of endobronchitis (catarrhal, fibrinous, purulent), the amount of secretions and X-ray data (signs of hypoventilation, atelectasis). The number of sanations ranged from 1-2 for a mild lesion and up to 13 sanations per patient for a severe lesion. A 0.9% NaCl solution was used for sanitation. In the presence of a viscous or purulent endobronchial secretion, the drug fluimucil-an antibiotic, 0.5% Metrogil solution in age-related dosages was used.

The main directions of intensive therapy

- **Respiratory therapy in victims with inhalation injury:** The most dangerous complication of inhalation injury is respiratory insufficiency which develops on the background of obstruction of the upper respiratory tract and ARDS (adult respiratory distress syndrome). Clinical manifestations of respiratory insufficiency sometimes are not clear during the first 24-72 hours after getting trauma, that makes the problems of early diagnostic and indications for bronchial intubation and respiratory support most urgent.
- **Inhalation (nebuliser therapy):** Inhalation of sympathomimetics (salbutamol, 0.1% solution of adrenaline hydrochloride) every 2-4 hours up to development of clinically significant increase of heartbeat rates. Aerosol introduction of mucolitics (acetylcysteine 20% - 3 ml) every 4 hours combining with introduction of 5000 units of heparin to 3 ml of physiological solution under the time control of blood coagulation (during 7 days).
- **Infusion therapy:** The fluid volume for resuscitation could be described as follows: The total fluid volume was 2.2 ml/(%TBSA.kg) including colloid fluid 0.5 ml/(%TBSA.kg), crystalloid fluid 1 ml/(%TBSA.kg) and water 0.7 ml/(%TBSA.kg) during first 24 hours. The total fluide volume was 1.8 ml/(%TBSA.kg) including colloid fluid 0.4 ml/(%TBSA.kg), crystalloid fluid 0.7 ml/(%TBSA.kg) and water 0.7 ml/(%TBSA.kg) during second 24 hours. There were no difference in fluid management between burns and burns with inhalation injury.
- **Antibacterial therapy:** It is recommended to carry out purposeful antibacterial therapy in development of infectious complications of respiratory organs. In progressing of infectious process, administration of antibacterial therapy based on the findings of epidemiological monitoring of medical subdivision is indicated. There are no recommendations concerning

prophylactic administration of antibacterial preparation in inhalation injury based on sufficient demonstrative base.

- **Glucocorticoids:** It is indicated to use "small" doses of glucocorticoids (300 mg/24 of hydrocortisone or methylprednisolon in 2 mg/kg/24 h dose during 5-7 days) in development of ARDS.
- Nutritional metabolic support of victims with inhalation injury is directed to necessary substrate supply taking into account the body weight and severity of burn injury. Therapeutic bronchoscopy is indicated in finding the products of burning in the respiratory tract and must be directed on rehabilitation of patiency of airways, elimination of secretion, desquamated epithelium, and products of burning.

For endobronchial lavage it is advisable to use warm solution of 2% of natrium hydrogen carbonate on the basis of 5-10 ml on segmental bronchus in first 24 hours after getting trauma. In severe damage to airways by products of burning as well as in development of endobronchitis sanation bronchoscopy must be carried out at least once during 24 hours. In combination of inhalation injury with deep burns in the area of the face and neck in most cases active surgical tactics was used - application of necrotomic incisions on admission, conduction of tangential and radical necrectomy in several first days from the moment of child's admission to the in-patient department with single-moment closure of injuries with autoscin in local burns.

Bronchoscopy was carried out daily up to complete soot sanation, later on its rate depended on the character of endobronchitis and findings of roentgenological study. The number of sanations made from 1-2 in mild injury and to 9 for one patient in severe damage. In a complex with endoscopic sanations from the first day the children received inhalation therapy (oxygentherapy, broncholitics, mucolitics, inhalation steroids) through the respiratory circuit or throughnebulaser. Systemic antibacterial therapy, syndromal therapy was carried out.

The most frequent complication of inhalation injury under our supervision was the development of pneumonia, which was usually detected 3-4 days after the injury in 11 (39.3%) patients.

All children with severe damage underwent control bronchoscopy before being discharged that made it possible to reveal cicatricial stenosis of subfolded part of the larynx with degree I - 2 patients, cicatricial stenosis of subfolded part of the larynx up to 2 mm - 1 patient (stenosis bougienage was performed by cone of rigid bronchoscope with a good-effect). In 2 patients who underwent severe degree of airways burn diffuse fibrosis of trachea and bronchi mucous membrane was formed. Contemporary and timely objective evaluation of thermal inhalation damage, active endoscopic management of patients and complex therapy significantly reduce probability of tracheobronchial and pulmonary complications that makes it possible to decrease the rate of unfavorable clinical outcomes of thermic injury, particularly in the group of patients which were earlier considered as having no prospects.

Discussion

Burn injury is still one of the most widespread injuries in peaceful time. According to WHO data 30% of all varieties of traumatic injuries are associated with burns, of them 42% of burns are observed in early age children, i.e. in children up to 3-years-old. In equal condition children have deeper injuries than adults.

In the United States, 486,000 burn patients received medical treatment in 2016 [16]. 3,275 died as a result of their injuries. Fire and inhalation casualties are combined in this total; deaths from thermal burns cannot always be distinguished from fatalities resulting from the inhalation of smoke and toxins. The National Burn Repository of the American Burn Association reports up to 10.3% of the burn patients have concomitant inhalation injury [17,18]. As such, 1 in 10 burn patients surviving to admission will have the inhalation injury with the respective increase in the mortality rate. The pulmonary system has three fundamental functions: ventilation, oxygenation, and expectoration. The duration of smoke exposure, temperature of the inhaled smoke, and composition of the smoke are determinants of injury severity [9,19,20]. Inhalation injury is a composite of multiple insults including: Supraglottic thermal injury, subglottic airway and alveolar poisoning, and systemic poisoning from absorbed small molecule toxins. These contaminant insults independently affect each of the pulmonary functions as well as having a direct effect on systemic physiology. Further, anatomic characteristics can predispose patients to inhalation injury. For example, an infant will develop airway obstructions much faster than an adult due to reduced airway diameter. Understanding the contributions of each of these pathologies to the patient's disease is critical to managing inhalation injury. The acute treatment of patients with inhalation injury is based on airway management, oxygenation, and correction of hemodynamic instability [21]. Although thermal injury and oxygen depletion are significant causes of inhalation injury, carbon monoxide and cyanide contribute to toxicity. According to our data, the frequency of combined inhalation injury in severely burned children is 13.4%, and the mortality rate reaches 34%. The prognosis depends on timely and objective diagnosis of inhalation injury, adequate local treatment, and early respiratory and intensive care [22]. Severe burn in children with inhalation injury are at greater risk than adults due to immaturity of anatomical and functional structures, imperfections of protective and adaptive responses of organs and body systems, and inadequate response to stress [23]. Early

complex antibacterial therapy, sanation fibrobronchoscopy help to reduce wound, bronchopulmonary pain. Adequate infusion therapy and high-quality parenteral nutrition create optimal conditions for reparative processes in conditions of hypercatabolism during toxemia of burn disease in children. This event they allow you to reduce the time of epithelization of surface burns, perform plastic closure of deep burn wounds.

Conclusions

1. Thermal inhalation injury is not always combined with burns of skin coveries, particularly in persons stayed in smoke-screen but not burning apartment.
2. Thermal inhalation injury severity can be determined not so much by airway burns but by toxic inhalation damage to the lungs and whole body with high toxic gaseous and vaporized chemical components of smoke.
3. In thermal inhalation injury treatment a single practically hopeful method of detailed diagnostics of its severity and effective, pathogenetically based treatment is sanative PhBS added by repeated during 24 hours ultrasonic inhalation with antibiotics, broncholitics, corticosteroid hormones, anticoagulants and mucolitics carried out on the background of multicomponent antishock, desintoxic, antibacterial and immunocorrecting systemic therapy.

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