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Smoke Inhalation and Consequent Lung Injuries in a Tragedy

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Abstract:- Relevant Brazilian incidents have occurred in the last decade involving indoor fires, including the Boate Kiss and the Flamengo Training Center, smoke inhalation in these situations are relevant causes of morbidity and mortality, with consequent clinical manifestations, dyspnea, fatigue, sputum. carbonaceous disease, respiratory rhythm disorders and neurological symptoms. This literature review used the Medline, Lilacs, Pubmed and Scielo databases., between 2010 and 2019, articles in Portuguese and English, with the keywords "toxic smoke effects" and "sequelae". Burns are among the top 5 causes of death in Brazil. The inhalation of soot, when associated with the thermal injuries themselves can end up killing the individual in a few moments. This smoke released during fires consists mainly of carbon monoxide (CO) and hydrogen cyanide (HCN), in which the former competes with oxygen for hemoglobin, causing asphyxiation and the second binds to cytochrome C oxidase A and prevents mitochondrial activity. There are terrible personal and social repercussions that can be avoided if better supervision by the public authorities of these places occurs.

I. INTRODUCTION

In January 2013, in the city of Santa Maria (RS), Brazil, the Kiss night club tragedy occurred, an incident that killed 242 people in an indoor fire[1]. In February 2019, in the city of Rio de Janeiro (RJ), Brazil, another fire occurred, this time involving 10 dead and 3 injured people, among them many young soccer players of the popular Flamengo club. In these two incidents, the inhalation of toxic smoke as a cause of death for many involved was a major factor, as the reports themselves confirm.

Inhalation of smoke and consequent lung injuries lead the cause of immediate death in fire victims and specifically represent the majority of the reported causes of morbidity and mortality in fire smoke exposure[2,3]. Upon inhalation of smoke, the most frequent clinical manifestations identified are dyspnea, carbonaceous sputum, dysphonia, wheezing, sore throat, dry or productive cough, fatigue, altered breathing, and neurological symptoms such as persistent headache, memory loss, and paraesthesia, In addition to chest pain and pulmonary edema, musculoskeletal injuries and extensive burns are observed in these victims, but as a cause of thermal injuries directly[4] . The presence of several toxic inhalants in a fire in a closed environment predicts the pathophysiological component of the victim's condition almost impossible, but the presence of the harmful hydrogen cyanide (HCN) and carbon monoxide (CO) commonly found in high smoke concentrations help. in understanding these lesions[5,6]. Individuals accidentally exposed to these toxic gases usually have nonspecific symptoms[7].

Previous studies have addressed the long-term effects of smoke inhalation on the respiratory system. These studies demonstrated a decline in pulmonary function and chronic respiratory symptoms[8,9,10]. However, the evaluation of clinical manifestations resulting from accidents that cause acute toxic inhalation of smoke components is still scarce in the literature studies.

II. METHODOLOGY

This literature review used the Medline, Lilacs, Pubmed and Scielo databases from 2010 to June 2019. The keywords used were "toxic smoke effects" and "sequelae" and their corresponding " toxic smoke effects". "And" sequels ". Exclusion criteria were: articles published in languages other than Portuguese and English. After reading the titles of the articles, it was noted that some of them were repeated on different bases and others did not meet the criteria of this study. 77 articles were selected for reading the abstract and excluded those that did not concern the purpose of this study, with the largest number of exclusions referring to the non-reference to the effects of human contact with substances present in toxic fumes. After reading the abstracts, 15 articles were selected that met the initially proposed criteria and were read in full.

III. PEOPLE, DAMAGES AND THE CASE

Human disasters, also called anthropogenic, can lead to numerous deaths, morbidity and serious injuries in most cases. In the health field, they generate important imbalances about the available resources and the needs of the affected population, turning the situation into a very relevant scenario[1]. According to the World Health Organization, burns are the leading cause of skin lesions, standing out among the most frequent accidents occurring in the world, with almost 35,0000 victims in 2002, and being the fifth leading cause of death in the world. world.

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In Brazil, it is estimated that at least 1,000,000 people suffer burns a year, without distinction between sex, age, origin or social class, which ends up having major economic and social impact[2].

In this context, in recent years Brazil has experienced tragedies of national commotion related to fires, such as those that hit the Club Kiss and the training center of the Flamengo Regatta Club. Facts like these motivate the study of the consequences of these incidents, to understand the biological processes inherent in the organism of the exposed victims and to avoid new disasters, which are never accidental, as they result from human failures, either at the source of the fire or inability to do so. to assess and prevent risk[11].

In 2013, the fire in the nightclub located in Santa Maria (RS) wounded 680 people and killed 242. In similar situations, the fire was considered the 3rd largest in the world and, about the number of deaths, ranks second among the fires in Brazil. Most survivors suffered burns and inhaled toxic fumes requiring urgent and emergency care. In addition to physical damage, emotional damage was profound, thus requiring the social readjustment of these people[1]. The chemical composition and the mechanism that explains the formation of smoke in fires are very complex. In burning solid fuels, there is incomplete combustion of gases and dispersion of particles, producing a material known as soot, which is inhaled. This incomplete combustion causes the emergence of some gases such as carbon monoxide, the most toxic gas. The darker the smoke, the higher the concentration of this gas in the soot. Thus, it is possible to identify the type of fuel by the color of smoke from a fire: white or light gray smoke suggests burning of common fuels such as paper, wood, and fabrics, while black or dark gray smoke points to burning tires, oils, gasoline, greases or plastics. Red or yellow smoke, on the other hand, calls attention to the burning of liquids, which, in most cases, generates toxic gases[6].

During a fire in an enclosed environment, the oxygen concentration in the air reduces to 10-15%, causing 60-80% of sudden deaths from asphyxiation, airway burns, and pulmonary irritation. This is because the smoke consists mainly of carbon monoxide (CO) and hydrogen cyanide (HCN), which cause great systemic effects, since CO has rapid absorption of the pulmonary epithelium and high affinity for hemoglobin, competing with oxygen. , and HCN, when transported by red blood cells bound to the iron ion, binds to the enzyme "cytochrome C oxidase A" and blocks the process of cellular respiration[12]. The burned patient has other important changes, such as upper airway obstruction, associated with the formation of mucus plugs in this region, caused by deposits of materials that hinder ciliary motility. Also, the restriction caused by compressive dressings causes direct responses to pulmonary compliance, limiting the mobility of the rib cage and generating atelectasis and diaphragmatic involvement[13].

In patients with a history of exposure to smoke indoors, inhalation injury should be suspected in the presence of some signs such as tearing, severe cough, hoarseness, tachypnea, anxiety, wheezing, conjunctivitis, carbonaceous sputum, facial burn, singed nasal vibrissae, stridor, bronchorrhea , dyspnea, disorientation, obnubilation and coma. Suspicion can only be confirmed by bronchoscopic findings of airway soot or early inflammatory changes in the tracheobronchial mucosa, such as hyperemia, edema, necrosis, scaling or ulceration[14]. Although one has a general idea of the main mechanisms, it is not possible to predict all the pathophysiological changes caused by smoke toxins, considering the variety of components involved in pyrolysis. This is due to the unpredictable rate of byproduct formation, which depends on the temperature, space, and composition of the environment[16].

The combustion of materials such as rubber and plastic produces sulfur dioxide, nitrogen dioxide, ammonia, and chlorine, which when combined with water in the airways forms strong acids and bases. Due to the increasingly constant use of synthetic materials in building construction, fires in more modern buildings progress with severe inhalation injuries and worse clinical outcomes in victims compared to fires in older buildings. Among the materials most likely to cause lower airway injuries are those with the highest solubility, such as plastics, wood, rubber, wallpapers, cotton and acrylics[15]. The burns of the victims of the Kiss Club occurred due to the combustion of the toxic by-product of polyurethane, nylon, wool, and cotton present in the soundproofing material of the place. These by-products quickly caused inhibition of aerobic metabolism, which resulted in cell death, as there was intense oxygen deprivation to the cells, causing tissue anoxia by inhibiting some enzymes, leading to the accumulation of acid metabolites [2].

In analyzes taken after the nightclub fire in Santa Maria, the prevalence of medium-term respiratory signs and symptoms among people who inhaled toxic gases was discussed. Among the people who inhaled toxic smoke in the fire, the most frequent manifestations related to the inhalation injury were sore throat, tearing and hoarseness. Also, it is important to highlight that the clinical manifestations characteristic of the acute phase of inhalation injury were discussed by the study participants and persisted after eight months of episode[8].

In other post-disaster studies, it was noted that the main stakeholders were male individuals with complete or ongoing higher education and a predominance of non-smokers. Economic vulnerability and more markedly social vulnerability were reported by the sample. Among the pre-existing comorbidities, the most common were rhinitis and sinusitis. Regarding respiratory symptoms, it was noticed that they remained after 10 months of the event, representing a very large impact on the health of individuals, requiring careful monitoring in the following years[6]. Some complementary exams may be useful in the evaluation of fire victims, as they help define the type of

injury and guide its treatment and prognosis, such as radiology, spirometry, laboratory tests, and arterial blood gas analysis. Thus, the performance of these tests may be crucial for the best management of the case and to intervene before complications appear[15]. Inhalation of smoke causes respiratory complications that represent the main cause of acute respiratory failure in burn patients. Inhalation injury (LI) represents a 20 to 70% increase in morbidity and mortality of burned patients compared to other individuals with similar burns but without inhalation injury[14].

Other studies estimate overall mortality among burned patients considering factors such as inhalation injury along with age greater than 60 years and Burned Body Surface (SCQ)> 40% as an independent factor of death, whereas in the presence of only one of these factors, mortality is 3%, increasing to 33% and 90% respectively with two or all factors present[16]. Early complications occur from 1 to 5 days, causing pulmonary edema to acute respiratory distress syndrome (ARDS). Thus, ventilatory strategies for reversing IL should be started as early as possible, including orotracheal intubation (OTI), in most cases, maintaining 100% oxygen therapy, ventilatory support, and airway maintenance [17]. Another point to be emphasized is that certain pre-existing comorbidities such as sinusitis, asthma and chronic bronchitis can cause a greater involvement of the airways, causing the symptoms to be exacerbated and these patients to have a worse prognosis[8].

Regarding responsibilities, when assuming an engineering project, regardless of the type of work, the engineer must be legally responsible for the intended part. This means that if there are failures, this professional should be responsible for them if they occur. This also applies to all other projects involved in work, and the responsible engineer is responsible for the consequences, whether involving morbidity or mortality[7]. The social disorders caused by fires are very significant. Approximately 20% of organizations suffering from fire action disappear forever. Market loss and unemployment for most people are other highly relevant factors. Also, the treatment of burns is a very long process, in most cases taking years, leaving aesthetic scars and marks on people's social life, often irreparable damage that could be avoided[10].

IV. CONCLUSION

Given the above, the severity of the fires and the consequent increase in the population morbidity and mortality rate caused by them have already been stressed. Therefore, it is extremely important to focus on the prevention of these events, through more active supervision of buildings and establishments, evaluating the quality of the products that are present, their validity and proper installation.

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