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Inhalation injury after exposure to indoor fire and smoke: The Brazilian disaster experience

Tatiana Helena Rech [a], *Márcio Manozzo Boniatti* [a,*], *Cristiano Augusto Franke* [a], *Thiago Lisboa* [a], *Iuri Christmann Wawrzeniak* [a], *Cassiano Teixeira* [b], *Juçara Gasparetto Maccari* [b], *Felipe Schaich* [b], *Angelica Sauthier* [c], *Luciele Medianeira Schifelbain* [d], *Diego Fontoura Mendes Riveiro* [e], *Deisi Leticia Oliveira da Fonseca* [e], *Paula Pinheiro Berto* [f], *Leonardo Marques* [f], *Moreno Calcagnotto dos Santos* [g], *Vanessa Martins de Oliveira* [g], *Carlos Fernando Drumond Dornelles* [c], *Sílvia Regina Rios Vieira* [a]

[a] *Department of Intensive Care Medicine, Hospital de Clínicas de Porto Alegre, Ramiro Barcelos, 2350, Porto Alegre, Brazil*
[b] *Department of Intensive Care Medicine, Hospital Moinhos de Vento, Ramiro Barcelos, 910, Porto Alegre, Brazil*
[c] *Department of Intensive Care Medicine, Hospital de Pronto Socorro de Porto Alegre, Largo Teodoro Herzl, Porto Alegre, Brazil*
[d] *Department of Intensive Care Medicine, Hospital de Caridade Dr. Astrogildo de Azevedo, Presidente Vargas, 2291, Santa Maria, Brazil*
[e] *Department of Intensive Care Medicine, Hospital Cristo Redentor, Domingos Rubbo, 20, Porto Alegre, Brazil*
[f] *Department of Intensive Care Medicine, Santa Casa de Misericórdia, Professor Annes Dias, 295, Porto Alegre, Brazil*
[g] *Department of Intensive Care Medicine, Hospital Nossa Senhora da Conceição, Francisco Trein, 596, Porto Alegre, Brazil*

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ABSTRACT

Objective: To describe the pre-hospital, emergency department, and intensive care unit (ICU) care and prognosis of patients with inhalation injury after exposure to indoor fire and smoke.

Materials and methods: This is a prospective observational cohort study that includes patients admitted to seven ICUs after a fire disaster. The following data were collected: demographic characteristics; use of fiberoptic bronchoscopy; degree of inhalation injury; percentage of burned body surface area; mechanical ventilation parameters; and subsequent events during ICU stay. Patients were followed to determine the ICU and hospital mortality rates.

Results: Within 24 h of the incident, 68 patients were admitted to seven ICUs. The patients were young and had no comorbidities. Most patients (n = 35; 51.5%) only had an inhalation injury. The mean ventilator-free days for patients with an inhalation injury degree of 0 or I

* *Corresponding author at*: Dolores Duran, 1584/185, ZIP Code 91540-220, Porto Alegre, Brazil. Tel.: +55 5133598000.
E-mail address: mboniatti@hcpa.edu.br (M.M. Boniatti).

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was 12.5 ± 8.1 days. For patients with an inhalation injury degree of II or III, the mean ventilator-free days was 9.4 ± 5.8 days ($p = 0.12$). In terms of the length of ICU stay for patients with degrees 0 or I, and patients with degrees II or III, the median was 7.0 days (5.0–8.0 days) and 12.0 days (8.0–23.0 days) ($p < 0.001$), respectively. In addition, patients with a larger percentage of burned surface areas also had a longer ICU stay; however, no association with ventilator-free days was found. The patients with <10% of burned body surface area showed a mean of 9.2 ± 5.4 ventilator-free days. The mean ventilator-free days for patients who had >10% burned body surface area was 11.9 ± 9.5 ($p = 0.26$). The length of ICU stay for the <10% and >10% burned body surface area patients was 7.0 days (5.0–10.0 days) and 23.0 days (11.5–25.5 days) ($p < 0.001$), respectively.

Conclusions: We conclude that burn patients with inhalation injuries have different courses of disease, which are mainly determined by the percentage of burned body surface area.

1. Introduction

Burns are a major global public health problem. It is estimated that over 300,000 people die from burns each year worldwide. Most accidents occur at home or in the workplace, affecting mainly men and children [1]. Due to the progress made in the care of severely burned patients, burn-related mortality has decreased in recent years, whereas inhalation injury has become the leading cause of death among these patients [2]. The mortality rates related only to smoke inhalation are low (0–11%); however, the mortality rates related to smoke inhalation combined with skin burns may reach 90% [3].

On the night of January 27, 2013, a fire spread through the soundproofing material of a crowded nightclub in the city of Santa Maria in southern Brazil. Indoor smoke inhalation was the main cause of death in this fire disaster. The polyurethane foam used to soundproof the walls of the nightclub caught fire and spread toxic fumes, causing death by suffocation. It is very difficult to determine the exact amount of toxic substances that were inhaled in the smoke indoors because there are many materials in indoor roofs; however, carbon monoxide and cyanide are common in many cases of toxic smoke inhalation [4,5].

Managing patients with inhalation injury is very complex, and there are several controversial aspects involved. On admission, fiber-optic bronchoscopy (FOB) is a useful diagnostic test because it helps establish the severity of the injury and diagnose the inhalation injury. The degree of the inhalation injury is associated with an increased incidence of ventilator-associated pneumonia (VAP), a longer duration of mechanical ventilation (MV), and a longer length of stay in the intensive care unit (ICU) [6,7]. The following are some of the controversial aspects of managing these patients: time to repeat the FOB; ventilation mode; indication of extracorporeal circulation; prophylactic use of corticosteroids and antibiotics; inhaled use of heparin and n-acetylcysteine, and the benefit of the delayed use of hydroxocobalamin. These controversial aspects are unlikely to be tested in randomized clinical trials.

To the best of our knowledge, this is the largest cohort of patients with smoke inhalation injuries caused by an indoor fire that has been described in the literature. The objective of the present study was to describe the pre-hospital, emergency department and ICU care, and the prognosis of patients with an inhalation injury after exposure to indoor fire and smoke.

2. Material and methods

2.1. Design and ethic aspects

We conducted a prospective observational study. The patients who were admitted to seven ICUs (one in the city of Santa Maria and six in Porto Alegre, the state capital) after the tragedy were included in the study. The present study was approved by the Research Ethics Committee of each center. Participants were not required to sign a consent form due to the observational nature of the study.

2.2. Data collected

The following data were collected: demographic characteristics, use of FOB, degree of inhalation injury, percentage of burned body surface area, MV parameters (i.e., baseline tidal volume, positive end-expiratory pressure (PEEP), plateau pressure, and PaO_2/FiO_2) and subsequent events during the ICU stay (i.e., incidence of VAP, acute respiratory distress syndrome (ARDS), prone position, extracorporeal membrane oxygenation (ECMO), extubation failure, tracheostomy, renal replacement therapy and skin infections). Patients were followed to determine the number of ventilator-free days and mortality rates during the ICU and hospital stays. Each center decided on the performance of the FOB and its frequency. Flexible bronchoscopes (Olympus Medical Systems Corporation, Hamburg, Germany) were used at all of the centers. The degree of the inhalation injury was determined by three experienced pulmonologists who performed all of the bronchoscopies in the seven centers and in accordance with the classification of Chou et al., as follows: 0, no mucosal lesion; I, mild edema and hyperemia with or without soot; II, severe edema and hyperemia with or without soot; and III, ulceration, necrosis, no cough reflex or bronchial secretion [8].