Smoking-Related Home Oxygen Burn Injuries: Continued Cause for Alarm

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Key Words

Smoking · Home oxygen therapy · Chronic obstructive pulmonary disease · Combustion injury · Burns · Substance abuse

Abstract

Background: Home oxygen therapy is a mainstay of treatment for patients with various cardiopulmonary diseases. In spite of warnings against smoking while using home oxygen, many patients sustain burn injuries. **Objectives:** We aimed to quantify the morbidity and mortality of such patients admitted to our regional burn unit over a 6-year period. **Methods:** A retrospective chart review of all patients admitted to a regional burn center from 2008 through 2013 was completed. Admitted patients sustaining burns secondary to smoking while using home oxygen therapy were selected as the study population to determine morbidity. **Results:** Fifty-five subjects were admitted to the burn unit for smoking-related home oxygen injuries. The age range was 40–84 years. Almost all subjects were on home oxygen for chronic obstructive pulmonary disease (96%). Seventy-two percent of burns involved <5% of the total body surface area, 51% of patients were intubated, and of those 33% had evidence of inhalation injury. The hospital mortality rate was

14.5%. The mean length of hospital stay was 8.6 days, and 54.5% were discharged to a nursing home or another advanced facility. Finally, concomitant substance abuse was found in 27%, and a previous history of injury from smoking while on home oxygen was discovered in 14.5%. **Conclusions:** This single-center analysis is one of the largest describing burn injuries stemming from smoking while using home oxygen therapy. We identified the morbidity and mortality associated with these injuries. Ongoing education and careful consideration of prescribing home oxygen therapy for known smokers is highly encouraged.

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Introduction

Oxygen therapy is a common treatment employed for patients demonstrating hypoxemia from various cardiopulmonary diseases. Of these diseases, chronic obstructive pulmonary disease (COPD) is the most common indication for oxygen therapy worldwide. It is estimated that of the 15 million patients in the United States that

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have COPD, over 800,000 patients currently receive oxygen therapy at an annual cost of 2.3 billion dollars per year [1, 2]. Studies assessing the use of oxygen therapy to correct hypoxemia in COPD patients have demonstrated many important benefits including increased survival, improved quality of life, and decreased hospitalizations [3, 4]. Importantly, the seminal randomized controlled trials demonstrating these benefits included active smokers in their population. While the efficacy of oxygen therapy is undisputed, medical providers continue to deliberate over whether to offer it to known smokers. Most providers recognize that burn injuries associated with oxygen use can cause serious and life-threatening risks to their patients, the patients' cohabitants, and emergency responders. Unfortunately, up to 52% of patients who use oxygen therapy continue to smoke in spite of these risks and their ongoing hypoxemia [5]. While oxygen providers may counsel patients to avoid open flames and recommend signage attesting to the presence of oxygen, patients may either forget these instructions or disregard them altogether.

We conducted a retrospective review of burn injuries sustained from smoking on oxygen therapy that were admitted to our regional burn center. Our goal was to confirm that this is an ongoing problem and to classify our morbidity. We hope this information will enable us to better counsel our patients about the hazards of smoking with oxygen therapy.

Materials and Methods

This study was conducted with the approval of the Indiana University Institutional Review Board. We conducted a retrospective review of admissions to our regional burn center from 2008 through 2013. The Richard M. Fairbanks Burn Center at the Sidney and Lois Eskenazi Hospital in Indianapolis, Ind., USA, is the largest burn unit in the area, averaging 350 admissions per year. From this burn unit database, we reviewed discharge diagnoses to identify 84 subjects admitted after injury involving smoking, cigarettes, or home oxygen therapy over the 6-year study period. We excluded individuals who sustained cigarette injuries unrelated to oxygen therapy and those who experienced burns from home oxygen plus a source besides smoking (candles, lighting a stove, and grease fires). Over our 6-year period, we identified 55 subjects out of approximately 2,000 in the database with smoking-related oxygen therapy burn injuries necessitating admission.

Two authors working independently performed a review of the included medical records and cross-checked each other for accuracy and completeness. Demographic information, oxygen prescription, location of injury including bystander presence, and medical comorbidities were all recorded. Following identification, each subject was screened using the Indiana Network for Patient Care [6], a regional health information exchange tool, to look for

Table 1. Demographics, oxygen prescriptions, and comorbidities

Age range (mean), years	40–84 (62)
Race, n (%)	
African-American	3 (5.5)
White	51 (92.7)
Asian	1 (1.8)
Sex, n (%)	
Female	24 (44)
Male	31 (56)
Reason for oxygen therapy, n (%)	
Emphysema	53 (96)
Asthma	4 (7)
Oxygen dose, n (%)	
1 liters/min	0
2 liters/min	9 (20.9)
3 liters/min	15 (34.9)
4 liters/min	11 (25.6)
5 liters/min	3 (7.0)
6 liters/min	3 (7.0)
10 liters/min	1 (2.3)
>10 liters/min	1 (2.3)
Unknown	12 (21.8)
Oxygen delivery method, n (%)	
Canister	31 (56)
Concentrator	22 (40)
Unknown	2 (4)
Comorbidities, n (%)	
Diabetes mellitus	18 (32.7)
Coronary artery disease	17 (30.9)
Congestive heart failure	13 (23.6)
Anemia	7 (12.7)
Pulmonary hypertension	6 (10.9)
Obesity	7 (12.7)
Obstructive sleep apnea	3 (5.5)
Cancer	4 (7.3)
Dementia	5 (9)
Psychiatric condition	14 (25)
Depression	12 (21)
Schizoaffective disorder	2 (3.6)
Substance abuse	15 (27.3)
Alcohol abuse	10 (18.2)
History of illicit drug use	5 (9)

evidence of prior oxygen therapy-related injury, substance abuse history, and smoking cessation counseling. To evaluate the extent of each injury, we recorded the percent of total body surface area burned, locations of injury, need for intubation, and presence of inhalation injury. Inhalation injury was confirmed by notation of airway edema, soot and/or erythema of the tracheobronchial tree on bronchoscopic reports. We additionally analyzed the number of operative procedures performed including tracheostomy for each subject following injury. Total length of stay, length of intensive

Table 2. Morbidity data and discharge disposition

Intubated	28 (51)
Ventilator days	
Median (range)	1 (0–53)
Mean $\pm$ SD	4.2 $\pm$ 8.5
Intensive care unit days	
Median (range)	4 (1–53)
Mean $\pm$ SD	7.4 $\pm$ 8.8
Hospital length of stay	
Median (range)	5 (1–53)
Mean $\pm$ SD	8.6 $\pm$ 9.3
Inhalation injury	18 (32.7)
Sloughing	2 (3.6)
Soot	10 (18.1)
Edema	6 (10.9)
Erythema	8 (14.5)
Operations	9 (16.3)
Autograft	8 (14.5)
Homograft	7 (12.7)
Debridement	7 (12.7)
Tracheostomy	4 (7.4)
Discharge disposition	
Home	25 (45.5)
Home with services	6 (11)
Subacute rehabilitation facility	8 (14.5)
Long-term acute care facility	6 (11)
Acute rehabilitation facility	2 (3.6)
Death	8 (14.5)

Values are n (%), unless otherwise indicated.

care unit stay, and number of ventilator days were recorded. Finally, we noted the discharge disposition for each subject including mortality, location, and ongoing prescriptions for oxygen therapy.

Analysis

All information was recorded in a web-based Research Electronic Data Capture (REDCap) database [7]. Descriptive statistics were then used to characterize the population and analyze and interpret our specified study metrics.

Results

We identified 55 patients admitted with smoking-related burn injuries over a 6-year period from January, 2008, through December, 2013. Our study population demographics are shown along with prescription flow rates and comorbidities (table 1). The number of patients in our population who admit to smoking while using home oxygen is unknown, but our physicians estimate our per-

Fig. 1. Example of facial burn from smoking a cigarette while using home oxygen (http://www.tobaccofacts.info/dangers_of_tobacco.htm).

centage to be in keeping with previous studies (25–33%) [3, 4]. Most burn injuries identified occurred at home (93%). In 24 patient instances (44%), other adults were in the home at the time of the event. We found evidence of children in the home in 3 cases. In 5 cases, it was noted that the initial burn led to a house or apartment fire.

Seventy-two percent of burns involved <5% total body surface area burned. The majority of burns (87%) involved the face (fig. 1), and 11% involved one or both hands. Twenty-five patients underwent bronchoscopy to evaluate for airway injury, and 18 patients had injuries as described (table 2).

Over half (51%) of the subjects required intubation for respiratory failure, 9 subjects required plastic surgical interventions, and 4 eventually required tracheostomy (table 2). Two subjects were living in an Extended Care Facility on admission, and 29% were discharged to a facility. Mortality was 14.5%, and mean length of hospital stay was 8.6 days (median 5). Of those that died, the mean time to death was 10 days following hospital admission (range 1–53). There were 43 survivors (78%) discharged with oxygen after the injury. Seven subjects (13%) were noted to have documented evidence of counseling about smoking cessation and oxygen use prior to combustion injury. Eight subjects (14.5%) were found to have a prior cigarette-oxygen therapy-related injury, and a history of substance abuse was noted in the medical record in 27%. Repeat injuries occurred in 14.5% of our subjects, and we

found that 78% of subjects were discharged with home oxygen and only 13% had documented evidence of prior counseling regarding smoking cessation.

Discussion

Smoking remains an addictive habit for many of our patients. In our state, Indiana, USA, the smoking rates are approximately 24% for adults over the age of 18 years [8]. These rates demonstrate the addictive power of cigarettes as many people continue to smoke in spite of the known risks of cardiovascular disease, COPD, and lung cancer. It may be no surprise that many patients who are prescribed oxygen therapy for severe cardiopulmonary diseases continue to smoke in spite of the burn risks as well. Our review of our burn database affirms the high morbidity and mortality that can be seen with these injuries. Similar to other authors, we found these patients to generally be older, have a higher rate of inhalation injury, and a longer hospitalization despite smaller body surface area injuries [9].

Ongoing education and very careful consideration regarding withholding home oxygen to substance abusers or prior burn-injured patients is called for particularly at our institution given our repeat occurrence and counseling rates. Given the effects carbon monoxide has on oxygen uptake, carrying capacity, and tissue delivery, we question the utility of home oxygen use in smoking patients with hypoxemia. Further studies would help elucidate if the effects of smoking mitigate any physiologic or clinical benefit from oxygen therapy in this population.

Despite relatively low percent body surface area involvement (most subjects had 1–5% body surface area burns), oxygen therapy burn victims experience significant morbidity (table 2). Our findings are similar to previous studies of burn patients injured while on oxygen therapy [6, 9–11]. It is not surprising that these patients have a high morbidity in part because they already have a baseline disease state (96% COPD) that renders them medically jeopardized. Perhaps in part due to their pre-existing medical conditions, we found that 54.5% of our subjects were discharged with home health or to a care facility. This is significant in that the majority of admissions came from home (93%), indicating transition to a higher level of care on discharge. A 2008 study noted a similar trend with 47% of their population requiring higher levels of care on discharge [11]. Oxygen therapy-related burns lead not only to complex and expensive hospital stays but to increased health care utilization after discharge as well.

Finally, over the 6-year study period, there were 8 deaths following admission to a specialized burn unit. This 14.5% hospital mortality is higher than in previous studies of similar size [6, 10]. All deaths involved withdrawal of life-sustaining interventions including mechanical ventilation due to the catastrophic nature of the injury coupled with the underlying illnesses. All deaths had documentation of over >20% body surface area involvement. In 4 of the deaths, the combustion caused a house fire leading to more extensive injury and smoke inhalation. Notably, in 16 records we noted stories of collateral damage involving house fires, other occupants in the household also injured by fire, and reports of children in the home at the time of fire. Two patients caused fires in their assisted living facilities. We are not the first to recognize the risk posed by smoking on oxygen therapy to health care workers. A recent review identified that 9% of home health aid visits were to residences with home oxygen of which 25% patients were identified as smokers [12].

There are some limitations to our study. We do not know the prevalence of smokers who smoke while using home oxygen in our population, but we estimate that it is around 25–33%. Also, we only assessed patients that were admitted and were not able to include patients treated in the Emergency Department for minor burns. We were not able to capture patients who died at the scene or patients that died in the Emergency Department. Another limitation was our inability to discern oxygen dose in 12 patients. We suspect that there is an increased risk for oxygen therapy burn injuries as the oxygen dose increases, but we cannot reliably make this assertion based on our data.

In conclusion, our findings suggest that smoking-related home oxygen burn injuries cause morbidity in our population. We agree with our colleagues that further work is needed to better characterize the magnitude of these potential risks and to inform the development of practice guidelines that help clinicians make appropriate determinations about the safety and effectiveness of home oxygen, particularly in known smokers [13]. We believe that aggressive educational and smoking cessation efforts should be employed in this population in an effort to avoid the harmful effects of this explosive combination. As part of this effort, we would ask that guidelines developed for COPD stress the dangers of smoking while on oxygen therapy. Currently, a minority of international COPD guidelines state or stress the risks of smoking on home oxygen therapy [14]. An exception would be the Swiss Guidelines for COPD Diagnosis and Management which specify the criteria for home oxygen therapy and state that ‘smoking cessation is a requirement for long-

term oxygen therapy' [15]. At our institution, we intend to use the information from our analysis to counsel our patients about the consequences of choosing to smoke on oxygen therapy.

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Statement of Ethics

All ethical standards have been adhered to and respected.

Financial Disclosure and Conflicts of Interest

The authors have no potential conflicts of interest with any companies/organizations whose products or services may be discussed in this article.