Title Page

Smoking Related Home Oxygen Burn Injuries: Continued Cause for Alarm

Authors:

William G. Carlos, MD, MS[1]

Mary S. Baker, MD[1,2]

Katie A. McPherson, MD[1]

Gabriel T. Bosslet, MD, MA[1,2]

Rajiv Sood, MD[3,4]

Alexia M. Torke, MD, MS[2]

[1]Division of Pulmonary/Critical Care/Allergy and Occupational Medicine, Department of Medicine, Indiana University School of Medicine, Indianapolis, IN; [2]Charles Warren Fairbanks Center for Medical Ethics, Indiana University Health, Indianapolis, IN; [3]Richard D. Fairbanks Burn Center, Eskenazi Health, Indianapolis, IN; Division of Plastic Surgery, Department of Medicine, Indiana University School of Medicine, Indianapolis, IN[4]

Corresponding author information: William G. Carlos, MD, Division of Pulmonary/Critical Care/Allergy and Occupational Medicine, Department of Medicine, Indiana University School of Medicine, Gatch Hall 1120 West Michigan Street, Indianapolis, IN 46202. Email: wcarlos@iu.edu

Key words: smoking; home oxygen therapy; COPD; combustion injury; burns; substance abuse

Author contributions:

WGC, MSB, KM, and AMT had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. MSB, AMT, WGC contributed to the design of the review database and decisions of data-points collected. MSB, AMT, WGC, KM, GTB contributed to data analysis. MSB, AMT, WGC, GTB, RS contributed to manuscript preparation.

Financial/nonfinancial disclosures: The authors have no potential conflicts of interest with any companies/organizations whose products or services may be discussed in this article. All ethical standards have been adhered to and respected.

This is the author's manuscript of the article published in final edited form as:

Carlos, W. G., Baker, M. S., McPherson, K. A., Bosslet, G. T., Sood, R., & Torke, A. M. (2016). Smoking-Related Home Oxygen Burn Injuries: Continued Cause for Alarm. Respiration, 91(2), 151–155. http://doi.org/10.1159/000443798

Funding: This work was supported by the Charles Warren Fairbanks Center for Medical Ethics, which is funded by the Richard M. Fairbanks Foundation and the Methodist Health Foundation, all located in Indianapolis, Indiana

Notation of prior abstract publication/presentation: ACCP Annual conference, Chest 2014, Austin, TX, oral presentation of original research while in progress

Running Head: Morbidity Analysis: Burns from Smoking on Oxygen

Descriptor Number: 6.17

Mesh Headings: Pulmonary Disease, Chronic Obstructive; Burns, Inhalation

Total Word Count (Body): 1715

Abstract

Introduction: 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 warranting hospital admission. We quantified 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 2008-2013 was completed. Admitted patients sustaining burns secondary to smoking while using home oxygen therapy were selected as the study population. This population was then analyzed to determine morbidity based on standard criteria.

Results:

We identified 55 subjects admitted to the burn unit for smoking related home oxygen injuries. Age range was 40-84 years. Almost all subjects were on home oxygen for COPD (96%) and 79% of the burn injuries involved flow rates of 3L or higher. Seventy-two percent of burns involved less than 5% TBSA, 51% of patients were intubated, and of those 33% had evidence of inhalation injury. The hospital mortality rate was 14.5%. Mean length of hospital stay was 8.6 days and 54.5% were discharged to a nursing home or other 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 significant morbidity and mortality associated with these injuries in spite of low total body surface involvement. Despite efforts to counsel patients on the possibility of combustion injuries secondary to smoking on home oxygen these injuries continue to be prevalent. Ongoing education and careful consideration of prescribing home oxygen therapy for known smokers is highly encouraged.

Text

Introduction:

Home oxygen therapy (HOT) 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 HOT worldwide. Studies assessing the use of HOT to correct hypoxemia in COPD patients have demonstrated many important benefits including increased survival, improved quality of life, and decreased hospitalizations.[1, 2] It is estimated that of the 15 million patients in the United States that have COPD, over 800,000 patients currently receive home oxygen therapy at an annual cost of 2.3 billion dollars per year.[3, 4]

While the efficacy of HOT is undisputed, medical providers continue to deliberate over whether to offer HOT to known smokers. Most providers recognize that burn injuries associated with home oxygen can cause serious and life-threatening risks to their patients, the patient's cohabitants, and emergency responders. Unfortunately, up to 52% of patients who use HOT continue to smoke in spite of these risks and their ongoing hypoxemia.[5] While home 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 HOT that were admitted to a regional burn center. Our goals were to better characterize the

morbidity of these injuries and determine if our incidence rates were comparable to previously published data.

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, Indiana 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 HOT and those who experienced burns from home oxygen plus a source besides smoking (candles, lighting a stove, grease fires). Over our six-year period we identified 55 subjects out of approximately 2000 in the database with smoking related HOT burn injuries necessitating admission.

Two authors working independently performed 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 evidence of prior HOT 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

(TBSA), 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 care unit (ICU) stay and number of ventilator days were recorded. Finally, we noted the discharge disposition for each subject including mortality, location, and ongoing prescription for HOT.

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 over a six-year period from January, 2008 through December, 2013. Our study population demographics are shown along with prescription flow rates and comorbidities (Table 1). Most injuries (93%) occurred at home. 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 five cases it was noted that the initial burn led to a house or apartment fire.

Seventy-two percent of burns involved less than 5% TBSA. The majority of burns (87%) involved the face and 11% involved the 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, nine subjects required plastic surgical interventions, and four 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 days). 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-HOT related injury and a history of substance abuse was noted in the medical record in 27%.

Discussion:

Smoking remains an addictive habit for many of our patients. In our state, Indiana U.S.A, the smoking rates are an astounding 24% for adults over age 18.[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 HOT 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]

Interestingly, we discovered high rates of substance abuse history and previous smoking related HOT injury among our study population. While we do not have demographic data of our entire population to make definitive correlations, to our knowledge this association has not

been previously described and thus warrants more investigation. We speculate that individuals who have a record of "throwing caution to the wind" may be more likely to attempt to smoke while using home oxygen. Interestingly, in spite of the high prevalence of repeat injuries (14.5%), we found that 78% of subjects were discharged with home oxygen and only 13% had documented evidence of prior counseling regarding smoking cessation. Ongoing education and very careful consideration regarding withholding home oxygen to substance abusers or prior burn injured patients is called for. 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 HOT in this population.

Despite relatively low percent BSA involvement (most subjects had 1-5% BSA burns) HOT burn victims experience significant morbidity. (Table 2) Our findings are similar to previous studies of burn patients injured while on HOT.[6, 9-11] It is not surprising that these patients have a high morbidity in part because they already have a severe 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] HOT related burns lead not only to complex and expensive hospital stays but to increased health care utilization after discharge as well.

Finally, over the six-year study period, there were eight deaths following admission to a specialized burn unit. This 14.5% hospital mortality is higher than previous studies of similar size.[6, 10] All deaths involved withdrawal of life sustaining interventions including mechanical ventilation due to catastrophic nature of the injury coupled with the underlying illnesses. All deaths had documentation of over > 20% BSA involvement. In four of the deaths, the combustion caused a house fire leading to more extensive injury and smoke inhalation. Notably, in sixteen 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 HOT to healthcare workers. A recent review identified that 9% of home-health aid visits were to residences with home oxygen of which 25% identified as smokers.[12]

There are some limitations to our study. We only assessed patients that were admitted and were not able to include patients treated in the Emergency Department for minor burns. We also were not able to capture patients who died at the scene or patients that died in the Emergency Department. We believe that inclusion of this data this would only serve to increase the prevalence and perhaps morbidity of smoking related HOT burns. Another limitation was our inability to discern oxygen dose in 12 patients. We suspect there is an increased risk for HOT burn injuries as oxygen does increases but without knowing the actual dose at the time of injury of the prevalence of each dose in our population we cannot reliably make this assertion.

In conclusion, our findings suggest that smoking related home oxygen burn injuries continue to be prevalent. 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 HOT. Currently, a minority of international COPD guidelines state or stress the risk of fires associated with smoking.[14] With ongoing attention to this important issue we how our local experience helps influence change.

References

1. Long term domiciliary oxygen therapy in chronic hypoxic cor pulmonale complicating chronic bronchitis and emphysema. Report of the Medical Research Council Working Party. Lancet 1981; 1(8222):681-6.

2. Nocturnal Oxygen Therapy Trial Group. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. Ann Intern. Med. 1980; 93 (3):391-8.

3. Ward MM, Javitz HS, Smith WM, Bakst A. Direct medical cost of chronic obstructive pulmonary disease in the U.S.A. Respir Med 2000; 94(11):1123-9.

4. Dunne PJ. The demographics and economics of long-term oxygen therapy. Respir Care 2000; 45(2):223-228.

5. Vercruysse GA, Ingram, WA. A rationale for significant cost savings in patients suffering home oxygen burns: despite many comorbid conditions, only modest care is necessary. Journal of Burn Care and Research 2012; 33(6):e268-74.

6. Indiana Network for Patient Care. http://www.ihie.org/indiana-network-for-patient-care

7. Research Electronic Data Capture (REDCap) database. http://redcap.uits.iu.edu

8. Centers for Disease Control. [Accessed 2014 November 5] Available from: http://apps.nccd.cdc.gov/brfss/list.asp?cat=TU&yr=2012&qkey=8161&state=all.

9. Murabit A, Tredget EE. Review of burn injuries secondary to home oxygen. Journal of Burn Care and Research 2012;33(2):212-7.

10. Amani H, Lozano DD, Blome-Eberwein S. Brother. Have you got a light? Assessing the need for intubation in patients sustaining burn injury secondary to home oxygen therapy. Journal of Burn Care and Research 2012; 33(6)e280-285.

11. Murabit A, Tredget EE. Review of burn injuries secondary to home oxygen. Journal of Burn Care and Research 2012; 33(2):212-17.

12. Galligan CJ, Markkanen PK, Fantasia LM, Gore RJ, Sama SR, Quinn MM. A growing fire hazard concern in communities: home oxygen therapy and continued smoking habits. New Solut. 2015; 24(4):535-54.

13. Al Kassis S, Savetamal A, Assi R, Crombie RE, Ali R, Moores C, et al. Characteristics of patients with injury secondary to smoking on home oxygen therapy transferred intubated to a burn center. J Am Coll Surg. 2014; 218(6):1182-6.

14. Litt EJ, Ziesche R, Happak W, Lumenta DB. Burning HOT: revisiting guidelines associated with home oxygen therapy. Int J Burns Trauma. 2012;2(3):167-70.

Tables

Table 1: Demographics, oxygen prescriptions, and comorbidities.

Age (mean)	40-84 (62)
Race (%)	
African-American	3 (5.5)
White	51 (92.7)
Asian	1 (1.8)
Sex (%)	
Female	24 (44)
Male	31 (56)
Reason for HOT (%)	
Emphysema	53 (96)
Asthma	4 (7)
Oxygen dose LPM (%)	
1	0
2	9 (20.9)
3	15 (34.9)
4	11 (25.6)
5	3 (7.0)
6	3 (7.0)
10	1 (2.3)
>10	1 (2.3)
Unknown	12 (21.8)
Comorbidities (%)	
DM	18 (32.7%)

CAD	17 (30.9)
CHF	13 (23.6)
Anemia	7 (12.7)
Pulmonary hypertension	6 (10.9)
Obesity	7 (12.7)
OSA	3 (5.5)
Cancer	4 (7.3)
Substance abuse	15 (27.3)

Table 2: Morbidity data and discharge disposition.

Intubated (%)	28 (51)
Ventilator days, median (range) , mean (SD)	1 (0-53) , 4.2 (8.5)
ICU days, median (range), mean (SD)	4 (1-53) , 7.4 (8.8)
Hospital LOS, median (range), mean (SD)	5 (1-53) , 8.6 (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 rehab	8 (14.5)
LTAC	6 (11)
Acute rehab	2 (3.6)
Death	8 (14.5)