Retrospective Pilot Study to Examine Potential Predictors of a Standardized Scoring System for Smoke Inhalation Injury

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Introduction

Burn victims forced to breathe heated smoke are at increased risk of morbidity and mortality compared to those with burns alone. There is currently no standardized scoring system for smoke inhalation severity and most scoring systems that do exist are highly subjective. Standardized assessment of the presence and severity of smoke inhalation is imperative to develop successful treatment algorithms and improve outcomes. Bronchoscopy is the gold standard for diagnosing and stratifying severity of smoke damage to the pulmonary system. Its performance is highly dependent on the presence of an endotracheal tube, and the interpretation of the bronchoscopic results tends to be subjective and varies widely among hospitals and burn centers. Bronchoscopy at many institutions is based upon the abbreviated Injury Score and is a visual assessment whereby the interpreter gives a numerical score which is currently scored as follows: 0 (no injury)= absence of any carbonaceous deposits, erythema, edema, or bronchorrhea, 1 (mild injury)= minor erythema, carbonaceous deposits or bronchorrhea, 2 (moderate injury)= moderate erythema, carbonaceous deposits, or bronchorrhea, 3 (severe injury)= severe inflammation with friability, copious carbonaceous deposits, or bronchorrhea, 4 (massive injury)= mucosal sloughing, necrosis, endoluminal obstruction. This study was undertaken to assess multiple factors including history, clinical findings such as carbon sputum, voice changes and soot on clothing, carbon monoxide, as well as bronchoscopy to improve the reliability of diagnosing and determining the severity of inhalation injury. The study specifically examined variables that could be used to create an accurate smoke inhalation injury scoring system.

Methods and Materials

This is a retrospective evaluation of burn victims with the concern for possible smoke inhalation at the time of admission to the ED who then received care from a regional verified Burn Center in Lubbock, TX. Inclusion criteria consisted of: age 18-89, admission to UMC between Jan 1st, 2004 and May 31st, 2018, intubation at the scene or on admission, and suspected diagnosis of smoke inhalation injury along with burn injury. Data extracted included demographics, history of event specifically focusing on enclosed space fires, clinical presentation (voice changes, wheezing, carbon sputum, red oropharynx, soot on clothes/skin), carboxyhemoglobin level, need for intubation, bronchoscopy, additional comorbidities, hospital course, and outcomes associated with heated smoke inhalation such as significant increased fluid resuscitation needs above predicted, pneumonia rate (confirmed by positive culture) and mortality. Bronchoscopy findings included the following: red mucosa, carbon particles at the carina, and/or a numerical score ranging from 1-4 given by the physician performing the procedure. The primary outcome was the total of resuscitation fluid the patient required over the course of the first 24 hours of treatment as compared to the predicted amount given by the current ABA recommended resuscitation formula (2cc*patient weight in kg* Total Burn Surface Area). A patient was considered positive for smoke inhalation injury in our study if resuscitation fluid received within the first 24 hours exceeded that predicted by the ABA recommended formula; if this condition was not met, the patient was not considered to have inhalation injury. Differences between the predictors and outcome variables were determined using a Wilcoxon rank sum test for continuous variables and Chi-squared test for categorical. Significance levels were set at 0.05.

Differences Between Patients with a Diagnosis of Smoke Inhalation Injury based on Excess Resuscitation Fluids

Smoke Inhalation Injury	No (n=16)	Yes (n=61)	p-value
TBSA	28 (13.5 – 40)	15 (3-36)	0.13
Carboxyhemoglobin level	1.4 (0.3 -2)	1.4 (0.45-3.10)	0.54
Positive Enclosed Space	13 (81.25)	43 (70.49)	0.53
Positive physical exam	7 (43.75)	42 (68.85)	0.06
Positive Bronchoscopy	7 (43.75)	54 (88.52)	<0.001
Initial BUN	13 (9.5-23)	13 (12-16)	0.41
Initial Creatinine	0.6 (.5-1.6)	0.9 (0.8-1.2)	0.71
Pre-arrival Fluids(ml)	3500 (1425-12103.5)	2000 (1300-3000)	0.24

Table 1. Sample characteristics between patients who were determined to have a positive smoke inhalation injury based on the condition of receiving excess resuscitation fluid and those who did not receive excess fluids. Data was summarized using a median (interquartile range) for continuous variables and frequency (percentage) for categorical data.

Differences in Pneumonia Incidence and Mortality Between Patients with a Diagnosis of Smoke Inhalation Injury Based on Excess Resuscitation Fluids

Smoke inhalation injury	No (n=16)	Yes (n=61)
Pneumonia	3	18
Mortality	3	12

Table 2. Mortality and pneumonia incidence comparison among smoke inhalation injury and non-injury groups. Pneumonia incidence in the non-injury group was 18.75% as compared to 29.5% in the injury group. Mortality rate in the non-injury group was 18.75% as compared to 19.6% in the injury group.

Resuscitation Requirements in Patients with Smoke Inhalation Injury

	Yes	No
Number of patients requiring over 50% more fluid than estimated within the 1st 24 hours	56	5

Table 3. volume status distribution of patients who met our condition of positive smoke inhalation injury by requiring more resuscitation fluid within the 1st 24 hours of hospitalization than estimated based on the current ABA resuscitation formula. 56 out of the 61 patients positive for smoke inhalation (91.8%) received over 50% more fluid than estimated. Out of the 5 patients who did not, 2 received approximately 40% more fluid resuscitation than estimated.

Results

150 patients admitted with a concern for smoke inhalation injury were included in the study, of which 77 fit our inclusion criteria and underwent analysis. There was no significant difference between those who fit our condition of a positive smoke inhalation injury and those with no inhalation injury in regard to total burn surface area alone (TBSA; p=0.13, Table 1), TBSA separated into higher respective percentages of 2nd/3rd degree burns (p=0.418, Table 4), blood carboxyhemoglobin level (p=0.54, Table 1), enclosed space (p=0.53, Table 1), or a positive physical exam (p=0.06, Table 1), initial BUN (p=0.41, Table 1), initial creatinine (p=0.71), or pre-arrival resuscitation fluids (p=0.24). Incidence of pneumonia in our total population was 27.2% (n=21) and mortality rate was 19.5% (n=15). In patients with smoke inhalation injury, the incidence of pneumonia was 10.8% higher than in non-injury patients (Table 2) and mortality rate was increased by 0.92% (Table 2).

In assessing all parameters used to determine the risk for and severity of smoke inhalation, bronchoscopy was 9 times more significant than any history, physical finding, or lab value (p<0.001, Table 1).

Hypothesis Test Summary

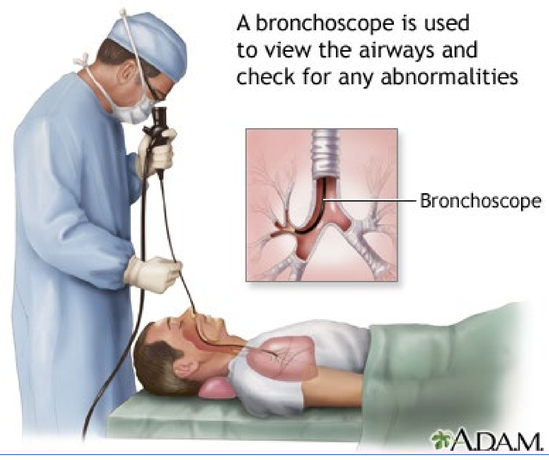
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Second-Degree Burn is the same across categories of Smoke Inhalation Injury.	Independent-Samples Mann-Whitney U Test	.158	Retain the null hypothesis.
2	The distribution of Third-Degree Burn is the same across categories of Smoke Inhalation Injury.	Independent-Samples Mann-Whitney U Test	.534	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 4. Hypothesis Test Summary comparing distribution of 2nd and 3rd degree burns in smoke inhalation injury and non-injury groups

Conclusions

Out of all of the variables used to assess for the possibility of smoke inhalation, the only assessment that ultimately establishes the diagnosis of smoke inhalation is bronchoscopy. Moving forward, all efforts should be placed on objectifying the bronchoscopic findings to improve diagnosis as severity assessment in these patients.



Visual representation of bronchoscopy
Source: MedlinePlus.gov

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