

Inhalational Injury: The Philippine General Hospital Experience (2008-2013)

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Objective: Profiling of burn patients with inhalational injury will lead to better practices in the immediate and supportive management of their injuries. The goal of this study was to determine demographic and clinical factors associated with mortality in burn patients with inhalational injury admitted at Philippine General Hospital - Alfredo T. Ramirez (PGH - ATR) Burn Center from 2008 to 2013.

Methods: All patients who were admitted from 2008 to 2013 were included in the study. The patient database was searched for cases of burn patients with inhalation injury. Medical records were reviewed for further analysis. This study was exempted from review by the University of the Philippines Manila Research Ethics Board.

Results: Out of 1900 burn patients included in the study, 134 presented with concomitant inhalation injury with a prevalence rate of 7.0% and with a mortality rate of 38.06%. The study showed that the following variables: 1) percent total body surface area (%TBSA), 2) length of time from injury to resuscitation, 3) nebulization with N-acetylcysteine, 4) development of pneumonia, 5) administration of systemic antibiotics, and 6) performance of bronchoscopy correlated significantly with patient outcomes ($p < 0.05$). Other variables did not show significant correlations with outcomes. The study also revealed that most of the patients were males with a mean age of 30.62, who sustained severe burns usually greater than 39% TBSA.

Conclusion: Poorer prognostic indicators include: 1) larger burnt body surface area, 2) delayed intubation, 3) delayed resuscitation, and 4) development of pneumonia.

Keywords: Burn, inhalational injury

Burn injuries are devastating to patients and their families. These injuries change patients' lives, physically and psychologically. The pain and distress caused by a large burn are not limited to the immediate post burn period, but persist up to the time patients return to their homes and communities. Visible physical and invisible psychological scars are long lasting and often lead to chronic disability.¹ Burn injuries represent a diverse challenge to the medical and paramedical staff; correct management requires a skilled multidisciplinary team approach that addresses all the problems facing a burn patient.

Certain factors increase the risk of death - the most important of which are: increasing age, larger burn size, and the presence of inhalation injury. Evidence suggests a patient aged over 60 with a burn covering more than 40% of body surface area with inhalation injury has a >90% chance of dying.²

Pulmonary complications, such as inhalation injury, adversely affect the outcomes of patients with burn injuries. It significantly complicates the care of burn patients and consistently increases their morbidity and mortality.³ Inhalational injury independently increases the risk of death in burn patients over that predicted by age and burn size alone by a maximum of 20%. It also

increases the risk of pneumonia; in turn, pneumonia acts independently to increase the risk of death by a maximum of 40%.⁴

Most important in the management of a burn patient is early diagnosis of inhalation injury, in order to identify those patients who merit close ICU observation and possibly, prophylactic intubation. However, not one physical or historical finding is highly sensitive or specific for the diagnosis of inhalation injury.⁵ Chest radiographs are routinely obtained, but only to provide a baseline since they are normal on admission in 92% of patients with inhalation injury.⁶

In the Philippines, the incidence of burn and inhalation injury remains high. The Bureau of Fire Protection statistics showed that the number of fire incidents nationwide continues to increase from 2010 to 2012. Twenty-seven percent (27%) of all fires during those years had reported casualties - 33.5% of which were deaths and 65.9% were injuries.⁷

The Alfredo T. Ramirez Memorial Burn Center of the University of the Philippines- Philippine General Hospital (PGH-ATR Burn Center) admits around 300 patients per year. A previous study made by Sy, et al. showed that the mortality rate was 77% in all inhalation injuries admitted at the PGH-ATR Burn Center in 2002.⁸ A subsequent study by Cruz, et al. in 2006 revealed a still significant mortality rate of 63.64% in all burn patients with inhalation injury.⁹ Despite the advances in burn management and improved approaches by a multi-disciplinary team of burn surgeons, pulmonologists and anesthesiologists working closely, mortality remains significant.¹⁰ Advances in the management with inhalation injury especially in performing immediate and repeated bronchoscopy, early intubation and nebulization with N-acetylcysteine (NAC) and heparin have decreased the mortality rate of patients with inhalation injury.¹¹ In the Philippines, there is little available data to give an accurate picture regarding the outcome of burn patients with inhalation injury. This study aimed to determine the factors associated with outcomes in burn patients with inhalation injury. The results may influence current practices and guidelines in the management of patients with inhalation injury.

Methods

Inclusion criteria

All burn patients with inhalation injury admitted to the Philippine General Hospital-Alfredo T. Ramirez (PGH-ATR) Burn Center from 2008 to 2013 no later than 48 hours from injury. Inhalation injury is suspected based on clinical history and physical examination (i.e. burn patients who presented with history of burns in a closed space, patients with facial burns, singed nostrils, sooty phlegm, hoarseness or stridor, circumferential chest burns, etc.). The burn team - composed of burn consultants, junior and senior burn residents assess and diagnose the patients as to having inhalational injury or not. All ISIS entries with a diagnosis of inhalational injury are included in the study. Final diagnosis of inhalational injury is made upon concurrence with the Section of Pulmonology of the Department of Medicine.

Exclusion criteria

Patients referred from other hospitals more than 48 hours from injury.

Methodology

The Integrated Surgical Information System (ISIS) of the Department of Surgery of UP-Philippine General Hospital electronic patient database from January 01, 2008 - December 31, 2013 was searched for cases of patients with the diagnosis of inhalation injury. Included in the medical records search were:

- Age at diagnosis
- Sex
- Etiology of burn injury
- Total body surface area (TBSA%) affected
- Presence and depth of facial burns
- Whether the patient was intubated or not, if intubated, what was the time interval from injury to intubation
- Whether bronchoscopy was performed or not and the time interval of bronchoscopy from injury and the number of patients who underwent bronchoscopy.
- Use of N-acetylcysteine (NAC)/ heparin nebulization
- Systemic antibiotic administration

- Presence of co-morbid medical illness
- Development of pneumonia
- Length of time from injury until the initiation of resuscitation
- Survival

This study was exempted from review by the University of the Philippines Manila Research Ethics Board.

Data Analysis

Stata version 12.1 (College Station, TX: StataCorp LP) was used in data analysis. Descriptive statistics such as mean, median and range were used in continuous data. Frequency and percentage were used in categorical data. Chi-square test, Mann-Whitney U test and Fisher's exact test were used to determine the significant relationship between demographic, clinical characteristics and patient survival.

Results

There were approximately 1,900 burn patients admitted in UP-PGH ATR Burn Center from 2008-2013. This study considered 134 burn patients with concomitant inhalation injury with a prevalence rate of 7.0%. Fifty-one (51) of the 134 patients died from burn injury infection and/or associated illness giving a mortality rate of 38.06%.

The demographic and clinical profile of burn patients with inhalation injury is presented in Table 1.

Ninety-four (70.15%) were males, while 40 (29.85%) were females. The mean age was 30.62 (18.35%). The youngest was 17 days old and the oldest was 85 years old.

Majority of the patients suffered from flame burns followed by electrical injury with flame component, flash burns and patients who did not present with cutaneous burns. One hundred eighteen (88.06%) of the total 134 patients sustained facial burns. Ninety (90) had superficial partial thickness burns, 21 incurred deep partial thickness burns, 5 incurred full thickness burns. Most of the patients were classified to have major burns. The mean TBSA was 39%, median was 35% (range 0-98).

Table 1. Demographic and clinical profile of burn patients with inhalational injury, 2008-2013 (N=134).

	Number (%)
Age (years)	
Mean	30.62
Median	31.50
Range	0.1 - 85
Sex	
Female	40 (29.85)
Male	94 (70.15)
Total burnt surface area (%)	
Mean	39.00
Median	35
Range	0 - 98
Etiology of burn injury	
Flame burn	105 (78.36)
Electrical injury with flame component	14 (10.45)
Inhalation injury without cutaneous burn	4 (2.99)
Flash burn	11 (8.21)
Presence of facial burns	118 (88.06)
Length of time from injury to resuscitation (hrs)	
Mean	5.79
Median	4
Range	0.25 - 24
Intubation (hours)	
Mean	8.03
Median	6
Range	0.25 - 27
Number of patients who underwent bronchoscopies	
1x	67 (50.00)
2x	59 (88.05)
8	11 (11.94)
Use of NAC/Heparin nebulization	104 (77.61)
Development of pneumonia	43 (32.09)
Administration of systemic antibiotics	117 (87.31)
Co-morbidities	
Hypertension	20 (14.93)
Diabetes mellitus	6 (4.48)
Cardiovascular disease	2 (1.49)
URTI	2 (1.49)
Asthma, COPD	1 (0.75)
Pneumonia	3 (2.24)
Autism	1 (0.75)
Mortality	51 (38.06)

Table 2. Distribution of burn patients with inhalational injury according to demographic, clinical characteristics and survivor and non-survivor, 2008-2013.

	Survivor	Non-survivor	p-value
Age (years)			
N	83	51	
Mean (SD)	31.80(17.34)	28.68(19.93)	
Median	32	30	0.284 ^a
Range	0.1 - 68	0.2 - 85	
Sex (%)			
Male (n = 94)	64.89	35.11	0.280 ^b
Female (n = 40)	55.00	45.00	
Total burnt surface area (%)			
N	83	51	
Mean (SD)	27.74(18.77)	57.32(23.87)	
Median	23	55	<0.0001 ^a
Range	0 - 75	20 - 98	
Facial burns, %			
Yes (n = 118)	60.17	39.83	0.137 ^b
No (n = 16)	75.00	25.00	
Length of time from injury to resuscitation (hours)			
N	83	51	
Mean (SD)	4.71 (4.52)	7.54 (5.95)	
Median	4	6	<0.0008 ^a
Range	0.25 - 23	1-24	
Intubation (hours)			
N	27	44	
Mean (SD)	6.33 (4.78)	8.73 (5.74)	
Median	6	7.5	<0.112 ^a
Range	0.25 - 27	1 - 24	
Bronchoscopy (%)			
Yes (n = 67)	73.13	26.87	0.008 ^b
No (n = 67)	50.75	49.25	
Number of patients who underwent bronchoscopy			
1x	42	17	0.433 ^c
2x	7	1	
Nebulization (%)			
Yes (n = 104)	56.86	43.14	0.031 ^b
No (n = 30)	78.13	21.88	
Development of pneumonia (%)			
Yes (n = 43)	39.53	60.47	<0.0001 ^b
No (n = 91)	72.53	27.47	
Systemic antibiotics (%)			
Yes (n = 117)	56.41	43.59	0.001 ^b
No (n = 17)	100.00	0	
Co-morbidities (%)			
Yes (n = 29)	61.94	38.06	0.677 ^b
No (n = 105)	62.86	37.14	

^a Mann-Whitney U-test^b Chi-square test^c Fisher's exact test

Patients were resuscitated upon arrival at the emergency room using the standard protocol of the PGH-ATR Burn Center.¹² A mean of 5.81 hours from injury to initial resuscitation was recorded (range 0.25-24 hours). Forty-nine patients were intubated upon admission with a median of 6 hours and mean of 8.03 hours (range 0.25-27 hours).

Fiber-optic bronchoscopy was performed in 67 (50%) patients. Among these patients, 73.13% survived while 26.87% led to mortality. It is noted that 27 (20.14%) patients were not able to undergo bronchoscopy because either the patient was unstable or the bronchoscope was unavailable. Seven (7) out of 8 who had serial bronchoscopies had improved outcome.

There were 104 (77.61%) patients nebulized with the bronchodilator, N-acetylcysteine alone or a combination of N-acetylcysteine + heparin. Forty-three (32.09%) patients developed pneumonia during their stay in the burn center. A total of 117 (87.31%) patients received systemic antibiotics.

Thirty-five patients had associated co-morbid conditions. Hypertension was noted in 20 (14.93%) patients, diabetes mellitus in 6 (4.48%), Cardiovascular disease in 2 (1.49%), upper respiratory tract infection in 2 (1.49%), asthma/chronic obstructive pulmonary disease in 1 (0.75%), pneumonia in 3 (2.24%), and autism in 1 patient.

The distribution of burn patients included in this study is presented in Table 2, which also tabulates the statistical correlation of the mentioned parameters with disease outcome (survival versus non-survival).

Discussion

Over the past decades there has been remarkable improvement in the survival of patients treated in Burn Centers. This success can be attributed to a number of therapeutic developments including early diagnosis and treatment, adequate fluid resuscitation, advances in critical care and nutrition, early excision of burn wounds, powerful topical and systemic antibiotics and availability of medical practitioners, nurses and ancillary staff trained in the care of severely burnt patients. During the earlier years (2000-2005), only 2 residents were assigned in the

PGH-ATR burn center. This has now improved, to include one senior resident, one junior resident and one or two burn rotator/rotators. This increase in medical and surgical manpower has led to early recognition of problems and intervention in patients admitted at the PGH-ATR Burn Center.

Present results showed that the variables: % TBSA, length of time from injury to resuscitation, non-nebulization with NAC with or without heparin, development of pneumonia, use of systemic antibiotics, bronchoscopy and number of patients who underwent repeated bronchoscopies were statistically significant when correlated with patient mortality ($p < 0.05$). The bronchoscopy data reinforce currently accepted opinion that bronchoscopy in patients with inhalation injury is not only for diagnostic, but for therapeutic purposes as well.¹³ Age, gender, etiology of burns, presence and depth of facial burns, intubation interval from time of injury and existence of co-morbidities did not show significant correlation with patient mortality.

The mortality rate on this series was computed to be at 38.06%, significantly lower compared to earlier studies by Sy, et al.⁸ and Cruz, et al.⁹ Causes of death include pneumonia, sepsis and multiple organ dysfunction syndromes. Although this mortality rate has decreased, it is still significant when compared to the overall mortality rate of all patients with burn injuries.

The investigators attribute the decrease in mortality rate to the increased manpower in the PGH-ATR Burn Center, adherence to established protocols leading to quicker response time in dealing with potential life-threatening complications and the improvement in overall patient care.

For many years, it was accepted that age and extent of burn injuries were the two most important determinants of mortality in patients with inhalation injury.¹⁴ However, in the present study, age did not correlate significantly with mortality. This is similar to the finding of Tan, et al. that age is not a significant predictor of mortality in the PGH setting.¹⁵ A possible reason is that most of the patients in all age groups admitted had significant % TBSA involvement which by itself is a significant predictor of mortality in burn patients in the same setting.¹⁵ The PGH is the national referral center for

burns, as such, patients with large % TBSA involvement are sent to the PGH-ATR Burn Center.

The length of time before initiating resuscitation from time of injury among survivors had a median value of 4 hours (mean 4.71 hours, range 0.25-23 hours) compared to non-survivors who were resuscitated with a median of 6 hours from time of injury. This shows the importance of early resuscitation in establishing adequate fluid volumes in these patients in quickest possible time.²

Delay in airway protection significantly increased the rate of mortality.¹⁶ When upper airway injury is suspected, prophylactic/elective intubation should be considered because progression of edema over the next 24-48 hours may make intubation difficult if not impossible.

Among the seventy-one (71) intubated patients, only 27 survived (median 6 hours, mean 6.33 hours and range 0.25-27 hours). This time interval from injury to intubation shows that patients who were intubated within 6 hours had a better chance of surviving compared to those whose intubation was delayed. However, intubation did not correlate significantly with patient outcome. Those who were intubated had higher %TBSA involved, and were the patients with poorer prognosis because of the severity of injury.

Patients who were not nebulized with N-acetylcysteine with or without heparin showed improved survival, this maybe explained by the clinical judgment of the burn team in the non-prescription of these nebulizing agents in patients with less severe inhalation injuries. This finding is not consistent with the current literature wherein pharmacologic adjuncts, like N-acetylcysteine and heparin, can help improve prognosis.¹¹ This inconsistency maybe further verified in future studies wherein a protocol provides for the nebulization with the above pharmacologic agents in all patients with inhalation injury.

There were 117 patients treated with systemic antibiotics. Among these patients, 56.41% had improved outcome. Systemic antibiotics were not routinely given in burn patients unless procedures such as bronchoscopies and surgical procedures, or presence/development of respiratory complications were anticipated. Antibiotic therapy is initiated based on the PGH-ATR Burn Center service manual.¹²

Among the 134 burn patients involved in the study, 38% had co-morbidities. These included diabetes, hypertension and pulmonary disease. However, these did not correlate significantly in terms of mortality in this group of patients.

Furthermore, 43 patients eventually developed pneumonia. Among these patients, 60% led to mortality. In the study of Cruz, et al. in 2006, 53% developed pneumonia.⁹ The incidence of pneumonia among patients with inhalation injury remains high and that the mortality from this complication is still significant. This also adds to higher cost of hospital expenses as well as increases the length of hospital stay.

It has been proven in many studies that the % TBSA correlates with poorer outcomes.⁸ Patients who died in this study had an average injury of 55% total body surface area while those who survived have an average injury involving 23% TBSA. This research is supportive of previous studies correlating % TBSA and mortality.¹⁵ In the Cruz, et al. study, those who did not survive have an average injury of 45% TBSA.⁹

Lastly, a study by Catindig in 2004 regarding pediatric burn patients in PGH, showed that the larger area of injury involved led to severe consequences and poorer outcome.¹⁷

Conclusion

This study showed that most of the patients who suffered from inhalation injury were males with a mean age of 31 years, who sustained severe burns mostly greater than 39% TBSA. These patients were managed and resuscitated as early as 4 hours from time of injury and were treated accordingly depending on the clinical assessment and severity of patient condition. Patients with larger total burnt body surface area, those whose intubation was delayed, those whose resuscitation was delayed and those who developed pneumonia eventually had poorer outcomes.

Non-nebulization with adjunct pharmacologic agents NAC with or without heparin correlates with better outcomes, however, this finding needs to be further verified in future studies due to its inconsistency with the current available literature.

Early detection and management of inhalation - related burn injuries are absolutely essential in improving outcomes and decrease the mortality rate in patients with inhalation injury.

The findings in this study may be utilized for the development of institution specific protocols for inhalation injuries that may be duplicated at similar institutions across the country and similar settings in other developing countries. Further studies looking at multiple factors such as length of stay, microbiological studies, and surgical management among others should be performed for a better analysis of the interaction of these factors affecting the clinical outcomes of burn injured patients.

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