Burn Therapy: *

III. Beware the Facial Burn!

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IN THE PRECEDING PAPER, respiratory tract damage is revealed as a principal killer of the burned patient today.[2] This paper is concerned with the ominous significance of deep flame burns around the nose and mouth and with other clues to the presence of damage in the respiratory tree. The signs and symptoms of that damage, together with the x-ray findings and the pathologic changes, are dealt with in the paper to follow.[3]

The major findings are as follows: 1) the patients who suffer damage to their respiratory tracts generally have been burned by flames and in enclosed spaces; 2) the development of respiratory difficulties is closely correlated with the presence of second or third degree burns of what might be called the respiratory area of the face, the area around the nose and mouth; and 3) such deep burns of the respiratory area are associated with an increased mortality rate and, in many of those who survive, with prolonged hospitalization.

Material and Plan of Study

The patients included in this study are described in detail in the second paper.[2] Nine hundred and thirty-two patients were studied of whom 181 developed respiratory difficulties. One hundred and six died. Death in 46 cases is attributed partially or entirely to respiratory tract damage.[2]

As a preliminary study, the role of the burning agent in producing respiratory damage and in determining the final outcome has been investigated. The incidence of respiratory difficulties has been tabulated for each burning agent, and the findings considered in the light of each patient's age, health prior to injury, extent of burn, and extent of full thickness skin damage. Mortality rates have been similarly calculated and compared. An explanation for some of the findings has been sought, and has been found in the subsequent investigation of the importance of flame burns of the face. Since the majority of the cases of respiratory difficulty have been found in patients injured by flames, the remainder of the study has been confined to flame burn cases.

The effect of confinement of the patient and fire in an enclosed space on the incidence of respiratory difficulties has been studied in 398 of the 410 flame injury cases. The remaining 12 were excluded because they were admitted more than a week after injury. The location of each patient at the time of the burn, confined or out-of-doors, has been tabulated with the presence or absence of respiratory difficulties.

Flame injuries of the face have been evaluated as portents of respiratory tract damage. The location and severity of the

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TABLE 1. *Incidence of Respiratory Difficulties in Patients with Thermal Injuries from Various Burning Agents*

Burning Agent	Respiratory Difficulties %	No. Patients
Flame	40	161
Hot liquids	3	9
Electricity	4	2
Chemicals	9	3
Steam	3	1
Semi-liquid semi-solids	4	2
Hot objects	4	3
Ultraviolet light	0	0
Total		181

facial burn in each case have been correlated with the respiratory findings.

The duration of hospitalization in patients with and without second degree flame burns of the respiratory area of the face has been compared for all patients with minor and superficial cutaneous burns. Those with deep and extensive burns were excluded from this last portion of the study, lest the effects of respiratory tract damage on hospitalization be masked by skin-grafting procedures or other time-consuming factors.

Observations

I. Clues to the Presence of Respiratory Tract Damage

Certain questions have evolved from this study which, if asked when the burned patient is admitted to the hospital, provide clues to the presence of respiratory tract damage.

TABLE 2. *Influence of Enclosure of the Patient on the Incidence of Respiratory Difficulties*

Location of Patient	No. Cases	Respiratory Difficulties No.	Respiratory Difficulties %
Not Enclosed	77	10	13
Enclosed	321	151	47

A. What Was the Burning Agent? Volatile Chemicals and Combustion Products Injure the Airway. An overwhelming majority of the patients who develop respiratory difficulties were injured by flames. Such difficulties were experienced by 40 per cent of the flame injury cases and by only three per cent of those burned by all other agents (Table 1). Even if the 36 patients suffering from pre-existing pulmonary or cardiac disease are eliminated from the flame burn cases, the difference remains striking. Three hundred and sixty patients, all of whom were apparently healthy prior to flame injury, encountered respiratory difficulties (32%).

In chemical burns the volatility and irritating properties of the chemical determined the effect on the respiratory tract. Patients burned by volatile irritants, such as hot trichlorethylene and fuming nitric acid, had severely disturbed respirations, while those exposed to less volatile or non-irritating chemicals had few, if any, respiratory symptoms.

B. Were Patient and Fire in an Enclosed Space? Confinement Increases Respiratory Irritation. Respiratory difficulties developed in almost half of the patients who were burned while indoors, but in only 13 per cent of those burned out-of-doors (Table 2). Of the 398 flame burn cases, 321 were in enclosed spaces at the time of injury, and the remaining 77 were burned out-of-doors. The difference in incidence of respiratory difficulties between the two groups is statistically significant ($P < 0.01$).

C. Are There Facial Burns? Burns of the Respiratory Area Go Hand in Hand with Respiratory Difficulty. The incidence of respiratory difficulties in patients with burns of the respiratory area of the face was 59 per cent, more than twice that occurring in patients whose faces were spared (Table 3). Patients who sustained only peripheral face burns encountered essentially the same

amount of respiratory difficulty as those whose faces were spared (23%).

D. *Are the Facial Burns Deep? First Degree Burns Are of Little Moment; Deep Burns Threatening.* There was little difference in the incidence of respiratory difficulties between the 87 patients having first degree burns of the face and the 139 patients having no facial burns (25 versus 22%). However, in 172 patients with second or third degree burns the incidence was 63 per cent, more than twice as high as in those with faces spared (Table 4).

E. *Did the Patient Sustain Deep Burns of the Respiratory Area Indoors? This Combination Proves to be the Most Deadly.* The combination of enclosure, severe facial burns, and the location of those burns in the respiratory area resulted in respiratory difficulty for 88 per cent of the patients so afflicted. In contrast, those receiving such severe burns out-of-doors suffered little respiratory difficulty (Table 5). On statistical analysis the association between the location and severity of the burn and the occurrence of respiratory difficulties proves highly significant. The probability that chance alone is responsible for the difference in incidence of respiratory difficulties between those patients with second and/or third degree burns of the respiratory area and those with unburned faces is less than 1 : 1,000 (Chi square = 109.7).

F. *Was the Patient Overcome by Smoke? The Absence of Facial Injury Does Not Rule Out Respiratory Damage. Look for a Reddened Pharynx.* Seven patients who had inhaled smoke but had no body burns were admitted for observation. Four had been unconscious, and one was found in a dazed condition, lying on the floor. In the two who retained consciousness, pharyngeal examination was negative and respiratory difficulties minimal. The pharynx of the dazed patient was slightly injected, and he

TABLE 3. *Influence of the Location of Facial Burns on the Incidence of Respiratory Difficulties*

Location of Facial Burn (if any)	No. Cases	Respiratory Difficulties	
		No.	%
None, face spared	139	31	22
Periphery burned, respiratory area spared	52	12	23
Burn of any part of face, regardless of location *	259	130	50
Respiratory area burned, with or without peripheral burns	192	114	59

* Although 259 patients suffered flame burns of the face, in only 244 cases is the distribution of burns on the face known. The 15 cases whose records are not clear on that point are excluded from the figures for the two areas of the face, considered separately.

experienced mild respiratory difficulties. Of the remaining four, all of whom had been unconscious, two were critically ill. Both developed stridor, cyanosis, and sternal retraction, gaining partial relief from tracheotomy. The third patient was gasping on admission, but improved promptly with oxygen therapy. All three exhibited red throats or had smoke particles in their noses and mouths. The fourth, whose nose and mouth were normal, had no respiratory difficulties.

TABLE 4. *Influence of the Severity of Facial Burns or the Absence of Facial Burns on the Incidence of Respiratory Difficulties*

Severity of Facial Burns (if any)	No. Cases	Respiratory Difficulties	
		No.	%
None, face spared	139	31	22
First degree	87	22	25
Second and third degree	172	108	63

TABLE 5. *Incidence of Respiratory Difficulties in 398 Flame Burn Cases* *

Location of Facial Burn (if any)	Face Spared		First Degree Facial Burns		Second and Third Degree Facial Burns	
	Not Enclosed	Enclosed	Not Enclosed	Enclosed	Not Enclosed	Enclosed
None, face spared (139 cases)	3 of 30 10%	28 of 109 26%	—	—	—	—
Any part of face** (259 cases)	—	—	4 of 17 24%	18 of 70 26%	3 of 30 10%	105 of 142 74%
Periphery of face (52 cases)	—	—	0 of 4 0%	4 of 12 25%	1 of 9 11%	7 of 27 26%
Respiratory area of face (192 cases)	—	—	4 of 12 33%	13 of 54 24%	2 of 18 11%	95 of 108 88%

* Patients admitted more than 6 days after injury have been excluded from this table.

** Includes all facial burns, among which are 15 cases recorded as "facial burns" without accompanying sketch or mention of facial location.

II. The Ominous Significance of Deep Flame Burns of the Respiratory Area of the Face

Not only respiratory difficulties, but death comes more frequently to patients with deep flame burns of the respiratory area of the face than to those whose faces escape injury. Such injury appears to be an important factor in the difference in mortality between flame and liquid burn cases, although extent and depth of burn, age and health of the patient prior to injury, are all involved. Among many of the survivors, deep flame burns of the respiratory area prolong hospitalization.

A. *Flame Burns of the Respiratory Area Give Warning.* In two groups of patients with minor burns having identical mor-

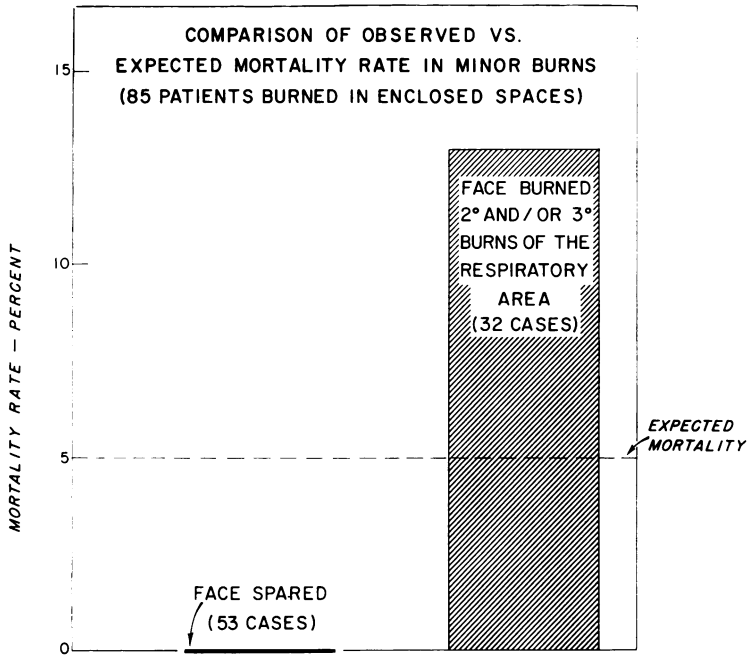

FIGURE 1.

tality expectancies, there were no deaths among those whose faces were spared, while 13 per cent of those with the respiratory area of their faces severely burned succumbed (Fig. 1). Based on the patients' ages and extent of burn, 5.0 per cent in each group were expected to die (Barnes,[1] Fig. 1). All of the patients were burned by flames while in enclosed spaces and all were well prior to injury.

The evidence suggests that the same is true for extensive burns, but two factors make statistical analysis invalid: first, the intervention of causes of death totally unrelated to facial injury or pulmonary damage in the severely wounded; and second, the paucity of patients having extensive burns without facial injury. (See below.)

B. *Respiratory Tract Damage is an Important Factor in the Difference in Mortality between Flame and Liquid Burns.* The mortality rate from flame burns in this series was more than ten times that from hot liquids, accounting for 87 per cent of the deaths (Table 6, 7). Five possible factors in this difference have been investigated: pre-existing illness, patient age, burn extent, burn depth, and respiratory tract damage. The flame burn patients were on the average older, more extensively and more deeply burned, and more often ill prior to injury, than the patients burned by hot liquids (Table 8, 9). They also were more frequently burned about the face.

TABLE 6. *Role of the Burning Agent in Determining Burn Mortality*
(Based on Data from 932 Patients Who Sustained Burns of 1.0% or More of Body Surface)

Burning Agent	No. Cases	% Total Cases	No. Deaths	% Total Deaths
Flames	410	44	92	87
Hot liquids	266	29	6	6
Hot objects	72	8	4	4
Electric arcs *	56	6	1	1
Semi-liquid semi-solids	51	5	1	1
Steam	38	4	0	0
Chemicals	35	4	2	2
Ultraviolet light	4	<0.5	0	0
Totals	932	100+**	106	101**

* Patients whose clothing ignited from electric arcing are considered as flame burns.

** Greater than 100% due to rounding out of fractions.

Only one of 41 patients with flame burns of more than 40 per cent of the body surface completely escaped facial injury! Sixty-six per cent of them suffered second or third degree burns of the respiratory area.

Unfortunately for statistical analysis it is not possible to select from the series sizeable groups of patients in whom all factors but one are controlled. Only five of the patients who sustained liquid burns of more than 25 per cent of body surface were adults, and only three had second or third degree damage in the respiratory area, re-

TABLE 7. *Influence of Burn Extent on Mortality from Burns due to Various Burning Agents*

Burning Agent	No. Cases	No. Deaths	Mortality Rate (%)	Average Burn Extent (%)
Flames	410	92	22	21
Hot liquids	266	6	2	8
Hot objects	72	4	6	14
Electric arcs	56	1	2	6
Semi-liquid semi-solids	51	1	2	17
Steam	38	0	0	9
Chemicals	35	2	6	13
Ultraviolet light	4	0	0	Not determined
	932	106	106/932=11%	Mortality Rate

TABLE 8. *Age, Burn Extent, and Health Prior to Injury in Fatal Burn Cases*

	Liquid Burns	Flame Burns
Average age	17 years	41 years
Average burn extent	8%	21%
Ill preburn	3%	9%
No. cases	266	410

gardless of age. It is possible, however, to compare patients with liquid and flame burns of comparable total extent (25–50%) having uninjured faces (Table 9-A). Despite the greater extent of full thickness burn in the flame burned, the mortality rates are the same. In contrast, flame burn injuries of similar extent but including deep respiratory area injury proved four times more lethal (Table 9-A). The data in Table 9-B suggests, as might be expected, that it is not the facial damage, *per se*, but a factor associated with it (such as respiratory irritation), which is responsible for the high mortality of facial injury. Statistical analysis is invalid since there were only three cases of severe damage to the respiratory area due to liquids.

C. *Damage to the Airway Prolongs Hospitalization.* In the group of patients with minor and superficial burns, those with second degree burns of the respiratory area spent nearly two weeks longer in the hospital than patients who escaped facial injury. The patients with uninjured faces averaged seven days in the hospital, while those with second degree burns of the respiratory area remained 20 days (Table 10-A). This finding is based on a study of the length of hospitalization in patients who were under 50 years of age, who were well prior to injury, and who sustained superficial burns of 10 per cent or less of their body surfaces while in enclosed spaces. The elderly, the sick, and those with third degree burns, fractures, or other injuries prolonging hospitalization, were excluded from the analysis. The two groups of patients were essentially comparable from the standpoint of burn extent, but the patients with facial burns proved older (Table 10-A).

TABLE 9–A. *Effect on Mortality of Facial Injury Due to Liquid and Flame Burns* (Burns in Previously Healthy Patients)

	Face Spared (25–50% Burns)		Second or Third Degree Burns of Respiratory Area of Face (25–40% Burns) *
	Liquid Burns	Flame Burns	Flame Burns
Mortality rate	11%	11%	46%
Average burn extent	30%	33%	32%
Average extent of full thickness burn	2%	19%	13%
Average age	7 years	33 years	37 years
Incidence of respiratory difficulties	22%	43%	92%
No. cases	9	18	13

* In order to obtain cases with an average burn extent similar to the patients with uninjured faces, 7 patients with burns between 40 and 50% were excluded.

To answer the question whether age, instead of respiratory injury, as reflected by facial damage, was responsible for the longer hospitalization, a further comparison was made between the length of hospitalization of the patients under and over 30 in the group with their faces spared. Although the number of cases is small, it would appear that age was not the responsible factor. The four patients over 30 spent one, two, seven, and eight days in the hospital, respectively, the older two being in for the shorter stay (average five days). The average for the 12 patients under 30 years was seven days (Table 10-B). The difference is not significant.

The possibility that older people sustain facial injuries more readily than younger ones because of a slower reaction time in protecting their faces is not borne out by the data. A comparison of the ages of all previously healthy patients with and without facial injury regardless of burn extent, reveals that adults who escaped facial injury averaged 39 years of age as compared with 40 years for those with severe facial burns. The number of patients over 60 in the facial damage group slightly exceeded that in the group with facial sparing, but the difference is statistically insignificant. There also is a greater incidence of deep burns of the respiratory area in children under six years of age (36%) than in those between the ages of six and sixteen (13%), but here again the difference is not significant statistically.

Discussion

The knowledge gleaned from this study has an obvious clinical application as a diagnostic aid. Possibly of equal importance may be its contribution to the prevention of respiratory tract damage.

Facial injury in the burned patient serves as a signal to alert the physician. The cause of the burns, the location of the patient at the time he was hurt, and the distribution of the burns on his face will provide further clues to the presence or absence of respiratory tract damage. Only if its presence is suspected can appropriate steps be taken to augment the patient's oxygen supply, diminish oxygen utilization, and combat respiratory tract sepsis.

TABLE 9–B. *Second or Third Degree Burns of Respiratory Area of Face*

	Liquid Burns	Flame Burns
Mortality	33%	61%
Average burn extent	59%	53%
Average age	23 years	29 years
Incidence of respiratory difficulties	0%	90%
No. cases	3	31

TABLE 10–A. *Length of Hospitalization in Patients Burned in Enclosed Spaces Who Sustained Superficial Burns of 10% or Less of Their Body Surfaces*

	Face Spared	Second Degree Burns of the Respiratory Area of the Face
Average No. hospital days	7 days	20 days
Average burn extent	4%	5%
Average age	22 years	33 years
No. cases	16	15

TABLE 10–B. *Length of Hospitalization in Patients Burned in Enclosed Spaces Who Escaped Facial Injury*

	Under 30 Years Old	Over 30 Years Old
Average No. hopsital days	7 days	5 days
Average burn extent	4%	7%
Average age	17 years	38 years
Number of cases	12	4

Perhaps greater emphasis should be placed on protection of the airway by all those exposed to the danger of inhalation of the products of incomplete combustion. It would be informative if all burned patients were asked on admission whether they had protected their faces and, if so, with what material. Data on this subject is sorely lacking at present. However, the high incidence of respiratory difficulties and death among those with deep burns of the respiratory area, as compared with those without facial damage, warrants the assumption that facial protection may be lifesaving until proved otherwise. It is interesting, in this connection, to note that in the Cocoanut Grove catastrophe, of the 114 casualties received at this hospital, 75 were either dead on arrival or died of anoxia within minutes. Of the 39 who survived long enough to be treated, only three were entirely without respiratory symptoms and those three had covered their mouths with wet cloths.

Summary and Conclusions

1. Respiratory tract damage should be suspected in every patient with deep flame burns around the nose and mouth. Eighty-eight per cent of the patients in this study who sustained such burns while in enclosed spaces encountered respiratory difficulties.

2. Death has a predilection for patients with second and third degree burns of the respiratory area of the face, tending to spare those with equally extensive burns whose faces escape injury.

3. First degree burns of the respiratory area and severe burns of the periphery of the face do not carry the same grave prognosis.

4. Respiratory tract damage may be present occasionally in the absence of facial injury. The patients without facial injury in whom respiratory damage was found generally had been overcome by smoke and were found on admission to have reddened pharynges.

5. The majority of the patients with flame burns of more than 40 per cent of their body surfaces were found to have second or third degree burns of their respiratory areas (66%).

6. Confinement of both patient and fire in an enclosed space increases the respiratory hazard.

7. Respiratory difficulties are uncommon among patients who suffer deep flame burns of the respiratory area while out-of-doors.

8. Flame burns are more lethal than liquid burns of equal extent. Respiratory difficulties in the flame burn cases are an important factor in the difference.

9. Survivors with minor and superficial burns which include second degree damage in the respiratory area require longer hospitalization than those with similar burns whose faces are spared.

Acknowledgment

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Bibliography

1. Barnes, B. A.: Mortality of Burns at the Massachusetts General Hospital, 1939–1954. Ann. Surg., **145**:210, 1957.
2. Phillips, A. W. and O. Cope: Burn Therapy: II. The Revelation of Respiratory Tract Damage as a Principal Killer of the Burned Patient. Ann. Surg., **155**:1, 1962.
3. Phillips, A. W. and O. Cope: Burn Therapy: IV. Respiratory Tract Damage and the Meaning of Restlessness—An Account of the Clinical, X-ray and Post-Mortem Findings. In Progress.