

Mortality Rates in Patients with Burns

A Report of Experience at San Francisco City and County Hospital, 1943-1956

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DURING 1956 several moderately to severely burned patients admitted to the University of California Service at the San Francisco City and County Hospital died. They were patients who, on the basis of previous experience, should have survived. In attempting to evaluate the causes of death it was soon evident to the staff that clinical impressions were not sufficient. A more detailed study of burned patients who had been admitted to the hospital in the past was undertaken to see if a significant mortality trend was taking place and to evaluate past and present methods of therapy.

The records of burned patients admitted to the University of California Service from 1943 to 1956 inclusive were studied. (All burned patients who are either indigent or incapable of being moved and who require hospitalization are admitted from the emergency unit to either the Stanford University Service or the University of California Service of San Francisco City and County Hospital; coverage of the emergency unit is rotated weekly.)

During the 14-year period, 488 burned patients were admitted to the University of California Service. Only those patients with second and third degree burns of more than 20 per cent of the body surface were studied in detail, since those who were less severely burned usually survived with little or no supportive therapy. There were 110 such patients; 17 were transferred elsewhere for treatment, leaving 93 who received all their treatment on the University of California Service. Patients of all ages were included. All the burns studied were thermal injuries to the surface of the body. Initially all patients were treated in the emergency unit and then transferred to the open wards for men, women or children. The rule of nine* was used to estimate the amount of surface area involved.

In order to make a comparison with previous experience, the 14-year period was arbitrarily divided into three periods of five, four and five years. For no apparent reason there were fewer patients in

*The head is considered 9 per cent of the body surface area; each of the arms, 9 per cent; the front of the torso, 18 per cent; back of torso, 18 per cent; each of the legs, 18 per cent; the neck, 1 per cent.

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• A review was made of the cases of 93 patients with burns covering more than 20 per cent of the body surface who were treated at the San Francisco City and County Hospital, University of California Service, between 1943 and 1956.

The mortality rate increased from 40 per cent during 1943-1947 to 69 per cent during 1952-1956. A significant change in survival time was noted: During 1943-1947, 69 per cent of the deaths occurred within 48 hours of admission; during 1952-1956, only 19 per cent of the deaths occurred within the first 48 hours. In the period 1943-1947 the majority of deaths resulted from shock in the immediate post-burn period; in the later years of the study the major cause of death was infection.

No patient more than 50 years of age who had burns of more than 25 per cent of the body surface survived. Only one patient with burns involving more than 45 per cent survived.

No patient who had a blood culture positive for bacteria survived. The use of antibiotics had no effect on the incidence of infection. Elderly patients, children and alcoholics were less able to resist the effects of infection.

The lowest mortality rate was in the age group of 15 through 35 years.

the early post-war years; however, by 1956 the number of burned patients being admitted was definitely increasing. The problem of burns is of increasing importance to this hospital, particularly because of a heightened mortality rate (Table 1).

Mortality in Relation to Age and Area Burned

The cases of the 93 patients with greater than 20 per cent of their body surface burned are described in Table 2, which relates the age of the patient to the area burned. Two significant facts are evident from this table: (1) Only one patient in the entire group during this 14-year period survived with a surface burn of greater than 45 per cent. The patient was a four-year-old child, admitted in 1948, who had a 65 per cent burn, 20 per cent of which was third degree. (2) In the group of patients who were 50 years old or older only five survived; in this group no patient survived who had burns over more than 25 per cent of the body surface.

It seemed to us that our most intense studies and future efforts should be applied to the type of case

TABLE 1.—Relation of Age and Alcoholism to Mortality in Patients with Greater Than 20 Per Cent Surface Burns, University of California Service, San Francisco City and County Hospital, 1943-56

Period		Ages 0 to 15	Nonalcoholics Ages 16 to 50	Alcoholics Ages 16 to 50	All Patients* 51 or Older	Total
1943-47	Patients.....	8	10	10	4	32
	Dead.....	1	3	5	4	13
	Mortality.....	12%	30%	50%	100%	41%
1948-51	Patients.....	3	7	0	6	16
	Dead.....	0	4	....	5	9
	Mortality.....	....	57%	....	83%	50%
1952-56	Patients.....	11	3	10	21	45
	Dead.....	4	1	8	18	31
	Mortality.....	36%	33%	80%	86%	69%

*Alcoholics 51 years of age or older were grouped with their age group; age more than 51 was arbitrarily considered a greater factor in mortality than was alcoholism.

TABLE 2.—Mortality Related to Per Cent of Area Burned for 14-Year Period, University of California Service, San Francisco City and County Hospital, 1943-56, with Comparative Results at Massachusetts General Hospital, 1939-54 (Shown in Italics)

		20 to 24 Per Cent	25 to 34 Per Cent	35 to 44 Per Cent	45 to 64 Per Cent	>65 Per Cent				
0 to 15 years	Total.....	10	4	9	8	4	2	1	2	6
	Dead.....	0	1	1	3	2	1	1	1	6
	Per cent mortality..	0	25	<i>11.1</i>	37.5	<i>50</i>	50	<i>100</i>	50	<i>100</i>
16 to 35 years	Total.....	5	6	<i>11</i>	3	7	0	3	3	5
	Dead.....	0	0	2	0	<i>1</i>	....	2	3	2
	Per cent mortality..	0	0	<i>18.2</i>	0	<i>14.3</i>	....	<i>67</i>	100	<i>40</i>
36 to 55 years	Total.....	4	3	<i>11</i>	6	6	7	<i>14</i>	10	7
	Dead.....	1	1	<i>1</i>	4	3	7	<i>12</i>	10	7
	Per cent mortality..	25	33.3	<i>9.1</i>	66.7	<i>50</i>	100	<i>85.7</i>	100	<i>100</i>
56 to 100 years	Total.....	7	5	4	5	3	0	<i>10</i>	7	9
	Dead.....	5	5	3	5	3	....	<i>10</i>	7	9
	Per cent mortality..	71.5	100	75	100	<i>100</i>	....	<i>100</i>	100	<i>100</i>

in which less than 45 per cent of the body surface was burned and the patient was less than 50 years of age (see Chart 1). Eight of the 41 patients who were in this category died. These eight patients can be divided into two groups: (1) *Children*. Four children died of septicemia. (2) *Alcoholics*. Four of the patients who died were alcoholics. Three of them apparently died of infection; the fourth died of coronary thrombosis.

Table 2 shows the relationship of the mortality rate to the area burned and to the age of the patient. For patients with burns covering 25 per cent or more of the body surface, we could compare data with data from the Massachusetts General Hospital series reported by Barnes.¹ Inasmuch as the reports covered a like period of time, the methods of therapy were probably similar.* It should be noted that in the age group of 16 to 35 years, there were fewer deaths from burns. Many investigators have pointed out that the patients of this age group are best able to survive injuries from burns. Only one patient of 43 older than 55 years in the combined totals of the University of California and Massachusetts General Hospital series survived with a burn of more

*One hundred and ten patients with greater than 25 per cent surface burns were treated at Massachusetts General Hospital during a 16-year period; the mortality rate was 59 per cent. Seventy-one such patients were treated on the University of California Service of San Francisco City and County Hospital during a 14-year period; the mortality rate was 67 per cent.

than 25 per cent of the body surface. The age of the patient and the proportion of surface that is burned are still the major determining factors in the mortality rate of burned patients.

Chart 2 shows the relationship of mortality to the area burned in each of the three periods into which the 14-year period studied was divided. In all the time periods the mortality rate in patients with greater than 40 per cent burns was understandably high. It should be noted, however, that there has been a change in the mortality in the group with less than 40 per cent burns. During the first two time periods the mortality rate was quite low. During 1952-1956 there was a significantly higher rate than in the earlier periods.

Trends in survival time. Although more burned patients died in the later than in the earlier years of the study, a recent trend toward longer survival before death was noted (Chart 3). In the two groups admitted between 1943 and 1951, 68 per cent of the deaths occurred within 48 hours after admission. In the group admitted between 1952 and 1956, however, only 19 per cent of the deaths occurred within 48 hours of admission. Increased knowledge concerning fluid and electrolyte therapy has unquestionably brought about better handling of the shock phase in burned patients. However, many patients who survived the shock phase died later of

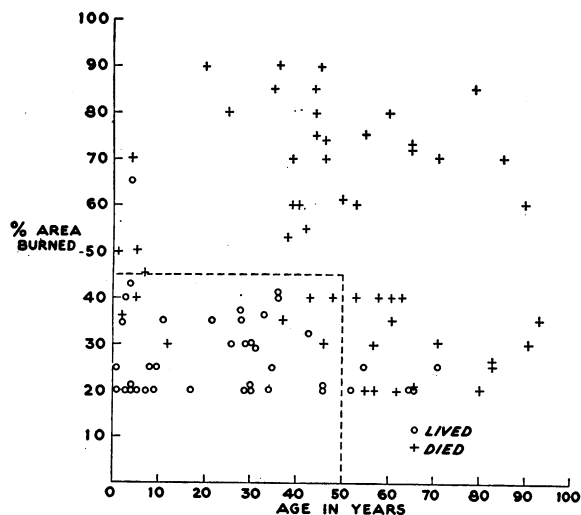


Chart 1.—Age as related to severity in burns of more than 20 per cent—University of California Service, San Francisco City and County Hospital, 1943-56.

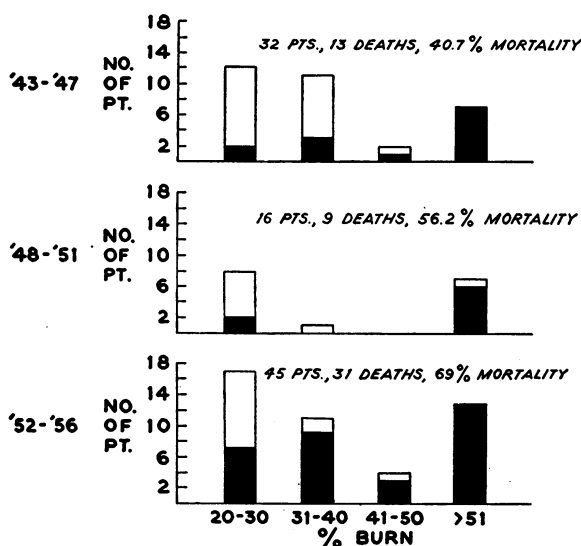


Chart 2.—Graph of mortality related to burn area, by time periods—University of California Service, San Francisco City and County Hospital, 1943-56. Each bar indicates the total number of patients burned in a specific category; the black portion indicates the number who died.

infection and other complications. As has often been pointed out, treatment of shock has advanced much further than has the ability to keep burned patients alive after the period of shock is over.

Trends in causes of death. Chart 4 shows the probable causes of death in patients who had burns covering more than 20 per cent of the body. The three arbitrary time periods are compared. Both the absolute and the relative numbers of deaths due to acute shock after being burned were lower in the later than in the earlier periods. In the first two

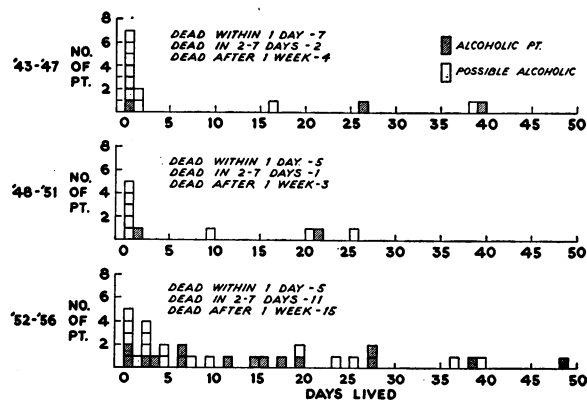


Chart 3.—Number of deaths related to number of days lived, with number of patients indicated, in cases of burns of more than 20 per cent—University of California Service, San Francisco City and County Hospital, 1943-56.

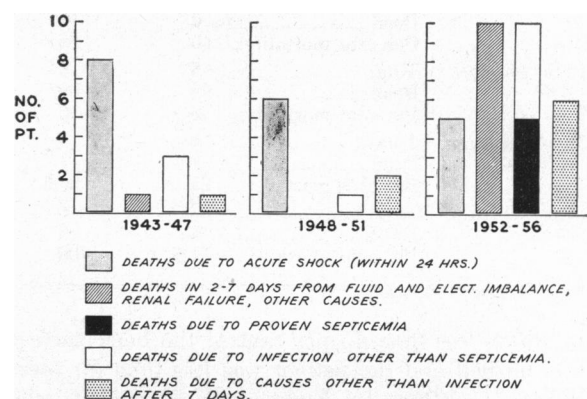


Chart 4.—Comparison, by time periods, of the causes of death in cases of burns of more than 20 per cent—University of California Service, San Francisco City and County Hospital.

periods, 69 per cent and 66 per cent of the deaths occurred within 48 hours of admission, but only six of the 31 patients, or 19 per cent, died within 48 hours of admission during the period 1952-1956.

The cause of death was fairly obvious for those patients who died in shock within the first 24 to 48 hours after admission, but it was difficult to ascertain the causes of late death. The cases of those patients who died between two and seven days after admission were arbitrarily grouped together, since the causes of death appeared similar: They apparently died of cardiac complications, acute renal insufficiency, or hepatic and renal changes. The cases of patients who died a week after admission from causes other than infection were grouped together: One died of gastrointestinal hemorrhage, one of renal insufficiency, one of aspiration pneumonia and six of vascular complications.

The cases of patients who died of infection were grouped together: Most of the deaths due to late complications occurred during the most recent time

period in our series (Chart 4). It was not always easy to determine whether a patient had died as the result of infection. Our criteria for listing a case under this heading were one or more of the following: (1) Positive blood cultures for bacteria; (2) definite evidence of pronounced wound infection; (3) fever greater than 101° F. during the entire hospital course or for an extended period before death; (4) evidence at autopsy of serious infection, such as metastatic abscesses or multiple sites of encrusted pus.

In the most recent period (1952-1956), ten, or 33 per cent, of all deaths, was due to infection. Six of the ten patients died of septicemia, the diagnosis of which was established by blood cultures or by evidence of metastatic abscesses at autopsy. Four of the six patients who died of septicemia were children twelve years old or younger. The patients who died of infection were either very young or very old or were alcoholics. These three types of patients apparently have a diminished ability to combat the complications of burns. Most of these patients were severely burned. Only three received partial grafts before they died. With the exception of three cases, cultures were made from material taken from burned wounds. Multiple cultures were made from the wounds of most of these patients, and the results agreed.

As the infection progressed in these patients more antibiotics were administered (usually those that had *in vitro* effectiveness against the specific organisms cultured). An average of four kinds of antibiotics were administered to each patient who was dying of infection. In no case in which a culture of the blood became positive for a pathogenic organism did the patient live. The recent trend at the San Francisco City and County Hospital is reminiscent of that described in the study of Markley and co-workers² in Peru. In a period of four and a half years, Markley and co-workers treated 275 patients who had greater than 10 per cent of the body surface burned. Thirty-four (12.3 per cent) died of *Pseudomonas* septicemia.

Analysis of Possible Causes of Increasing Mortality

1. *Time of grafting.* Our first impression was that in the early years of the study, the patients received grafts earlier, with consequently better results. However, a review of the cases did not confirm this; the average time of the first graft in patients with a greater than five per cent, third degree burn remained about the same during the 14-year period.

The ratio of patients who received grafts as compared to the number who needed grafts (the latter arbitrarily defined as those patients with greater than 5 per cent, third degree burns) decreased in

recent years. Two possibilities existed here: (1) Either the optimum time for grafting was missed and malnutrition and infection were permitted to deteriorate the patient's condition beyond the point where grafting could be done; or (2) the patients were never in a satisfactory condition for grafting. The latter appeared to be true. For example, in 1956, 11 patients had greater than 5 per cent, third degree burns; two of the patients received grafts and lived and three others died within a week. In five patients the infection became severe at a very early stage and they apparently could never have received grafts. Only one patient might have survived had more vigorous measures been taken and earlier grafting done.

Meeker and Snyder's method³ of early dermatome débridement and grafting is now being used on the University of California Service in selected cases. A review of the cases mentioned previously leads us to believe, however, that their method could not have been applied in the cases in which infection was present and the patient critically ill in the period soon after he was burned.

2. *Increasing age of patients.* During the period that was under study, the number of elderly patients increased and the number of patients between 16 and 50 years of age greatly decreased (Table 1). This trend would affect mortality trends adversely and undoubtedly was related to the recent rise in the mortality of burned patients at the San Francisco City and County Hospital. Surprisingly, the proportion of children entering with severe burns did not change.

3. *Alcoholism.* Alcoholism did not seem to contribute more to one phase of mortality than to another. The number of alcoholic patients who died was evenly distributed all along the time-of-death graph (Chart 3). The same number of alcoholics or drug addicts was present in each treatment group; apparently alcoholism is not a factor in the recent increase in mortality.

Fifty-four per cent of all deaths in burned patients on the University of California Service occurred in definite or questionable alcoholics. Alcoholics are more likely to become burned than are people generally and they have decreased ability to survive trauma resulting from burns.

4. *Method of treatment.*

(a) *Closed as compared with open.* From 1943 to 1951 the wounds of burned patients were almost invariably treated closed, with compression bandages applied over xeroform or vaseline gauze. From 1952 to 1956 the wounds were nearly always treated open. Almost no local antibiotics were used. On the basis of the experience of other investigators, it is

our impression that the differences in local treatment had little effect on mortality.

(b) *Supportive treatment.* The patients admitted during the first two periods, 1943 to 1951, received variable amounts of plasma during the shock phase. Little or no whole blood or electrolytes were given. From 1952 to 1956 the Evans Formula* was followed fairly closely. In the recent group, application of modern physiologic principles resulted in much improvement in survival rates during the period of acute shock. However, ability to keep the patients alive after the shock period has not improved, and the patients then die of sepsis or other complications.

(c) *Antisepsis.* The general measures for combating sepsis in burned patients remained about the same from 1943 to 1956. Burns were still treated on the open surgical ward or in side rooms, using sterile or clean techniques. The laundry of burned patients was not handled separately from that of other patients. Excretory receptacles were interchanged. Both burned and other surgical patients used the same dressing cart and bathtubs.

*Evans Formula: (a) *For the first 24 hours:* Requirements for the first 24 hours may be estimated by the following formula: Per cent of body surface burned times weight in Kg. equals the number of cubic centimeters of plasma, plasma substitute and/or blood needed in first 24 hours.

An equal amount of isotonic saline should be administered, plus 2000 cc. of glucose in water. For example, the fluid requirements in the first 24 hours for a 70 Kg. man suffering a 35 per cent body burn can be illustrated as follows:

Plasma, plasma substitute, and/or blood (in cc.)	$=70 \times 35=2,450$ cc.
Electrolyte solution (0.9 per cent NaCl, in cc.)	$=70 \times 35=2,450$ cc.
5 per cent dextrose in water.....	2,000 cc.

Total required in first 24 hours.....	6,900 cc.
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(b) *For the second 24 hours:* Half the amount of fluid required in the first 24 hours is usually adequate to maintain the patient in good balance. Close observation of urine output and if possible of hematocrit will reveal exceptions, and the fluid ration should be altered as necessary.

DISCUSSION

The only change in antiseptic technique was the increasing use of multiple, systemic antibiotics as prophylaxis and as definitive treatment, not only for the burned patients but for the surgical patients being treated on the same wards. During the period covered by this study there was an increase in resistant organisms and in serious and fatal infections due to organisms that were previously considered nonpathogenic or of very low virulence. Although increased age was a factor in the rising mortality rate among burned patients on the University of California Service, we believe the increasingly early infection in burned patients that is caused by organisms that are resistant to all antibiotics also played a prominent role.

The steadily increasing mortality rate in burned patients, primarily due to infection, would seem to warrant establishing a separate ward for these patients. Because of their greater susceptibility to infection, isolation techniques should be used. Hospital personnel assigned to this ward should not be permitted to care for other patients.

Since the use of antibiotics prophylactically has had no effect on the incidence of infection, these drugs should be reserved for therapeutic use.

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