



PRIVY COUNCIL

MEDICAL RESEARCH COUNCIL.

SPECIAL REPORT SERIES No. 249

STUDIES OF BURNS AND SCALDS

**(REPORTS OF THE BURNS UNIT, ROYAL
INFIRMARY, GLASGOW, 1942-43)**

General Introduction, by L. Colebrook ; Part I, by L. Colebrook, T. Gibson and J. P. Todd ; Part II, by L. Colebrook, A. M. Clark, T. Gibson and J. P. Todd ; Part III, by T. Gibson and A. Brown ; Part IV, by A. Brown ; Part V, by A. N. Anderson and E. Semeonoff ; Part VI, by T. Gibson ; with Appendices.

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PREFACE

In the four years immediately preceding the war there were approximately 1,270 deaths per annum from burns and scalds in England and Wales, of which nearly half were at ages under 15. The many thousands of burned patients who did not die represent a formidable loss of man-power in industry and of school-hours. Many recovered with crippling deformities due to scarring.

In the present war, in which petrol engines, explosives and fire play so large a part, burns and scalds have become still more important, and their treatment one of the major problems of war surgery. At El Alamein, one in four of the battle casualties were of this nature, and all through the desert campaign, quite apart from actual fighting, serious accidental burns due to petrol were of common occurrence.

These injuries present many unsolved problems. It is not clear why damage to the skin—sometimes, in children, involving only a tenth of the body surface—should so often prove fatal. Nor has it been possible up till now to prevent septic infection of most of the deep burns—as well as many of the more superficial ones. Skin replacement by grafting procedures has greatly assisted healing, but the possibility of improved methods needs to be explored. Finally, there is a whole train of difficult metabolic problems created by the long continued suppuration and exudation from the burned surfaces, and by the destruction of tissues.

The need for investigation of all these questions has long been recognized—indeed many enquiries have been set on foot in years gone by—but progress has been slow. It has always been hampered by the fact that burns and scalds occur at irregular intervals and the patients are received into every general hospital. Nowhere in Britain had there hitherto been a concentration of patients together with a team of surgeons and laboratory workers with facilities for a prolonged systematic study.

At the Royal Infirmary, Glasgow, wards have for many years been set aside for the treatment of burns, and a larger number of these injuries is dealt with there than at any other hospital in the British Isles (about 1,000 fresh cases every year). In these wards, 10 years ago, Dr. Robert Cruickshank made an important contribution to the bacteriology of burns, showing that, in many instances, infection by haemolytic streptococci develops within a few days after admission to hospital and is by far the most serious complicating factor. He also observed—probably for the first time—that haemolytic streptococci were frequently present in considerable numbers in the air of the Burns Wards, whereas they were found only in small numbers in the general surgical wards and not at all (in his experience) in the medical wards of the hospital.

In view of the urgent need created by the war emergency to initiate further research on various aspects of the treatment of burns, the Medical Research Council, in agreement with the Managers of the Royal Infirmary, Glasgow, decided to appoint a junior surgeon to give whole-time assistance to Mr. A. M. Clark, the surgeon in charge of the Burns Wards, and to establish a laboratory team with a view to a preliminary bacteriological, haematological and biochemical survey of the problem. Mr. Thomas Gibson was appointed from February, 1942, to the surgical post, and Dr. Leonard Colebrook, of the Council's staff, undertook to direct the laboratory studies, and to co-ordinate these with the clinical observations. Professor J. W. S. Blacklock, Pathologist to the Royal Infirmary, kindly arranged laboratory facilities for Dr. Colebrook and his team, and himself supervised the pathological

investigations of the cases. A part-time grant was made to Dr. Alexander Brown for the haematological work, and for the general medical supervision of the patients. Dr. A. Bruce Anderson, in charge of the Biochemical Laboratory of the Royal Infirmary, undertook to supervise the work of Miss E. Semeonoff, who received a whole-time grant from the Council.

The present Report embodies observations made in 1942 and 1943 on some 400 in-patients with burns, and on nearly 2,000 patients with less severe burns who were treated as out-patients.

MEDICAL RESEARCH COUNCIL,
c/o London School of Hygiene and Tropical Medicine,
Keppel Street, London, W.C.1.

July, 1944.

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APPENDIX I

SUMMARY OF PATIENTS DISCUSSED IN PARTS III-VI OF THIS MONOGRAPH

(S.B.B.=Superficial blister burn; P.S.L.=Partial skin loss;
W.S.L.=Whole thickness skin loss.)

Case No.	Age	Sex	Percentage of body surface burned—and sites	Depth of burning	Total fluid transfused (ml.)	Lived or died? Day of death
1	4½	F.	8 per cent.; buttock, hand.	4½ per cent. P.S.L. 3½ per cent. S.B.B.	1,600	L.
2	6	F.	7-8 per cent.; head, forearms, abdo., thigh.	Mainly P.S.L.	1,100	L.
3	8	F.	5 per cent.; thigh and leg.	Mainly P.S.L.	1,600	L.
4	2	M.	9 per cent.; arm and shoulder.	4 per cent. S.B.B. 5 per cent. W.S.L.	800	L.
5	5	M.	7 per cent.; axilla and back.	W.S.L.	1,000	L.
6	29	M.	12 per cent.; buttocks and thighs.	6 per cent. S.B.B. 6 per cent. P.S.L.	1,000	L.
7	19	F.	15 per cent.; chest and back.	7 per cent. S.B.B. 8 per cent. P.S.L.	800	L.
8	20	F.	16 per cent.; breast, arm, thigh, abdo.	9 per cent. P.S.L. 7 per cent. W.S.L.	1,600	L.
9	31	F.	16 per cent.; abdo., forearm and thigh.	2 per cent. S.B.B. 3 per cent. P.S.L. 11 per cent. W.S.L.	2,700	L.
10	66	M.	6 per cent.; head, neck and shoulder.	Mostly W.S.L.	800	D. 1
11	32	F.	6 per cent.; hands, face.	5 per cent. S.B.B. 1 per cent. W.S.L.	1,000	L.
12	32	M.	8 per cent.; face, palms.	5 per cent. S.B.B. 3 per cent. P.S.L.	1,500	L.
13	30	F.	10 per cent.; face, hands, ankles.	3 per cent. S.B.B. 7 per cent. W.S.L.	1,600	L.
14	27	F.	10 per cent.; back and shoulder.	7 per cent. S.B.B. 3 per cent. W.S.L.	2,500	L.
15	37	M.	10 per cent.; trunk axilla and arm.	7 per cent. S.B.B. 8 per cent. W.S.L.	1,100	L.
16	31	F.	15 per cent.; back and arm.	8 per cent. { S.B.B. P.S.L. 7 per cent. W.S.L.	1,200	L.
17	45	M.	15 per cent.; face, neck, shoulder, forearms.	11 per cent. { S.B.B. P.S.L. 4 per cent. W.S.L.	1,400	L.

<i>Case No.</i>	<i>Age</i>	<i>Sex</i>	<i>Percentage of body surface burned— and sites</i>	<i>Depth of burning</i>	<i>Total fluid transfused (ml.)</i>	<i>Lived or died? Day of death</i>
18	31	F.	16 per cent.; thighs and buttock.	2 per cent. S.B.B. 14 per cent. W.S.L.	3,000	L.
19	51	M.	19 per cent. ; R. leg.	16 per cent. W.S.L.	3,600	L.
20	6	F.	10 per cent.; trunk and thighs.	6 per cent. P.S.L. 4 per cent. W.S.L.	1,900	D. 3
21	6	M.	10 per cent. ; shoulder, chest.	6 per cent. P.S.L. 4 per cent. W.S.L.	1,200	L.
22	9	F.	12 per cent. ; forearm, thighs.	8 per cent. P.S.L. 4 per cent. W.S.L.	1,000	L.
23	2	F.	15 per cent. ; back and buttocks.	8 per cent. S.B.B. 7 per cent. P.S.L.	1,900	L.
24	$\frac{9}{12}$	F.	15-20 per cent. : chest, thighs, R. arm.	15 per cent. P.S.L. approx. 5 per cent. W.S.L.	500	L.
25	5	F.	12 per cent. ; side, buttocks.	6 per cent. S.B.B. 6 per cent. P.S.L. and W.S.L.	1,400	L.
26	$4\frac{1}{2}$	M.	12 per cent.; thigh, buttock, legs.	6 per cent. P.S.L. 6 per cent. W.S.L.	1,600	L.
27	2	M.	13 per cent.; chest, shoulder.	Mostly P.S.L.	1,300	D. 2
28	8	F.	14 per cent.; thighs and legs.	3 per cent. S.B.B. 6 per cent. P.S.L. 5 per cent. W.S.L.	2,350	D. 2
29	$1\frac{2}{12}$	M.	18 per cent ; lumbo-dorsal region.	4 per cent. S.B.B. 4 per cent. P.S.L. 10 per cent. W.S.L.	540	D. 36
30	21	F.	20 per cent. ; buttocks, thighs, arms and back.	Mostly W.S.L.	2,200	L.
31	22	F.	22 per cent. ; R. thorax; axilla, arm.	Mostly W.S.L.	1,600	L.
32	49	M.	26 per cent. ; face, arms and legs.	Mostly P.S.L.	3,400	L.
33	68	F.	26 per cent.; neck, trunk, thighs, hands.	10 per cent. P.S.L. 16 per cent. W.S.L.	2,700	D. 3
34	39	M.	20 per cent. ; face, arms, back.	10 per cent. S.B.B. 10 per cent. P.S.L.	3,600	L.
35	68	M.	20 per cent.; chest, arm, forearm.	Mostly W.S.L.	4,400	D. 21
36	37	M.	26 per cent. ; face, hands, arms, trunk.	6 per cent. W.S.L. 20 per cent. P.S.L., S.B.B.	2,200	L.

<i>Case No.</i>	<i>Age</i>	<i>Sex</i>	<i>Percentage of body surface burned— and sites</i>	<i>Depth of burning</i>	<i>Total fluid transfused (ml.)</i>	<i>Lived or died? Day of death</i>
37	12	F.	22 per cent.; abdo., thighs, arms.	6 per cent. W.S.L. 16 per cent. S.B.B. and P.S.L.	3,200	L.
38	19	F.	22 per cent.; buttocks, thighs.	5 per cent. S.B.B. 17 per cent. W.S.L.	4,420	D. 8.
39	19	F.	26 per cent.; face, back, hands, legs.	18 per cent. S.B.B. 4 per cent. P.S.L. 4 per cent. W.S.L.	3,540	L.
40	2	M.	20 per cent.; head, hand, shoulder, forearm.	14 per cent. P.S.L. 6 per cent. W.S.L.	800	D. 2.
41	4	F.	28 per cent.; arms, buttocks, thigh.	8 per cent. S.B.B. 10 per cent. P.S.L. 10 per cent. W.S.L.	2,650	D. 3.
42	2 $\frac{1}{2}$	M.	29 per cent.; trunk, arms, face, neck.	20 per cent. P.S.L. 9 per cent. W.S.L.	1,500	D. 2.
43	6	F.	35 per cent.; trunk, arms, legs.	Mostly W.S.L.	2,250	D. 3.
44	2	F.	40 per cent.; trunk, face, arms, legs.	30 per cent. P.S.L. 10 per cent. W.S.L.	1,900	D. 2.
45	6	M.	75-80 per cent.; trunk, legs, arms.	Mostly W.S.L.	1,500	D. 1.
46	10	F.	80 per cent.; trunk, arms, legs.	Mostly W.S.L.	6,600	D. 4.
47	2	F.	22 per cent.; abdo., thighs, R. arm.	5 per cent. P.S.L. 17 per cent. W.S.L.	1,000	L.
48	7	F.	40 per cent.; trunk, thighs.	5 per cent. P.S.L. 35 per cent. W.S.L.	3,600	D. 22.
49	9	F.	40 per cent.; arm, abdomen, legs.	20 per cent. P.S.L. 20 per cent. W.S.L.	2,200	D. 31.
50	3	M.	44 per cent.; trunk, arms, legs.	24 per cent. P.S.L. 20 per cent. W.S.L.	3,200	L.
51	6 $\frac{1}{2}$	M.	45 per cent.; trunk, arms, legs.	20 per cent. P.S.L. 25 per cent. W.S.L.	3,400	D. 43.
52	14	M.	31 per cent.; neck, trunk, arms, thighs.	19 per cent. P.S.L. 12 per cent. W.S.L.	2,300	D. 2.
53	68	F.	33 per cent.; back, arms, thighs.	24 per cent. P.S.L. 10 per cent. W.S.L.	2,000	D. 2.
54	40	M.	40 per cent.; trunk, face, arms.	Mostly W.S.L.	2,900	D. 3.
55	50	F.	75 per cent.; face, trunk, limbs.	20 per cent. S.B.B. and P.S.L. 55 per cent. W.S.L.	3,600	D. 2.

<i>Case No.</i>	<i>Age</i>	<i>Sex</i>	<i>Percentage of body surface burned— and sites</i>	<i>Depth of burning</i>	<i>Total fluid transfused (ml.)</i>	<i>Lived or died? Day of death</i>
56	51	M.	75 per cent.; trunk, arms, legs.	35 per cent. P.S.L. 40 per cent. W.S.L.	7,600	D. 1
57	44	M.	47 per cent.; trunk, arms, legs.	10 per cent. S.B.B. 20 per cent. P.S.L. 17 per cent. W.S.L.	3,600	D. 37
58	25	M.	40 per cent.; neck, trunk, arms, hands, thighs.	Mostly W.S.L.	5,600	L.
59	14	F.	40 per cent.; trunk, buttocks, thighs.	5 per cent. S.B.B. 5 per cent. P.S.L. 30 per cent. W.S.L.	2,200	L.
60	41	F.	45-50 per cent.; trunk, arms, thighs.	Mostly W.S.L.	7,200	D. 64
61	37	F.	50 per cent.; face, trunk, arms, legs.	10 per cent. W.S.L. 40 per cent. P.S.L.	3,600	D. 16
62	14	M.	50 per cent.; head, trunk, arms, legs.	Mostly P.S.L.	6,400	L.
63	60	M.	3 per cent.; R. foot	W.S.L.	—	L.
64	34	M.	1 per cent.; R. wrist	P.S.L.	—	L.
65	16	M.	4 per cent.; head, arms.	S.B.B., P.S.L.	—	L.
66	43	M.	4 per cent.; face, hand.	2½ per cent. S.B.B. 1½ per cent. W.S.L.	—	L.
67	51	M.	3 per cent.; face, neck.	S.B.B.	—	L.
68	35	M.	2 per cent.; R. arm	1 per cent. P.S.L. 1 per cent. W.S.L.	—	L.
69	19	F.	13 per cent.; buttock, legs, arm.	6 per cent. S.B.B. 7 per cent. P.S.L.	—	L.
70	35	M.	7 per cent.; head, forearms.	3 per cent. S.B.B. 4 per cent. P.S.L.	—	L.
71	78	M.	6 per cent.; face, hands.	3 per cent. S.B.B. 3 per cent. P.S.L.	—	L.
72	39	M.	8 per cent.; face, arms.	4 per cent. P.S.L. 4 per cent. S.B.B.	—	L.
73	40	M.	12 per cent.; face, neck, forearms.	6 per cent. S.B.B. 6 per cent. P.S.L.	—	L.
74	7	M.	8 per cent.; face, chest.	4 per cent. S.B.B. 4 per cent. P.S.L.	—	L.
75	1½	F.	14 per cent.; back, buttock.	6 per cent. S.B.B. 6 per cent. P.S.L. 2 per cent. W.S.L.	—	L.

<i>Case No.</i>	<i>Age</i>	<i>Sex</i>	<i>Percentage of body surface burned— and sites</i>	<i>Depth of burning</i>	<i>Total fluid transfused (ml.)</i>	<i>Lived or died ? 'Day of death</i>
76	32	M.	12 per cent. ; face, arms, back.	Mostly S.B.B.	—	L.
77	1 $\frac{5}{12}$	M.	7 per cent. ; neck, elbow.	P.S.L.	—	L.
78	41	M.	12 per cent.; hands, forearm, leg.	4 per cent. S.B.B. 4 per cent. P.S.L. 4 per cent. W.S.L.	2,000	L.
79	42	M.	16 per cent. ; face, neck, arms.	10 per cent. S.B.B. 6 per cent. P.S.L.	—	L.
80	40	M.	16 per cent. ; face, arms.	8 per cent. S.B.B. 8 per cent. P.S.L.	—	L.
81	34	M.	22 per cent. ; face, trunk, arms.	10 per cent. S.B.B. 12 per cent. P.S.L.	—	L.
82	62	F.	21 per cent.; neck, chest, forearms, thighs, legs.	7 per cent. S.B.B. 7 per cent. P.S.L. 7 per cent. W.S.L.	2,300	D. 41
83	68	F.	24 per cent.; trunk, shoulder, thigh.	4 per cent. S.B.B. 10 per cent. P.S.L. 10 per cent. W.S.L.	4,400	D. 11
84	39	F.	90 per cent. ; all but left flank.	Mostly W.S.L.	—	D. 1
85	78	F.	70 per cent.; trunk, arms, thighs.	20 per cent. P.S.L. 50 per cent. W.S.L.	—	D. 1
86	35	M.	67 per cent.; head, trunk, arms, legs.	Mostly W.S.L.	—	D. 1
87	51	F.	1 $\frac{1}{2}$ per cent. ; leg	S.B.B. and P.S.L.	—	L.
88	22	M.	3 per cent. ; foot	W.S.L.	—	L.
89	12	M.	4 per cent. ; leg	S.B.B.	—	L.
90	14	M.	4 $\frac{1}{2}$ per cent. ; face, hands.	S.B.B.	—	L.
91	8	F.	4 $\frac{1}{2}$ per cent.; shoulder, arm, chest.	1 per cent. S.B.B. 3 $\frac{1}{2}$ per cent. P.S.L.	—	L.
92	66	M.	4 per cent. ; face, hand.	Mostly S.B.B.	—	L.
93	13	M.	3 per cent. ; face, chest.	1 $\frac{1}{2}$ per cent. S.B.B. 1 $\frac{1}{2}$ per cent. P.S.L.	—	L.
94	58	M.	5 $\frac{1}{2}$ per cent. ; face, neck, hand.	S.B.B.	—	L.
95	9	M.	2 per cent. ; face, hand.	1 per cent. S.B.B. 1 per cent. P.S.L.	—	L.
96	13	M.	8 per cent. ; back	Mostly P.S.L.	—	L.

<i>Case No.</i>	<i>Age</i>	<i>Sex</i>	<i>Percentage of body surface burned— and sites</i>	<i>Depth of burning</i>	<i>Total fluid transfused (ml.)</i>	<i>Lived or died? Day of death</i>
97	39	M.	7 per cent. ; chest	2 per cent. S.B.B. 5 per cent. P.S.L.	—	L.
98	16	M.	13 per cent. ; legs	6 per cent. S.B.B. 7 per cent. P.S.L. and W.S.L.	—	L.
99	37	M.	6 per cent. ; face, hands, arms.	S.B.B.	—	L.
100	42	M.	8 per cent. ; head, arms.	1 per cent. S.B.B. 7 per cent. P.S.L.	—	L.
101	8	M.	9½ per cent. ; legs	4 per cent. S.B.B. 5½ per cent. P.S.L.	—	L.
102	35	F.	7 per cent. ; abdo., arm, leg.	2 per cent. S.B.B. 3 per cent. P.S.L. 2 per cent. W.S.L.	—	L.
103	59	M.	10 per cent. ; back, arm.	5 per cent. S.B.B. 5 per cent. P.S.L.	—	L.
104	25	F.	12 per cent. ; but- tocks, thighs.	3 per cent. W.S.L. 9 per cent. P.S.L.	2,400	L.
105	33	F.	15 per cent. ; chest, arms.	8 per cent. S.B.B. 7 per cent. P.S.L.	2,800	L.
106	7	F.	10 per cent.; back, legs.	6 per cent. S.B.B. and P.S.L. 4 per cent. W.S.L.	—	L.
107	36	F.	6 per cent.; shoul- der, arm.	4 per cent. S.B.B. 2 per cent. W.S.L.	—	L.
108	43	F.	14 per cent. ; but- tocks, thighs.	10 per cent. S.B.B. and P.S.L. 4 per cent. W.S.L.	—	L.
109	16	M.	8 per cent. ; legs	Mostly S.B.B.	—	L.
110	21	M.	23 per cent. ; arms, neck, chest.	11 per cent. S.B.B. 12 per cent. P.S.L.	—	L.
111	33	M.	29 per cent. ; face, neck, arms, back, chest.	26 per cent. { S.B.B. P.S.L. 3 per cent. W.S.L.	4,600	L.
112	7	F.	32 per cent. ; face, trunk, , arms, thighs.	12 per cent. W.S.L. 20 per cent. { S.B.B. P.S.L.	1,600	L.
113-114		These cases have been		omitted from the Re	ports.	
115	17	F.	66 per cent. ; head, trunk, arms, legs.	Mostly W.S.L.	—	D. 2
116	64	F.	3 per cent. ; legs	2 per cent. S.B.B. 1 per cent. P.S.L.	—	L.

<i>Case No.</i>	<i>Age</i>	<i>Sex</i>	<i>Percentage of body surface burned— and sites</i>	<i>Depth of burning</i>	<i>Total fluid transfused (ml.)</i>	<i>Lived or died ? Day of death</i>
117	2	F.	12 per cent.; back, shoulders.	Mostly S.B.B.	—	L.
118	1 $\frac{1}{2}$	F.	8 per cent.; chest, abdo., arm.	4 per cent. S.B.B. 4 per cent. P.S.L.	—	L.
119	$\frac{1}{3}$	M.	8 per cent. ; leg.	6 per cent. S.B.B. 2 per cent. P.S.L.	—	L.
120	25	M.	3 per cent. ; face, neck.	S.B.B.	—	L.
121-124		These cases have been		omitted from the Reports.		
125	59	F.	90 per cent.; head, trunk, arms, legs.	50 per cent. W.S.L. 40 per cent. { S.B.B. P.S.L.	—	D. 1
126	46	F.	45 per cent.; arms, trunk, thighs.	25 per cent. S.B.B. and P.S.L. 20 per cent. W.S.L.	—	D. 2
127	75	F.	25 per cent.; arms, buttocks, thighs.	15 per cent. W.S.L. 10 per cent. S.B.B. and P.S.L.	—	D. 1

APPENDIX II

ESTIMATION OF AREA BURNED

Throughout this Report, calculation of the areas burned has been based on Berkow's values (*Arch. Surg.*, 1924, 8, 138), which are shown in the table below, along with the similar values given earlier by Du Bois (*Arch. int. Med.*, 1915, 15, 868).

				<i>Berkow</i>	<i>Du Bois</i>
Head	..	..	..	6 per cent.	6 per cent.
Arms	..	..	..	13½ per cent.	14½ per cent.
Hands	..	..	..	4½ per cent.	4½ per cent.
Trunk	..	..	..	38 per cent.*	35 per cent.
Thighs	..	..	..	19 per cent.	20 per cent.
Legs	..	..	..	12¾ per cent.	13 per cent.
Feet	..	..	..	6½ per cent.	7 per cent.

* (anterior 20, posterior 18 per cent.)

The trunk includes the neck ; the lower extremities the buttocks.

Following Berkow, allowance for the different values applying in childhood was made as follows :—

The trunk was reckoned at 40 per cent., the upper extremities at 16 per cent. ; for the head, subtract the child's age from 12 and add remainder to the adult value (6 per cent.) ; for the lower extremities (including the buttocks), subtract the child's age from 12 and subtract the remainder from the adult value (38 per cent.). Thus, for a child of 6, the area of the head will be $6+6=12$ per cent. ; the area of the lower extremities will be $38-6=32$ per cent.

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