TREATMENT OF SKIN LESIONS CAUSED BY MUSTARD GAS

BY

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On the basis of clinical observations Chiesman (1944) and Davis (1944) published some general remarks on the treatment of skin burns caused by mustard gas. However, no study of the results of treatment under field conditions has appeared since the reports of the 1914-18 war casualties (Soltau and Elliott, 1923). The present paper deals with the treatment of a series of men exposed to mustard gas in the Tropics while living under an approximation to field conditions.

Material and Methods

Between 1943 and 1945 observations were made on 438 healthy young men exposed to mustard gas under tropical conditions—320 were exposed to mustard vapour and 118 to contamination by liquid mustard. Dressings were changed daily, and no attempt was made to maintain strict asepsis. The materials and methods used for treatment were purposely restricted to those readily available to any medical officer in the field. All applications were made on gauze or plain surgical lint and were kept in place by a bandage, since adhesive plaster did not adhere properly and gave rise to local irritation.

The lesions treated ranged from small superficial abrasion-like areas to large deep ulcers. Of the vapour cases 75 suffered nothing more than an erythema, and in only 154 of the remaining 245 did breaches of the continuity of the skin develop (Table I). Raw surfaces occurred

TABLE I.—Lesions Available for Treatment

Type of Case	Volunteers			Regional Raw Surfaces		
	No. Exposed	No. Treated	No. with Breaches of Skin	Total	No. Treated	No. of "Whole-thickness" Burns
Vapour ..	320	104	154	495	234	1
Liquid ..	118	83	79	254	68	18
Total ..	438	187	233	749	302	19

in 79 men exposed to liquid mustard, and 18 "whole-thickness" burns were distributed among nine of these men. The term "regional raw surfaces" in Table I refers to arbitrarily defined regions (Sinclair, 1948b) in which one or more breaches of surface continuity occurred, without regard to the number of these breaches. It will be noted that only 302 out of 749 regional raw surfaces received treatment: this figure includes all the whole-thickness burns and most of those lesions occurring in the 30 subjects who were admitted to hospital. In the remaining men 447 unselected regional raw surfaces received no treatment of any kind beyond the evacuation of vesicles, and were used as controls.

The irregularity and delay in development of mustard burns (Sinclair, 1948b) make it impossible to evaluate the effect of treatment unless the development of an exactly similar untreated burn in the same area of the opposite side of the same man can be observed. This requirement is seldom satisfied in mustard-gas burns. Further, in this series strict supervision of treatment was impossible. For these reasons no valid comparison can be made of the effect of the various treatments used on the development, course, and healing of the burns. However, sufficient

detailed information was obtained to enable a general clinical appraisal of treatment to be made.

General Treatment

Pain was controlled by acetylsalicylic acid, phenacetin, bromide and chloral, or hyoscine hydrobromide. In the worst cases, particularly those with severe burns of the genitalia, $\frac{1}{4}$ gr. (16 mg.) of morphine three times daily was necessary.

The treatment of systemic poisoning (Sinclair, 1948a) was purely symptomatic and unsatisfactory. Nausea and vomiting were unrelieved by either alkaline mixtures or sedatives. Alkali was, however, useful in alleviating abdominal pain when given in full doses after meals. The typical severe headache was unaffected by acetylsalicylic acid, phenacetin, and ergotamine.

Education formed a very necessary part of the treatment, owing to the prevalence of superstitious ideas about mustard gas. In two cases anxiety states developed, necessitating continued reassurance.

Local Treatment

Desquamation.—The onset of desquamation or exfoliation in any part was usually accompanied by considerable irritation, itching, and stinging pain. These symptoms were greatly aggravated by scratching, which took place in many cases while the men were asleep. For this reason it was occasionally necessary to apply a dressing to areas of severe desquamation. The treatment of choice was the inunction of zinc cream (*A.P.F.*) (anhydrous wool fat, 3; olive oil, 3; zinc oxide, 4; lime water, 4).

Raw Surfaces.—These were the result either of desquamation or of vesication. Vesicles were swabbed with weak "dettol" solution and pricked with a sterile needle to collapse down the vesicle roof. Subsequent re-evacuation was practised as necessary. Any blisters 1 cm.² or less in floor area were left without treatment of any kind (Table II). The treatments used for raw surfaces included the

TABLE II.—Liquid Burns: Treatment of Raw Surfaces by Area

Approximate Size of Raw Surface	No. of Lesions	No. Treated	Percentage Treated
0-1 cm. ²	81	0	0
1-10 cm. ²	192	19	10
10-100 cm. ²	55	36	65
Over 100 cm. ²	16	13	81

following: amyl salicylate, sulphonamide preparations (sulphanilamide powder and sulphathiazole powder), greasy preparations (zinc cream (*A.P.F.*), vaselined gauze, and acriflavine emulsion (*B.P.*)), and dyes (triple dye and 1 in 1,000 aqueous acriflavine).

Amyl Salicylate.—The drawbacks of amyl salicylate as a treatment for mustard burns are several. It is too irritant to apply to the scrotum by the ordinary method (Ministry of Health, 1942; Chiesman, 1944), and in vapour cases the scrotum is the region most commonly affected (Sinclair, 1948b). It cannot be applied to any area for longer than three or four days without causing pain (Ministry of Health, 1942; Cullumbine and Sinclair, 1942), it has an objectionable and persistent smell (Stewart, 1937), and it clings to the fingers, dressings, and bedclothes. It does not bring about more rapid healing (Cullumbine and Sinclair, 1942; Davis, 1944), and in the present series burns treated with it tended to be rather more painful than burns treated by other methods. "Hypersensitivity" to amyl salicylate has been reported (Stewart, 1937). In consequence of these objections, amyl salicylate has now fallen into disuse (War Office, 1944).

Sulphonamide Preparations.—In view of the effect of absorbed mustard derivatives in depressing leucocyte formation it is clear that the application of sulphonamides to any large mustard burn calls for considerable caution (Chiesman, 1944; Sinclair,

1944). Many lesions treated with local sulphonamides in this series became slightly irritated and inflamed; it should, however, be noted that micronized sulphonamides were not available.

Greasy Preparations.—The outstanding feature of this group of treatments was the comfort of the lesions so treated. Zinc cream (*A.P.F.*) was the most successful and, under local conditions, the most readily available in bulk. These preparations also enabled quick and relatively painless changes of dressing to be made. This factor was particularly important in the case of burns of the genitalia.

Dyes.—Triple dye was extensively used for small raw surfaces. The dye was applied as a paint, two or three coats being given at each dressing, and the burn was then left completely uncovered. Patients preferred this treatment to the inconvenience of a dressing and bandage, and burns so treated were very comfortable and quickly ceased discharging. It should be noted that no attempt was made to tan the raw surface. Owing to the difficulty of obtaining strict asepsis at the time of application, tanning should be used sparingly under field conditions (Cullumbine and Sinclair, 1942; War Office, 1944; Chiesman, 1944; Davis, 1944). Acriflavine solution, 1 in 1,000 in water, was also used, but was not nearly so satisfactory.

Untreated Controls.—The untreated lesions appeared to be as comfortable and certainly healed as rapidly as the treated burns of comparable severity. The pressure and friction of clothing, except in the case of burns of the scrotum, did not give rise to undue discomfort, and the lesions dried up rather more quickly than in cases where treatment was applied.

Treatment of Genital Lesions.—For lesions of the genitalia the most comfortable and convenient application was vaselined gauze. In hospital cases a daily tepid saline bath also relieved pain and irritation to a marked degree. All dressings applied to burns of the scrotum in ambulant cases were conveniently retained in position by an elastic suspensory bandage. The value of these bandages cannot be over-emphasized. The elastic support relieved the tension and dragging pain resulting from the presence of oedema fluid, and the friction of the clothing over the large, tender, raw scrotum was much reduced. Men with extensive deep burns, sometimes involving half the scrotal surface, were thus enabled to remain ambulant.

Complications

Dysuria.—Four cases with extensive raw surfaces on the glans penis suffered from intensely painful micturition, which was to a certain extent relieved by coating the burn heavily with vaseline. Ulceration of the meatus (Mackintosh, 1920) did not occur in this series.

Priapism.—In two vapour cases in which the penis was extensively burned, frequent, prolonged, and extremely painful priapism occurred, usually at night, during the first two weeks of treatment. Large doses of bromide and other sedatives were without prophylactic effect, and the only measure which afforded relief was an immediate cold saline bath.

Sepsis.—The presence of infection in any lesion was assessed as "slight" (some seropurulent discharge but no other local signs), "moderate" (frank pus present), or "severe" (frank pus, with local tenderness, inflammation of surrounding skin, and regional adenitis). The results of this classification are seen in Table III. The overall regional

infection rate was 32 out of 749 (4.3%), and the infection rate was higher (9.4%) in the case of liquid burns than in the vapour series (1.6%). Many of these infections were, however, of very little clinical importance, and Table III shows that in only 10 (1.3%) cases could infection be described as more than trivial. It is also interesting to note that sepsis became established while local treatment was being applied in 17 out of the 302 cases which received treatment—an infection rate of 5.6%. The infection rate in cases receiving no treatment was 3.4%.

Adenitis.—In four infected cases there was a regional adenitis throughout the period of infection. In eight other vapour cases, however, a regional adenitis appeared without any sign of local inflammation. The affected glands were rubbery, discrete, and not tender. These cases have not been considered under the heading of sepsis, since the absence of tenderness and pain, of any constitutional symptoms, of lymphangitis, and of any clinical evidence of infection in the drainage area was a noticeable feature.

Sloughs.—In the series of liquid burns small sloughs appeared in various situations in two subjects but separated rapidly; they were accompanied by slight sepsis. In the vapour series, however, it was a striking fact that slough formation, which occurred in six men, was confined to the prepuce. In the worst case gross annular sloughing occurred on the fifteenth day and did not completely separate until the thirtieth day.

Discussion

The mustard burn is not a specific and peculiar lesion, but is simply the response of the skin to a slowly acting tissue injurant (Sinclair, 1948b). It is therefore most unlikely that any specific treatment will be found, for established mustard lesions, and in consequence it is permissible to treat such burns exactly as thermal burns, according to the personal preference of the operator. Koontz (1944), as a result of animal studies, concludes that "there is no major difference, either qualitative or quantitative, between heat burns and mustard burns of equal intensity," and points out that the same methods of treatment should therefore be applicable to both. Davis (1944) concludes that "almost any of the generally accepted technics of burn treatment" may be used for mustard burns in man. Insufficient attention has been paid in the past to difficulties of assessment, and specific treatments—for example, amyl salicylate—have been recommended for mustard burns on inadequate grounds.

The healing-time of mustard burns is not greatly influenced by the type of therapeutic agent employed (Cullumbine and Sinclair, 1942; Davis, 1944), and there is no evidence that any of the treatments applied in the present series achieved significantly better results than could be expected in the absence of local treatment. There remain, however, the factors of comfort, ease of application, availability, cost, etc., to be considered. Bearing in mind these considerations, it may be said that for the irritation caused by desquamation of the skin zinc cream (*A.P.F.*) was useful. For the raw surfaces, which constituted the most important feature of these cases, zinc cream and vaselined gauze were the best of the treatments investigated, while triple dye paint was extremely useful for minor lesions of this type and when a dressing could not conveniently be retained in position. For scrotal burns the suspensory bandage was invaluable, and in hospital cases saline baths were found very comforting.

There is a widespread opinion that mustard burns are especially liable to infection. Chiesman (1944) states that "they are slow to heal, prone to sepsis, and respond badly to any form of tanning." There is, however, no evidence to show that a series of human experimental thermal burns

TABLE III.—Incidence of Sepsis

Type of Case	No. of Regional Raw Surfaces	No. of Regional Raw Surfaces Infected				No. of Infections Classed as More than Trivial
		Slight	Moderate	Severe	Total	
Vapour	495	6	1	1	8	2
Liquid	254	16	5	3	24	8
Total	749	22	6	4	32	10

is any less liable to infection than a series of mustard burns of similar intensity and distribution. Nor has it been shown that under these circumstances the thermal burns would heal any more quickly than the mustard burns. Until such an investigation has been made it is begging the question to hold that the mustard burn is specially prone to sepsis and slow to heal.

Summary

An account is given of some observations made on the treatment of a series of skin burns caused by mustard gas under tropical conditions. It was not possible to make any accurately controlled investigation, but it appeared that no local treatment achieved better results than could be expected in untreated burns.

On the basis of factors such as comfort, convenience, expense, etc., zinc cream (*A.P.F.*) and vaselined gauze were the best of the treatments investigated for breaches of skin continuity. Triple dye, used as a paint, was valuable for treating small superficial lesions.

Suspensory bandages were of great value in the treatment of scrotal burns.

There was a comparatively low incidence of sepsis, in spite of the fact that the burns were treated under an approximation to field conditions.

There is no reason to suppose that mustard burns behave any differently from thermal burns in regard to their healing or liability to infection.

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INCIDENCE OF DIABETES MELLITUS IN CHILDREN AND NEED FOR HOSTELS

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In an annotation in the *British Medical Journal* of Feb. 7, 1948 (p. 261), it was stated that "the incidence of diabetes is unknown, although some idea of its prevalence can be obtained from the mortality returns." Lawrence (1944) wrote: "Diabetes has been recorded in infants of a few months, but is very rare under 6 years of age." In America several surveys have been made. Joslin (1946) quoted the findings of the National Health Survey of 2,500,000 persons, carried out under the auspices of the United States Public Health Service in 1935-6, when it was found that in the age group 0-14 years one child in every 2,500 was a diabetic: the incidence was the same for boys and girls, and

for all age groups was 0.37% of the total population (adults and children). Wilkerson and Krall (1947) reported the results of a thorough investigation into the incidence of the disease in Oxford, Mass. Of the 4,983 inhabitants 3,516 had their blood and urine tested. After allowing for the 29.4% of the town's citizens who had not been tested it was estimated that 1.7% of the population had diabetes.

Joslin (1946) also mentioned that the mortality rate from diabetes in the U.S.A. in 1943 was 27.1 per 100,000 of the population; in England and Wales in 1944 it was 9.6 per 100,000. The much lower diabetes death rate in England and Wales supports the view that the incidence of the disease is considerably less in these islands than it is in the U.S.A.

Present Investigation

In the absence of up-to-date information about the extent of diabetes in children in this country it was decided to make a survey, during the period February-June, 1948, in the following areas: Bristol, Birmingham, Birkenhead, Wallasey, Liverpool, Bootle, Salford, Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Sheffield, Norwich, Ipswich, Great Yarmouth, Cambridge, Norfolk, Isle of Ely, Cambridgeshire, and East and West Suffolk.

All the school medical officers (who were, with one exception, also medical officers of health), the professors of child health, and all the hospitals in these areas likely to have child patients with diabetes were approached for information. The physicians of 32 hospitals co-operated: only one hospital ignored the requests made to it.

All lists of children supplied by the hospitals were cross-checked against the lists held by the school medical officers and the medical officers of infant welfare clinics to avoid duplication of names and to ensure that children not living in these areas were excluded, since many of the hospitals had patients from a wide countryside and from districts not included in this survey.

Size of Population Sampled.—The 16 cities and towns and the five counties selected for this inquiry had a total child population under 16 years of age of 1,307,000; there were about 750,000 school-children, being between one-sixth and one-seventh of the total school population of England and Wales: the rate was broadly similar for urban and rural children. Table I gives the number and age distribution of the children.

TABLE I.—Age Distribution

Age	Urban	Mainly Rural	Total
0-4 ..	470,000	70,000	540,000
5-9 ..	386,000	50,000	436,000
10-15 ..	290,000	41,000	331,000
Total	1,146,000	161,000	1,307,000

TABLE II.—Incidence of Diabetes in Sample Population

Age	No. of Children with Diabetes		
	Boys	Girls	Total
0-4 ..	1	2	3 (1 in 180,000)
5-9 ..	28	28	56 (1 in 8,000)
10-15 ..	70	54	124 (1 in 3,000)
Total ..	99	84	183 (1 in 7,000)

Of the 180 school-children (Table II) 145 (1 in 5,000) lived in urban areas, and 35 (1 in 3,000) lived in mainly rural areas. If the sample can be taken as representative of the child population then the estimated number of diabetic school-children in England and Wales is 1,200 (1 in every 4,000-5,000).