THE TREATMENT OF BURNS: A COMPARATIVE TRIAL OF ANTIBIOTIC DRESSINGS*

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In a previously published series[1] of burns, a 4-hourly powder spray containing neomycin, bacitracin and polymyxin (Polybactrin) as 'open' treatment (i.e. without a covering dressing) was used. Only in hands and feet and circumferential burns, or where burns were septic, was the 'closed' method of treatment employed, namely Neobacrin-Tulle (open mesh tulle impregnated with neomycin and bacitracin) covered with gauze and crepe bandages.

A comparative prospective blind trial between various other antibiotic preparations has subsequently been carried out. This has necessitated, therefore, the use of the closed method of treatment and the two antibiotics gentamicin (Garamycin—Scherag) and neomycin were used. Neomycin, another member of the aminoglycoside group of antibiotics, has a wide range of bactericidal activity, and is reported[2] to contain two chemically similar, biologically active components, neomycin B and C. According to Rhinehart *et al.*,[3] framycetin (which is contained in Soframycin) is identical with neomycin B, but this is disputed by the manufacturers. During the present trial, to obviate the inevitable objection that neomycin may be presented in a variety of forms, this latter group was subdivided into two subgroups: those burns in which Soframycin (Roussel) was used, and those where Neobacrin-Tulle (Smith & Nephew) was the dressing.

Criteria in the two trials such as mean surface area burned and full-thickness burns remained almost identical, as did other parameters such as total skin grafts and deaths.

MATERIALS AND METHODS

During a 12-month period from 23 April 1968 to 30 April 1969, 502 cases of burn injuries were admitted to the Burn Unit attached to the surgical paediatric wards of Livingstone Hospital. The Burn Unit which has been described in previous publications,[1,4,5] consists of 3 separate air-conditioned subdivisions, accommodating 21 children under the age of 12 years. All the patients are non-White.

*Date received: 2 November 1970.

The Burn Unit is air-conditioned throughout and is entirely separated from the other surgical wards. Strict asepsis is always maintained. On entry into the unit all nurses and doctors are required to discard white coats or jackets as appropriate and clean gowns, caps, masks and boots are donned in a gowning area. Once this has been completed, the individual is permitted to enter the isolated unit proper.

All new admissions of burn injuries are admitted to the Burn Unit. Following skin grafting, many of them are moved progressively to other parts of the surgical wards before discharge. Thus the Burn Unit proper is retained for all new cases which are always regarded as emergencies. Some 20% of cases admitted are moved progressively in this way.

All burns over 10% body surface area are admitted. Those cases under 10% body surface area which are admitted to the Unit, involve perineum, face, or hands and feet. Other burns under 10% body surface area are treated as outpatients unless there is a very specific reason for admission, perhaps on other grounds.

Selection

The method of selection for the different dressings to be used was entirely random. The procedure followed was to alternate the antibiotic dressing week by week, thus on one week from Monday morning 7.00 a.m. to Monday morning 7.00 a.m. the following week, all cases admitted would be dressed with gentamicin cream. The following week, all cases admitted would be dressed with neomycin application. These neomycin applications were then subdivided again alternately into Soframycin for one week and Neobacrin-Tulle on the next week for neomycin. The cots of all patients so designated were marked so that they received that particular dressing and that dressing only throughout their stay in hospital. Similarly, the patient's folder (case notes) was stamped with the name of the dressing selected for that particular patient. This method ensured a completely random selection of cases, varying in severity

and extent, and moreover ensured that the same dressing would be maintained throughout the child's stay in hospital. Strict observance of this rule was enforced throughout.

Technique

The technique of management was identical in every case with the difference in topical antibiotics only. This technique has been described previously,[3,4,5] and consisted of the immediate resuscitation of the child where necessary by means of intravenous infusion.

The formula followed was as follows, where X = % surface area × weight in pounds × 1·4:

Less than 10%: Intravenous Ringer's lactate if shocked.

10 - 15%: Low molecular dextran 3 ml/lb body wt, in 2 hours;
½ X ml in next 6 hours as plasma;
½ X ml in next 12 hours as plasma;
low molecular dextran 3 ml/lb in 2 hours and
¼ X ml in the next 24 hours as plasma.

15 - 20%: Low molecular dextran 3 ml/lb in 2 hours;
¼ X ml in next 6 hours as plasma;
¼ X ml in next 12 hours as blood;
low molecular dextran 3 ml/lb in 2 hours and
¼ X ml in the next 24 hours as plasma.

20% and over: Low molecular dextran 3 ml/lb in 2 hours;
⅓ X ml in next 6 hours as plasma;
⅓ X ml in next 24 hours as blood;
low molecular dextran 3 ml/lb in 2 hours;
⅙ X ml in next 12 hours as plasma;
⅙ X ml in next 12 hours as blood and
low molecular dextran 3 ml/lb in 2 hours.

In children under 2 years of age the maximum calculable area is 20%. In children up to 7 years it is 25% and up to 12 years and over 30%.

On admission children are sedated, usually with pethidine ½ - 1 mg/lb, and this is repeated if necessary or substituted with promethazine or paracetamol. The use of pethidine is usually discontinued after 24 hours. The limbs of the children are restrained by means of stockinette, which allows a range of movement but prevents the child from interfering with the dressings. This procedure is maintained throughout the period of hospitalization. Controlled physiotherapy is instituted from the second or third day. Cases with perineal burns are given sulphonamides but systemic antibiotics are otherwise withheld as a routine. Such antibiotics are only given where specifically indicated (Table VI). When antibiotics are administered for a specific purpose, these are usually penicillin and streptomycin. No other antibiotics are used except in rare instances, where penicillin and streptomycin fail. Then the appropriate antibiotic according to culture and sensitivity is used (Table VI).

Urethral catheterization is employed only where there is dysuria or oliguria (which latter has been rare) or group IV burns (see below).

Local Treatment

This consists of superficial cleansing of the area and removal of any home remedies which may have been applied. All blisters are allowed to remain intact and left strictly alone. Debrided skin and broken blisters receive a gentle toilet and the debrided skin is removed. They are cleansed with Savlon 1:80 solution which is applied by spray via a suitable container. The spray is ejected by means of a plunger. This ensures as little manual and physical contact with the patient as possible. All dressings are done under the strictest aseptic precautions. After adequate but gentle and superficial cleansing the burned area is closed with the appropriate dressing. Where necessary crepe bandages are applied to maintain the dressing in position or if possible the dressing alone on sterile lint is allowed to remain loosely in place. In the case of gentamicin and Soframycin creams, these are applied under aseptic conditions directly from a tube the nozzle of which is sterilized. That tube and subsequent tubes are maintained strictly for the same patient, and that patient alone. This is directed towards the avoidance of cross-infection. Having completely covered the area with the cream, sterile lint is applied lightly over the area to maintain it in position. In the case of Neobacrin-Tulle, this is applied directly, in a similar way but without the addition of any other creams. The procedure is repeated daily for the first week on each patient with diligent care to avoid cross-infection. Thereafter dressings are changed on alternate days.

All nursing staff handling the children are required to wash separately and individually for each child.

A week after admission, the method of cleansing is changed and the child is then taken to the dressing room and immersed almost totally in a warm Savlon bath (1:100), the area is cleaned carefully and then the dressings are reapplied. This procedure is carried out on alternate days until the area has healed or until skin graft is carried out. During the time in hospital, each child has an intake and output measured strictly. Haemoglobin estimation is carried out weekly and weekly swabs are taken from various parts of the burn wound for culture and sensitivity. This is maintained until skin graft is completed and the child discharged. All nursing and medical personnel have regular throat swabs taken for bacteriological culture and sensitivity. In the event of haemolytic streptococcus or other notable pathogens being identified the individual is removed from the Burn Unit.

RESULTS

There were 502 admissions with mean surface area burned of 13·51% and the mean hospitalization was 24·03 days. There were 84 fire burns and 418 burned by hot liquids

TABLE I. CASES TREATED

Type		*No.*	
Total number of cases		502	
Mean surface area burned		13·51%	
Mean hospitalization period		24·03 days	
Full-thickness burns		275	(54·7%)
Total number skin grafted		259	(51·05%)
Deaths		5	(0·99%)
Thermal agent:	Fire	84	
	Hot liquid	418	

(Table I) and 259 required skin graft; there was an over-all mortality of 0·99%. The maximum burned area was 50%. There were 3 such patients, all of whom survived. Two were dressed with gentamicin and one with Neobacrin-Tulle.

Table II indicates a breakdown of Table I into the

different dressings used. This table indicates the distribution of the dressings in the number of cases treated. There were slightly more cases where gentamicin was used than with neomycin dressings. The subdivision into Soframycin and Neobacrin-Tulle was almost equal. The mean surface area burned is almost identical in each case. The mean hospitalization is lowest with gentamicin and longest with Soframycin.

TABLE II. TREATMENT USED

Type		Gentamicin	Neomycin: Soframycin	Neomycin: Neobacrin-Tulle
Total number of cases		275	109	118
Mean surface area burned		14·01%	13·66%	12·86%
Mean hospitalization period		23·61 days	25·92 days	24·44 days
Full-thickness burns		155	58	66
Total skin grafts		130	65	52
Deaths		2	2	1
Thermal agent:	Fire	45	17	22
	Hot liquid	230	92	96

Table III indicates the distribution of surface areas of burn wounds with each type of dressing. The burns are divided into groups according to the size of the burn wound as indicated Group I includes burns of less than 10% surface area but situated on face, hands, feet or perineum. There were 285 cases and the mortality in this group was 0·7%. Group II includes burn surface area of 10 - 19%, of which there were 175 cases. Group III includes burn surface area of 20 - 29%, of which there were 26 cases. There were 16 cases with more than 30% surface area burned, i.e. group IV. The mortality in groups II, III and IV combined was 1·4%. Thus it will be seen that burns of the face, hands and perineum only (group I) outnumbered larger burns (which may or may not have involved these areas as well) fairly considerably in all instances. The distribution of burned surface area was very similar with each dressing used, with the exception of group IV burns dressed with Soframycin. These exceeded in number those in similar groups dressed with the other preparations, i.e. there was a higher percentage of group IV burns dressed with Soframycin (10·7%), than with the other topical antibiotics.

Table IV indicates the bacteriology from swabs taken from the burned areas. Only the 6 most frequently encountered organisms have been listed here. Other organisms encountered but regarded as not being of any significance were non-haemolytic streptococcus, *Staphylococcus albus, Alcaligenes faecalis* and *Acromobacteria anitratus.* These other organisms have been excluded from description owing to their insignificance. It is seen clearly that again[1] the commonest invader is *Staphylococcus aureus,* being found present in 36·1% of patients. The incidence of this organism was highest when dressed with Soframycin, and this represents a considerably higher incidence when compared with the other two dressings. Next in frequency is *Streptococcus haemolyticus,* being found in 25·1% of cases, and here there is little significant difference in incidence in cases dressed with the various dressings. *Pseudomonas aeruginosa* was found to be present in 22·3% of cases. Here there were remarkably differing variations in incidence according to the dressings used. By far the lowest incidence of pyocyaneus was in those cases which received dressings with gentamicin cream (9·4%). Pyocyaneus was cultured in four times the number of cases when dressed with Soframycin (39·4%) and Neobacrin-Tulle (37·3%). *B. coli* were found in 17·5% of all cases admitted and here again there is a significant reduction in incidence in cases dressed with gentamicin (8·7%) as compared with cases dressed with Soframycin (29·3%) and Neobacrin-Tulle (27·1%). *Candida albicans* was one of the less common invaders encountered (3·4% of cases admitted). This pathogen showed no respect for the type of dressing used and occurred more or less equally in all three dressings. It is of significance that in all cases where *Pseudomonas aeruginosa* and *Streptococcus haemolyticus* were isolated, and to a lesser extent in all the other organisms, the incidence increased as the trial progressed. That is to say that, early in the trial, the incidence of pseudomonas particularly as concerned gentamicin cream was very low and only increased towards the end of the trial. This applied to the other organisms to a lesser extent and also similarly to those patients on whom Soframycin cream was used as a dressing. The progressive incidence with time was less noticeable with Neobacrin-Tulle. It will be seen from the figures in the last column that there was obviously considerable overlapping in incidence between the various organisms, hence combinations of these organisms were very frequent.

TABLE III. SURFACE AREA BURNT

Group		Gentamicin	Soframycin	Neobacrin-Tulle	Total	Mortality
Group I :	Less than 10% surface area	166	56	63	285	0·7%
Group II :	10 - 19% surface area	89	41	45	175	
Group III:	20 - 29% surface area	13	6	7	26	1·4%
Group IV:	30% surface area and over	7 (4·2%)	6 (10·7%)	3 (4·5%)	16	
Totals		275	109	118	502	0·99%

TABLE IV. BACTERIOLOGY

	No. of cases in group I			No. of cases in group II			No. of cases in group III			No. of cases in group IV			Total			Percentage				
Bacteriology	G	S	N	G	S	N	G	S	N	G	S	N	G	S	N	G	S	N	Over-all total	
Ps. aeruginosa	9	12	14	11	22	22	4	3	6	2	5	2	26	42	44	9·4	39·4	37·3	112	(22·3%)
Strep. haemolyticus	32	13	10	33	16	14	3	1	2	2	0	0	70	30	26	25·4	27·4	22·03	126	(25·1%)
Staph. aureus	46	26	21	29	26	14	3	4	3	3	5	1	81	61	39	29·4	55·9	33·0	181	(36·1%)
B. coli	10	6	12	10	14	14	1	1	4	3	2	2	24	32	32	8·7	29·3	27·1	88	(17·5%)
Proteus	7	5	8	10	8	11	1	2	4	3	2	2	21	17	25	7·6	15·5	21·1	63	(12·5%)
Candida albicans	3	0	1	4	4	0	1	0	2	2	0	0	10	4	3	3·6	3·6	2·5	17	(3·4%)

G = gentamicin dressing (275 cases); S = Soframycin dressing (109 cases); N = Neobacrin-Tulle (118 cases).

Table V is a composite table showing the number of cases of combinations of pathogens in the right upper diagonal half of the table, and the mean hospitalization of these combinations in the lower left diagonal half. It is of interest to note that *Candida albicans* never occurred alone but was always in combination with other organisms. A combination producing the longest mean hospitalization was the well-known pair of *Pseudomonas aeruginosa* and *Streptococcus haemolyticus. Candida albicans* in combination with other organisms was only significant when combined with *Pseudomonas aeruginosa* as well. Thus in group IV the case with a hospitalization of 143 days had a combination of *Pseudomonas aeruginosa* with *Staphylococcus aureus,* which was the commonest invader, and with *B. coli.* Apart from this the only other organism of significance in combination producing prolonged hospitalization, was *B. proteus.* This observation has been made on all previous studies undertaken in this Unit.[4,5] While of interest in noting the combinations of the organisms and those which produce the longest mean hospitalization, there is little significant difference between cases dressed with the 3 different antibiotic dressings.

Antibiotics

As described above, parenteral antibiotics are not used as a routine. It was necessary to exhibit specific antibiotic therapy in a total of 167 cases (33·28%). The indications for this systemic antibiotic therapy were a persistent temperature with obvious infection, e.g. infection of the wound itself as characterized by peripheral oedema, induration and erythema or a complicating infection such as pneumonia or a urinary infection or otitis. Table VI

TABLE VI. INCIDENCE OF SYSTEMIC ANTIBIOTICS EXHIBITED

			Systemic antibiotics		
Dressings	*Group I*	*Group II*	*Group III*	*Group IV*	*Total*
Gentamicin	55 (30·38%)	41 (51·80%)	3 (33·3%)	2 (33·3%)	101 (36·7%)
Soframycin	16 (25·4%)	15 (40·5%)	—	5 (100%)	36 (33·02%)
Neobacrin-Tulle	15 (21·12%)	11 (28·20%)	3 (50·0%)	1 (50·0%)	30 (25·4%)

indicates the breakdown of incidence of the use of antibiotics in each of the dressings employed. Thus, when gentamicin was the dressing in use, 101 cases required parenteral antibiotics, i.e. 36·7%. With Soframycin as the dressing 36 cases required the additional parenteral antibiotics (33·02%) while when Neobacrin-Tulle was used as a dressing, 30 cases required parenteral antibiotics (25·4%).

Deaths

As indicated, there were 5 deaths. Two of these patients had received less than 10% surface area burns. One of these was a 3% surface area burn on a malnourished 9-lb (4·08-kg) baby aged 6 months. The burned area was the scalp. The thermal agent was boiling water and the infant died 35 days after admission. The cause of death was a postoperative pneumonia together with malnutrition. The operation performed was a skin graft which was done on the 33rd day. The other was a 9% surface area burn in another malnourished child of 6 months weighing 12 lb (5·44 kg). This child had also sustained other injuries. She died 5 days after admission. The thermal agent was boiling water and the areas burned were face and hand. Culture was sterile. In the 3% burn, culture produced

TABLE V. RESULTS WITH PREPARATIONS ON VARIOUS ORGANISMS

	Ps. aeruginosa				*Haemolytic strep.*				*Staph. aureus*				*B. coli*				*Proteus*				*Candida albicans*			
	I	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*	*I*	*II*	*III*	*IV*
Gentamicin	2 25·50	1 33·00	3 45·00	—	2	3	1	1	6	8	1	2	3	3	—	2	3	5	—	2	—	2	—	1
Ps. aeruginosa					6	4			20	14	3	1	7	6	1	1	4	4	1	2	1	1	1	1
Haemolytic strep.	26·50	72·33	102·00	50·00	18·33	22·22	—	—																
Staph. aureus	37·33	65·40	102·00	96·50	17·05	33·07	56·66	50·00	9 28·07	3 37·33	—	1 40·00	7	7	1	2	4	4	1	2	2	2	1	1
Coli	34·00	89·33	—	96·50	25·85	33·50	54·00	50·00	20·71	54·28	54·00	96·50	—	1 42·00	—	1 30·00	3	3	1	2	1	4	1	1
Proteus	47·33	83·00	—	96·50	23·75	54·75	54·00	68·00	32·50	67·50	54·00	96·50	27·33	89·33	54·00	96·50	—	1 19·00	—	—	—	2	1	2
Candida albicans	—	98·00	—	143·00	17·00	21·00	54·00	68·00	22·00	98·00	54·00	143·00	17·00	74·75	54·00	143·00	—	98·00	54·00	114·50	—	—	—	—
Soframycin																								
Ps. aeruginosa	5 11·20	1 46·00	—	—	5	11	—	—	10	20	3	5	4	11	1	2	2	6	2	2	—	3	—	—
Haemolytic strep.	37·00	52·90	—	—	1 11·00	1 11·00	—	—	11	14	1	—	2	11	—	—	2	5	—	—	—	2	—	—
Staph. aureus	36·3	52·22	53·33	44·60	32·63	72·00	7·00	—	5 11·20	—	—	—	6	14	1	2	4	8	2	2	—	3	—	—
Coli	26·25	54·45	73·00	76·00	17·00	52·45	—	—	23·16	26·07	73·00	76·00	—	62·83	73·00	108·00	—	6 —	1 —	1 —	—	3 —	—	—
Proteus	52·00	77·50	53·00	71·00	37·00	65·40	—	—	31·75	64·12	53·00	71·00	—	81·33	—	—	—	81·33	—	—	1 29·00	—	—	—
Candida albicans	—	73·33	—	—	—	97·00	—	—	—	81·33	—	—												
Neobacrin-Tulle	2	1			3	10	2	—	8	12	3	1	6	12	4	2	4	10	4	2	—	—	2	—
Ps. aeruginosa	27·20	11·00	—	—	2	2			7	7	2	—	2	7	2	—	2	5	1	—	—	—	1	—
Haemolytic strep.	29·00	49·20	79·50	—	11·00	13·00	—	—	4	1			8	10	1	2	5	7	1	2	—	—	—	—
Staph. aureus	31·25	54·18	79·33	89·00	25·00	48·71	79·50	—	17·50	11·00	—	—	22·00											
Coli	30·58	46·08	67·25	57·00	23·50	53·57	79·56	—	24·25	42·70	49·00	57·00	—	—	—	—	2	8	2	2	—	—	1	—
Proteus	40·25	37·10	67·77	57·00	47·00	43·40	80·00	—	32·00	35·00	49·00	57·00	30·00	42·12	64·50	57·00	—	—	—	—	—	—	1	—
Candida albicans	—	—	79·00	—	—	—	79·00	—	—	—	—	—	—	—	79·00	—	—	—	79·00	—	1 5·00	—	—	—

Staphylococcus aureus, B. coli and *B. proteus*. Both these cases were dressed with Soframycin cream. The third death was that of a patient who had suffered a 20% surface area burn. This child was 3 years old, again malnourished, weighing 22½ lb (10·21 kg). He died 52 days after admission. The thermal agent was boiling water and the burned area included the back, the neck and the left arm. Skin graft was performed 18 days after admission and was only 35% successful. *Pseudomonas aeruginosa* was cultured in the swab from the burned area. Cause of death was gastro-enteritis together with pneumonia complicating burns in a malnourished child. The fourth death occurred in a patient who had received Soframycin cream dressings and had suffered a 35% surface area burn involving the chest, back and face. The thermal agent was boiling water. The child was a 16-month-old infant weighing 28 lb (12·7 kg). Culture from the burn produced *Staphylococcus aureus*. The cause of death was septicaemia from which *Staphylococcus aureus* was cultured. The fifth death was that of a child who died on admission following a fire burn sustained when a paraffin lamp exploded. There were 20% surface area burns and the child was 2 years old, weighing 32 lb (14·52 kg). The areas burned included face, arms, chest and thighs. There was some delay between the accident and admission to hospital and the cause of death obviously was shock. The burns had been dressed with Neobacrin-Tulle but the child died within about 45 minutes of the dressings having been applied, in spite of preliminary resuscitation.

DISCUSSION

The objective in the management of any form of trauma is basically immediate resuscitation, which should be maintained, and the prevention of infection. Thereafter the surgical correction of the trauma where possible is carried out with continuation of the first two basic principles. In burn wounds this also applies. No specific procedure is carried out to repair the damage done other than skin grafting at the appropriate time. It is held by some[6] that the appropriate time is immediately or within the first few days. This has not been the policy here. Resuscitation is carried out by intravenous infusion of low molecular dextran followed by plasma in 10 - 15% surface area burns and plasma and blood in larger burns. The amount given is calculated from the formula percentage area burned × weight in pounds × 1·4 = X ml. Some authors have criticized the use of a formula for resuscitation and intravenous therapy.[7] However, the employment of this method has been found to be effective in over 2 000 cases of burn injury during the past 6 years. The formula is based on the metric calculation of X = % surface area × weight in kg × 3·5. With the advent of metrication we will doubtless revert to this formula. The use of low molecular dextran does not appear to have been employed as a routine elsewhere and is based on the rationale of rapid rise in solids and albumin content in the vicinity of the burned area. This has been described by Leape[8] who found that there was a rapid rise by 75% in water content with a parallel increase in solid content by 64%. In addition, the tissue albumin content was doubled and there was an increase of capillary red cell content by as much as 52%. Added to these profound changes in viable tissues is the vasoconstriction in the area of the burns, with microthrombi.[9]

These alterations account for the progression of trauma to necrosis in this tissue with conversion to full-thickness loss in a wide area, unless these increases with sludging and capillary constriction were reversed. With such increases the tissue perfusion in these regions must obviously be at a very low ebb, and if they should persist, death of tissue in these areas must be expected. Thus, the employment of low molecular dextran solution infused during resuscitation of patients suffering from burns and repeated after 42 - 48 hours, is aimed at reversal of this state in the tissues. Reversion to normal tissue perfusion in the surrounding tissues, whose viability has been placed precariously in the balance by the burn injury, will prevent further loss of tissue with necrosis and conversion to full-thickness loss over a wider area. The low molecular dextran may also contribute towards the rarity of oliguria and renal shut-down in several series reported from this unit. Moreover, in tissues with restored perfusion and viability the risk of sepsis is considerably decreased.

Routine systemic antibiotic therapy more frequently produces more virulent and refractory infections than if antibiotic therapy is withheld entirely. The emphasis in this unit is on wound care rather than the administration of systemic antibiotics. The low incidence of fatal septicaemia in this series substantiates this statement (see below). Stone *et al.*[10] are in full agreement with this but they do, however, advocate vigorous toilet to the wound with breach and debridement of all blisters on admission. Bearing in mind the principles referred to earlier, it is felt that it can only add to the shock and increase the risk of sepsis further if the wounds are subjected to more traumatization, albeit in the sterile atmosphere of an operating theatre and under an anaesthetic. The objective in this burn unit is to simplify the management of burns as much as possible without detriment to their healing. Robinson *et al.*[11] manage burn wounds along similar lines, by avoiding vigorous toilet to the injured area.

It was our original intention to apply the antibiotic cream only to the burn, without a dressing. However, it became evident that this would not succeed as the cream tended to slide off the areas, particularly where the flanks and limbs are involved. To overcome this difficulty, the cream was held in place by means of sterile lint held very loosely over the burned area.

It is quite notable how little objection there is by the children to being restrained by means of stockinette. It must be emphasized that a limited range of movement is still permitted, but interference with the dressings by the children is obviated. It is suggested, moreover, that the relative immobilization of the burned area will reduce the pain in that area felt by the patient. Continual restless movement aggravates the pain and the vicious cycle ensues.

The near-total immersion in Savlon becomes necessary as sloughs and scar begin to form. These are then effectively removed in this way.

From a study of the mean hospitalization period and mortality in the groups treated with the different dressings, there appears to be little difference in the results (Table II) as expressed, with perhaps the balance slightly in favour of gentamicin. In cases with this dressing there was a higher incidence of deeper burn, a larger mean surface

area, and a lower mean hospitalization period. These differences, however, are probably not statistically significant. What is held to be of considerably greater significance is the vastly decreased incidence of *Pseudomonas aeruginosa* contamination of the burn wound, when dressed with gentamicin, as compared with the others (Table IV). The incidence of this organism is approximately equal with Soframycin and Neobacrin (39·4% and 37·3%), but is only one-quarter of this figure (9·4%) when gentamicin was the dressing. In 502 cases, there were 112 cases with *Pseudomonas aeruginosa*. Only 26 of these were in the gentamicin group. While Table II belittles the significance of this, the potential risk of *Pseudomonas aeruginosa* can never be ignored. It is all the more noteworthy when one considers that approximately 20 of the 26 cases mentioned were treated during the last 3 months of the trial. During the first 5 months, there were no cases of *Pseudomonas aeruginosa* among the group dressed with gentamicin. In this same period a total of approximately 20 cases produced a culture of *Pseudomonas aeruginosa* when dressed with Soframycin or Neobacrin. The significant feature of these findings is the rapidly increasing incidence as the trial progressed beyond the 6-month period indicating the development of strains resistant to the antibiotic creams. This took longest with gentamicin cream, and even then the incidence of the invader was considerably lower than with Soframycin and Neobacrin.

Van der Riet and Louw[12] have stated that gentamicin cream must be used if pseudomonas infection occurs and Stone[13] reduced both toxaemic and septicaemic mortality dramatically by using gentamicin in pseudomonas infection. Gentamicin is a broad-spectrum antibiotic with, in addition, a high activity against *Staphylococcus aureus*.[14]

Probably the most important lesson to be learned from this trial is the absolute necessity to change the nature of the topical antibiotic regularly and periodically. It would appear that the optimum periodic change is every 4 months, regardless of the incidence of organisms being cultured during this time. In this way, resistance would be far less likely to develop, and, if it did, this would take place much more slowly.

Moreover, should *Pseudomonas aeruginosa* occur, the systemic antibiotic exhibited should not be the one in the topical cream in use at the time, and preferably one entirely different, e.g. carbenicillin or gentamicin if not exhibited for 4 months previously.

The experience gained from a number of clinical trials over more than 2 000 cases of burn wounds is that the presence of pus or the culture of any organism other than *Streptococcus haemolyticus* or *Pseudomonas aeruginosa* should not be a deterrent to early skin grafting (10th to 14th day), unless of course pyrexia is present. In this case the cause of the febrile illness must be pursued vigorously and diligently.

Neither pus nor positive culture are an indication for the exhibition of systemic antibiotics, in the absence of pyrexia, provided the two abovementioned pathogens have not been cultured. *Candida albicans* requires to be treated, and caution exercised with proteus organisms. Wound care with adequate technique under aseptic precautions supersedes in importance all antibiotics in the absence of pyrexia.

The combinations of invading bacteria summarized in Table V produce insignificant variations in results when compared with individual organisms occurring alone. Thus, on superficial appraisal, organisms occurring in the company of others appear to be of little importance. It is suggested, however, that the reason for this is the abstinence from the use of routine antibiotics, and the strictly discriminate use of broad-spectrum antibiotics. Haphazard poly-pharmacy, based usually on guess-work, is to be condemned. Indiscriminate use of antibiotics, exhibited sometimes in panic, will of certainty alter the picture of Table V, and produce dangerous combinations of organisms potentiating each other by virtue of resistance to a range of antibiotics, developed by mutation. Septicaemia may then increase in frequency and become a major cause of death. In this and other published series in this Burn Unit[1,4,5] septicaemia is an extremely rare incident.

Table IV shows no significant differences in the incidence of cases requiring systemic antibiotics, with each topical antibiotic. This incidence is no true reflection of the efficacy or otherwise of topical preparations, since respiratory or other remote infections, e.g. otitis media, are usually unrelated to burn wound sepsis, from the pathogen aspect. If septicaemia had been prominent, the differences in incidence in this table might have been greater and have assumed more importance.

Malnutrition, as always, increases the risk of complication and mortality as shown here. However, it is submitted that notwithstanding this, malnutrition does not constitute an added indication for the use of more and bigger and better antibiotics as a routine. Each case must be treated individually on its own merits.

SUMMARY

A comparative trial of topical antibiotic preparations is described in a series of 502 cases of burn wounds. The most significant difference in the 3 preparations used was the unquestionable supremacy of gentamicin (Garamycin) cream in the prevention of contamination by *Pseudomonas aeruginosa*.

It is stressed that pathogens develop resistance to any topical antibiotic, and thus the topical preparation should be changed in the Burn Unit regularly, e.g. every 4 months.

The low mortality and relatively short hospitalization period achieved in this series are attributed to prompt and efficient resuscitation, diligent wound care, and the fact that routine prophylactic systemic antibiotics are withheld.

I wish to thank the nursing staff for their untiring and diligent care of these children, and the junior surgical staff for their co-operation in the resuscitation of patients. I should also like to thank Dr M. Tonkin, Director of Clinical Research, Scherag (Pty) Ltd, who initiated the comparative trial and sponsored a large part of it; and Roussel Laboratories and Smith & Nephew (Pty) Ltd for their co-operation.

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