It will probably never be possible to eliminate *Staph. aureus* completely from patients and staff, but, by the measures outlined above, conditions under which resistant organisms can invade and flourish in post-operative and medical cases may be avoided.

Conclusions

Staphylococcal diarrhoea is a common and often fatal post-operative complication when antibiotics are being used prophylactically as a routine. In the Radcliffe Infirmary it became the major cause of death after elective partial gastrectomy. In medical patients, too, prolonged courses of antibiotics—for example, in chronic respiratory infections—are fraught with danger, especially when given in hospital. We submit, therefore, that the routine prophylactic use of these antibiotics is not justified. The relatively insoluble sulphonamides provide adequate preparation for colonic surgery, and it is unnecessary, and even dangerous, to use antibiotics in order to prepare the patient for operation either on the stomach or on the unobstructed small bowel.

However, if post-operative complications ensue, or if definite indications are present at operation (for example, a grossly soiled peritoneal cavity), the appropriate antibiotic should be used—at full strength and in short courses. Garrod (1955) outlined the principles for the correct use of antibiotics. Their abuse may lead to tragedy.

In conjunction with these measures, every effort must be made to reduce the numbers of *Staph. aureus* in the environment of the patient, not only to avoid surgical sepsis but to allow the safe and effective use of antibiotics when this is necessary.

Summary

Thirty-one cases of diarrhoea are described. Fourteen patients died, seven from one surgical ward. Fourteen cases occurred after partial gastrectomy.

Infection with *Staph. aureus* following antibiotic therapy was the chief cause of diarrhoea in this series.

The literature concerned with enterocolitis and staphylococcal diarrhoea is reviewed.

The epidemiology of two outbreaks of staphylococcal diarrhoea is described. Of the 31 cases, 29 occurred in two short periods in 1954 and 1955.

The aetiology of the condition is discussed and an account is given of an investigation into the bacteriology of the small bowel.

It is strongly recommended that antibiotics should not be used as a routine prophylaxis in abdominal surgery, but should be restricted to cases with special indication and then in isolation.

Measures to reduce the numbers of *Staph. aureus* in the ward environment are discussed.

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APPENDIX: METHOD OF BACTERIOLOGICAL EXAMINATION OF THE FAECES AND GASTRIC ASPIRATES

The faeces and aspirates were plated on to blood agar, one plate for aerobic and another for anaerobic incubation. They were also plated on to nutrient agar containing an added 7% of sodium chloride and inoculated into Robertson's cooked-meat medium containing an added 10% of sodium chloride. The latter was plated out after 24 hours' incubation at 37° C. on to blood agar (aerobic) and salt agar. Suspicious colonies after 24 and 48 hours' incubation were tested by the coagulase test and their sensitivity to antibiotics was determined.

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EXPERIENCE OF THE BURNS UNIT A REVIEW OF 520 CASES

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Colebrook (1950) advocated the establishment of special burns units where difficult and often long-term cases could be treated by trained teams and full use made of special facilities and equipment. In 1952 the Ministry of Health recommended the setting up of special centres in all regions. Burns have been treated at the Basingstoke Plastic Unit since 1940, but not until 1950 was it decided to form a burns unit within the hospital where these cases could be grouped together for the necessary specialized attention. The unit consists of 18 beds, divided into one six-bed ward, one four-bed ward, a five-bed nursery, and three single rooms. A major dressing-room includes a saline-bath unit; a minor dressing-room is available for ambulant and less severe cases, and skin-grafting operations are performed in one of the major operating-theatres normally set aside for that purpose.

Up to the end of 1955, 520 cases had been admitted to the unit, the admission rate gradually increasing up to the present level of 120–130 cases annually.

In Table I the cases are classified according to age groups, and also according to the percentage area of body surface burnt.

The majority of cases are referred direct from neighbouring practitioners or transferred within a few hours

TABLE I

Age Groups			Area of Burns		
0-5 years	..	189	0-9%	..	309
6-15	..	69	10-19%	..	104
16-30	..	100	20-29%	..	50
31-59	..	95	30-39%	..	25
60 and over	..	67	40-49%	..	13
			50-59%	..	11
			60% and over	..	8
		520			520

from hospitals in the eastern area of the S.W. Metropolitan Region. Some of the latter may be held in the referring hospitals for the two to three days of the shock period, advice on early treatment often being given by telephone or the case being visited by one of the staff of this unit.

Those admitted within 72 hours are classified as "fresh cases" and constitute two-thirds of all admissions. The remainder are referred after a longer period, possibly in many cases because of initial failure to recognize the severity of the injury. Commonly the presence of full-thickness skin destruction is not appreciated, and the case is transferred only after a delay of two to three weeks, when it is increasingly obvious that spontaneous healing is not going to occur. In this group unsuitable dressings or abortive attempts at skin grafting may have been carried out, and the importance of a high-protein high-calorie diet has not always been appreciated. It is here that one may still occasionally see the picture of the "chronic burn" with offensive dressings, anorexia and weight loss, low morale, and continued dependence on analgesics.

In Table II the cases are divided into these two groups. The average in-patient stay of 34.5 days for the fresh cases compares favourably with the national average of

TABLE II

Fresh Cases (admitted within 72 hours)			Delayed Cases (average delay, 17.8 days)		
Total No.	..	348	Total No.	..	172
Fatal cases	..	30	Fatal cases	..	16
Surviving cases	..	318	Surviving cases	..	156
Average total in-patient stay, 34.5 days			Average total in-patient stay, 65.5 days		

50 days (Colebrook, 1950). It will be seen that in the delayed cases the average (total) in-patient stay is 65.5 days, an increase of 31 days. The cost to the N.H.S. of this prolonged hospitalization can only be guessed at, but it provides strong support to the Ministry's recommendation for the establishment of these units. It will be appreciated also that delayed healing increases the degree of harmful scarring and the production of severe deformities which may require prolonged reconstructive treatment by the plastic surgeon.

The general principles of treatment have become well established in the post-war years, and, broadly speaking, differ from unit to unit mainly in matters of detail. As so much has been written on this subject recently, the following brief account deals only with salient points, and much technical detail has been omitted.

Treatment of Shock

The rapid and severe depletion of blood volume consequent on fluid loss from damaged capillaries is made good by controlled intravenous fluid replacement. This is necessary in all burns greater than 18% of body surface burnt in the adult, and 12% in the child, and the intravenous drip must be maintained for a period of 48 hours from the time of the burn. Fluid balance is carefully recorded and an indwelling catheter is employed if there is any difficulty in assessing renal output.

There is an increasing tendency to rely on a formula for dosage control and these formulae are tending to become simpler. The following schemes of dosage are in use at this unit:

Fluid Replacement Formula in Adults

120 ml. dextran for 1% body surface area burned.
This gives total quantity of intravenous fluid in 48 hours, and is divided as follows:

one-half in first 8 hours after burn
one-quarter in next 16 hours
one-quarter in final 24 hours
(N.B.—Ceiling figure—6 litres)

Deep burns: Up to one-third of total quantity given as whole blood.

Metabolic requirements: Given as additional oral fluids 50 ml./kg. daily (in a 10-stone (63.5-kg.) adult, approximately 3 litres daily).

Fluid Replacement Formula in Children*

A. Burns less than 30% of body surface area

Age	Months				Years										
	<3	3	6	9	1	2	3	4	5	6	7	8	9	10	11
Dextran†	15	21	24	27	30	42	48	54	63	69	81	87	93	102	111

The above figure multiplied by the % area of the burn gives the total quantity of intravenous fluid in 48 hours, and is divided into three equal portions:

one-third in first 8 hours after burn
one-third in next 16 hours
one-third in final 24 hours

B. Burns greater than 30% of body surface area

Calculate 10% of body weight.

This gives total quantity of intravenous fluid in 48 hours, and is divided as follows:

one-half in first 8 hours after burn
one-quarter in next 16 hours
one-quarter in final 24 hours

Deep burns: Up to one-quarter of total quantity given as whole blood.

Metabolic requirements: Given as additional oral fluids daily.

<2 years .. 160 ml./kg. | 5- years .. 80 ml./kg.
2- " .. 100 " | 8-11 " .. 50 "

* Developed from a chart published by Wallace (1951).

† In millilitres for each 1%.

It will be noticed that no extra electrolytes are provided for, the emphasis being on restoration of the circulating blood volume by dextran, with inclusion of whole blood if there is much destruction of deep tissue. Plasma has been completely replaced by dextran and has not been used in this unit for six years.

It is well at this point to underline the danger of overheating these patients when treated in first-aid or casualty department, and certainly the electric "shock cradle" should never be used. Surface heating accelerates the circulation through damaged capillaries and thus intensifies the depletion of blood volume.

Local Treatment

Once the shock state is under control attention is paid to the burned areas, which are treated by exposure, and in this unit it is regarded as the method of choice in all fresh cases. It gives the greatest opportunity for damaged tissues to heal, and maintains the deeper lesions in that state of dry necrosis which makes surgery so much more favourable. Some difficulty has been experienced in the past with circumferential burns of the trunk, but considerable improvement has been achieved by nursing on the special frame shown in Fig. 2. This is strung with rug canvas (4-in. (6-mm.) mesh), and the patient lies on sections of "polythene" sponge which are directly in contact with the burns. This allows maximum evaporation from the surface in contact, and there is practically no adhesion. The polythene sponge is changed daily and is re-sterilized. A cradle is placed over the patient to prevent draughts, and the air under the frame is warmed with hot-water bottles or, better still, a fan heater which circulates slightly warmed dry air.

Involved limbs are, of course, suspended to reduce oedema, and the necessity of relieving incisions must be borne in mind where there are deep circumferential burns of the extremities.

In superficial burns the coagulum usually comes away in 12-16 days, when healing is found to be complete. The deeper burns will require excision and skin-graft replacement.

There is no doubt in this unit that the introduction of exposure has led to a definite lowering of infection, less pain and discomfort, and a marked improvement in the general condition of the extensively burned patient.

Surgical Excision and Skin Grafting

The procedure usual with most closed-dressing techniques of awaiting separation of moist sloughs and then grafting the resulting granulation tissues is employed here only in those late infected cases in which dry treatment is no longer practicable on admission. It is felt that in all fresh cases the areas of full-thickness skin destruction should be excised at the optimum time for the particular case (often the 14th–16th day) and maximum skin cover achieved at the same operation.

This extensive but necessary operation on a patient, whose general condition has been maintained only with considerable difficulty, is not undertaken lightly. Although the procedure has been made shorter and safer by technical advances such as the use of electric or pneumatic dermatomes, more rapid excisional techniques, etc., the greatest emphasis must always be placed on theatre team-work. Excision and grafting of a major burn should not be attempted unless a team of at least two surgeons and two sisters is available, and even with an experienced team it is often advisable to rehearse the various stages beforehand. It will be appreciated that most burns of 30% and upwards will require application of skin grafts on more than one occasion, although these secondary operations are comparatively minor. Full skin cover may not be achieved at the first operation, and areas of patchy graft failure are not uncommon.

Homografting is sometimes resorted to as a means of increasing the area of skin coverage possible in a patient whose own donor sites are limited, usually a child with extensive deep burns. The donated skin is preferably applied in the form of strips alternating with the autografts.

General Treatment

A high-protein high-calorie diet has long been regarded as essential for these patients, and this has recently been emphasized by the nutritional studies carried out in Wallace's unit in Edinburgh (Sutherland, 1953). The pronounced stress response of the burned patient in the early stages leads to a rapid and extreme loss of nitrogen in the urine, and this may be accentuated by the continuing loss of protein from the extensive areas of skin destruction. If this negative nitrogen-balance is not countered rapidly and efficiently, weight loss is soon apparent, the general condition deteriorates, and healing is considerably retarded. It is not possible to achieve the necessary levels of intake by ordinary diet, and reliance must be placed on supplementary feeds.

The recent introduction of "complan" has greatly simplified this problem and has almost completely removed the difficulty of meeting protein and calorie requirements. One pound (450 g.) of complan contains 140 g. of protein and provides 2,000 calories, and this daily quantity is easily managed by even the most difficult of patients. As this is supplementary to solid diet, and in addition may be given in milk, it is easy to maintain daily levels of 3 g. of protein per kg. of body weight and the equivalent number of calories. Even higher levels have been achieved where necessary and without having to resort to tube-feeding.

In addition haemoglobin levels must be watched, and repeated blood transfusions may be called for to combat the anaemia to which these patients are prone. Physiotherapy is employed to maintain joint movements, and occupational therapy may assist in this and also help to maintain morale.

Complete cessation of healing is fortunately a rare but extremely difficult complication, and appears to be pre-disposed to by inadequate early treatment.

A 20-year-old man was admitted from the Middle East some six weeks after he had sustained a 60% burn, most of which was full-thickness skin loss. Nine months later healing was still

far from complete in spite of repeated grafting operations and intensive supportive therapy. Investigation showed that his urinary excretion of 17-ketosteroids was down to 1.5 mg. daily (normal, 9–24 mg.), and a course of systemic cortisone, 100 mg. daily, together with methyltestosterone, 10 mg. daily, was started. Within three weeks more healing occurred than in the previous four months, and previously grafted skin became obviously more stable.

Experiments are also being made with local hydrocortisone applied to similar areas of slow healing, and it is obvious that further investigation is required in this type of case. In passing, it may be noted that this form of graft failure and instability is similar to that seen after unsuccessful homografting.

The Late, Infected Case

A somewhat different approach may be necessary for these patients. Frequent saline baths are combined with closed dressings, and there may be some delay before raw surfaces are suitable for skin grafting. Anaemia and protein deficiency may be pronounced and require intensive treatment as described above.

Illustrative Case

Only the following case has been chosen for detailed presentation, as it exemplifies most of the important features of present-day treatment of the more difficult type of case—the circumferential burn of the trunk.

A German maidservant aged 19 was admitted to the unit on February 12, 1956, after her nightdress had caught fire one and a half hours previously. She had sustained burns of both surfaces of the body, both thighs, the left arm, and the right hand. The posterior surface was the more severely involved, the burn extending almost completely from the neck down to just above the knees (Fig. 1). The extent of the burn was estimated at 45% of the body surface area, about two-thirds of this representing full-thickness skin destruction. Her weight shortly after admission was 67 kg.

FIG. 1.—Photograph of a girl aged 19 with burns of 45% of the body surface area, taken on admission.

FIG. 2.—Exposure treatment of extensive circumferential burn on special frame. The polythene sponge is not visible in the photograph.

Intravenous fluid was begun immediately, 3,780 ml. of dextran and 1,620 ml. of blood being given in 48 hours, providing a total of 5,400 ml. (120 ml. per 1% burn). Her metabolic fluid requirements were given orally in the form of

FIG. 3.—Use of deck-chair strung with $\frac{1}{4}$ -in. (6-mm.) mesh netting and covered with polythene sponge.

glucose drinks. Haemoglobin concentration was recorded graphically, the highest haemoglobin level being 16.52 g. per 100 ml. Fluid balance was recorded accurately, an indwelling catheter being used to help measure the renal output. During the second day her output fell to 25 ml. an hour, but diuresis occurred the following day with a 24-hour total of 2,420 ml. By this time she had started a solid diet supplemented by 1 lb. (450 g.) of complean daily. The burns

were treated by exposure, and for this purpose she was nursed on polythene sponge on the special frame (Fig. 2).

Most of the time she lay prone, but this was varied with periods of lying on the back. By the fifth day more movement was permissible without damage to the eschar, and she was allowed to sit in a deck-chair strung in the same manner as the bed frame (Fig. 3). The use of the commode for toilet purposes greatly simplified the nursing problem. The

burns remained clean and dry, and the freedom from infection is indicated by the mean evening temperature, which fell from 100.1° F. (37.8° C.) during the first week to 99.5° F. (37.5° C.) during the second week.

On the 16th day after the burn she was taken to the operating theatre, the full-thickness areas were excised (Fig. 4), and skin grafts cut with the pneumatic dermatome were applied, a blood transfusion of 3 pints (1,700 ml.)

FIG. 4.—Raw surfaces ready for grafting after excision of areas of skin destruction.

being given. A satisfactory "take" of the grafts was achieved, and two further lesser grafting procedures were carried out on March 13 and April 10. Many of the dressings were done in the saline bath, and exercises were encouraged in the bath under the supervision of the physiotherapist. Healing was substantially complete by the 10th week, but she remained in hospital for a further three weeks to ensure her fitness to travel to her home in Germany. She was discharged on May 16, 13 weeks after her injury.

From her admission great emphasis was laid on the maintenance of a high-protein high-calorie diet, and the successful management of this aspect of her treatment was largely

FIG. 5.—Chart of the case.

Phonocardiograms were taken at rest, using a Sanborn stethocardiette with logarithmic frequency response and a paper speed of 75 mm. a second. Lead II of the electrocardiogram was used as a reference tracing, but lead III was also studied in case there was an initial isoelectric interval of the Q.R.S. in lead II. The precautions necessary to obtain satisfactory phonocardiograms have already been described (Wells *et al.*, 1949).