STAPHYLOCOCCAL INFECTIONS OF THE SKIN AND THEIR TREATMENT*

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(With Special Plate)

Of the conditions which come under the care of the dermatologist, the following have been shown to be due to infection by staphylococci: sycosis coccigenia; sycosis nuchae; recurrent furunculosis; carbuncle; blepharitis; acne necrotica; hydradenitis (axillary abscess); pyogenic granuloma; acrodermatitis continua; porofolliculitis (Bockhart's impetigo); dermatitis infectiosa eczematoides; onychia and paronychia; multiple subcutaneous abscesses of infants; pemphigus neonatorum, and miliaria rubra (prickly heat). The type of lesion is determined by circumstances such as the age and state of health of the patient, the site of the initial infection, the condition of the skin at the time of infection, and the subsequent treatment. For example, porofolliculitis, which is an eruption of multiple follicular pustules, usually follows the application of some irritant, such as liniment, plaster, blue ointment, or foment, particularly to hairy parts.

These infections tend to remain pure, or textbook in type. The explanation may be that different strains of the organism are responsible for the differing types of infection. Cases of sycosis rarely develop boils or carbuncles. Few cases of recurrent furunculosis develop sycosis, though there must be daily contamination of the beard area with the infecting staphylococcus. A patient who has a pure staphylococcal infection of the nasal sinuses may develop blepharitis and sycosis of the upper lip, but he will not suffer from boils.

Predisposing Conditions

Most dermatologists will agree that the really troublesome and persistent infections occur in seborrhoeic patients.¹ Virulent staphylococci cannot be regarded as normal inhabitants of the human skin, but exposure to infection must be very frequent. Active lesions due to this organism are certainly a potent source of infection to other people, either by direct or by indirect contact. Nurses and doctors contract furunculosis from patients with this type of infection, and boils, porofolliculitis, and sycosis may originate in the barber's shop. When once the skin has been infected irritation of the hair follicles in which the organisms lurk predisposes to their active growth, and friction may determine the site of a boil or a carbuncle.

An unhygienic indoor life, overwork, anaemia, excessive or inadequate diet, chronic infections elsewhere, and occasionally hyperglycaemia are factors operative in certain cases. The most intractable of these infections, sycosis barbae, is never seen except in seborrhoeic persons. These patients usually have other seborrhoeic manifestations, such as pityriasis, seborrhoeic dermatitis, or acne, or these conditions have at one time been present. The most severe cases occur in those whose resistance to infection has been low since childhood—the subjects of chronic infectious eczematous dermatitis of the scalp, ears, and flexures, chronic blepharitis, rhinitis, and nasopharyngeal catarrh. Dolman has recently pointed out that many of these patients have a pure staphylococcal infection of the nasal sinuses. Sycosis of the moustache area is nearly always associated with nasal catarrh and blepharitis.

Treatment

The treatment of many of these conditions is simple. It follows the usual lines of attention to the general health by proper exercise and diet, with the local application of mild superficial antiseptics, of which every doctor has his favourites. Prevention of the spread of virulent staphylococci is important. This may be secured, as in the case of a boil, by an elastoplast dressing, or by the application of pure ichthyol. If the infection does not respond to simple measures, the administration of concentrated vitamins, the injection of heavy metals such as tin or manganese, autohaemotherapy, polyvalent bacteriophage therapy, Besredka antiviral, x-rays and ultra-violet light, and injections of various proprietary remedies have been tried, and have had their vogue. Vaccines, both autogenous and stock, have been used. The very multiplicity of remedies suggests that none can be relied upon to promote recovery in the obstinate cases.

The Infecting Agent

The most important factor in many of these conditions is the strain of the infecting staphylococcus. Burnet² has shown that a highly virulent toxigenic *Staphylococcus aureus* strain may have *albus* variants. The power of the organism to form pigment is no guide to the virulence. During the past four years organisms have been cultured from various lesions and the strains of staphylococcus cultured have been investigated. The variation in toxin production of different strains of staphylococci has stimulated work on skin infections by this organism.

The observation that the blood serum in man and in animals often contains measurable amounts of antitoxin has suggested a new method of treatment.³ We know that some strains of staphylococci may produce more than one toxin, and that each of the toxins (alpha and beta) can evoke a separate antitoxin. The differentiation between these toxins is achieved by their different haemolytic action on the red cells of the rabbit and sheep. The alpha toxin, which probably plays the major part in human infection, has several properties. It is haemolytic, induces dermonecrosis, and is lethal to animals. It has the power of destroying white blood cells, and so contains a leucocidin.

Panton and Valentine⁴ state that toxin produced by staphylococci isolated from sycosis barbae proved to be weak in leucocidin and strong in haemolysin; while cultures from patients suffering from pyaemia produced a toxin which was weak in haemolysin and strong in leucocidin. Research work is proceeding in several centres into the exact components of the exotoxin of the staphylococcus—work that will yield more exact knowledge of the antigen which recent investigations have suggested as a means of treatment.

Dolman and Kitching working in Toronto, and Morgan working in Melbourne, have shown that strains of alpha toxin vary considerably. To quote Dolman and Kitching⁵: "It should be emphasized that staphylococcal filtrates are by no means solely comprised of alpha and beta components . . . alpha toxin is not a simple entity. Moreover, one of us has demonstrated, by using the erythrocytes of various laboratory animals, the existence of a multiplicity of haemolysins in staphylococcus filtrates. Quite apart from this complexity of the haemolysins, a leucocidin, a plasma coagulase, and an enterotoxin have each been described as separate entities detectable in certain staphylococcal filtrates. No thoroughly reliable methods of titrating these other potentially pathogenic properties have yet been described, nor have these properties been investigated from the point of view of their relative significance in human disease. But we are satisfied that no one strain of staphylococcus can be relied upon to supply the multiplicity of antigens which it seems

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TABLE I.—Cases of Sycosis Barbae and Sycosis Nuchae Treated by Injections of Staphylococcal Toxoid

Case	Sex	Age	Diagnosis	Duration of Disease	Number of Injections	Result	Observation of A.H.T. during Treatment	Remarks
1	Male	56	S. B.	7 years	10	Cured	0.5-1.6	Chin and upper lip affected. Apparently cured; slight relapse after three months, which responded to further injections
2	"	25	"	2 "	28	"	0.5-3.6	Whole beard area affected—superficial type
3	"	34	"	12 "	30	Much improved	1.9-4.6	Old case with x-ray atrophy of both cheeks and blepharitis
4	"	23	"	1 year	30	Cured	0.5-9.2	Whole beard area with recurrent pustules on forearms
5	"	35	"	3 years	15	"	0.3-2.0	Old case with x-ray atrophy of both cheeks (concentrated toxoid used for treatment)
6	"	25	"	1½ years	10	"	1.7-5.1	Sycosis with subcutaneous abscesses of face
7	"	53	S. N.	5 months	9	"	1.0-10.0	Marked focal and general reaction to first injection of crude toxoid
8	"	28	"	6 "	8	"	1.1-6.0	
9	"	22	"	14 years	15	Much improved	1.9-4.0	Typical sycosis nuchae with much scarring
10	"	39	S. B.	7 "	10	Cured	0.5-5.0	Mild case without marked inflammatory symptoms
11	"	50	"	7 months	10	Much improved	0.8	Sycosis confined to chin
12	"	31	"	10 years	5	" "	0.5	Superficial type; had been epilated twice by x rays
13	"	40	"	1½ years	4	Improved	0.2	Infection of skin of eyebrows as well as beard area
14	"	44	"	1 year	20	Much improved	0.3-5.0	Limited to small area on chin
15	"	17	"	1½ years	10	" "	0.4	Beard area and blepharitis
16	"	21	"	2 months	9	Cured	0.3	Apparently cured; small area on chin. Joined permanent Army
17	"	40	S. N.	1 year	20	"	Private case	History of boils and pustules on neck with scarring
18	"	22	S. B.	4 years	36	Improved		Chin
19	"	40	"	3 "	14	"		
20	"	22	"	2 "	13	"		
21	"	24	Abscess	3 "	40	"		
22	"	30	"	1 year	14	Cured		
23	"	20	"	2 years	20	"		

S.B., sycosis barbae. S.N., sycosis nuchae. A.H.T., antihæmolytic titre of patient's serum.

TABLE II.—Cases of Staphylococcal Infection other than Sycosis Treated by Injections of Crude Toxoid

Case	Sex	Age	Diagnosis	Duration of Disease	Number of Injections	Result	Observation of Blood Anti-hæmolytic Titre	Comments
1	Male	56	Carbuncle and subcutaneous abscess	1 month	8	Cured and relapse	2.5-1.2	Recurrent single subcutaneous abscess three months later
2	"	19	Seborrhoeic dermatitis and pustules of face	9 months	27	Marked improvement	1.1-10.0	Pustulation improved with treatment, leaving seborrhoea of scalp
3	"	35	Boils	12 "	6	Cured	2.0-10.0	
4	Female	21	"	6 "	3	"	0.2-0.5	Local antiseptics
5	Male	40	"	5 years	10	"	1.2-4.0	Recurrent infection inside nostrils and boils elsewhere
6	"	35	"	6 months	12	"	1.0-8.0	
7	"	25	"	2 "	3	"	"	Local antiseptics
8	"	45	"	2 "	5	"	"	" "
9	Female	17	Pustules on face	9 "	15	"	"	" "
10	Male	16	Boils	6 "	4	"	"	" "
11	"	21	"	2 years	4	"	"	" "
12	"	24	"	1 month	4	"	"	" "
13	"	18	"	3 months	4	"	"	" "
14	"	23	"	5 "	4	"	"	" "
15	"	24	"	1 month	4	"	"	" "
16	"	21	"	2 months	6	Improved		
17	Female	46	"	2 "	5	Cured		Mixed infection—staphylococci and streptococci; boils on hand and neck
18	Male	31	Abscess on neck	15 years	4	Improved		Numerous boils on neck
19	Female	52	Boils	7 months	4	Cured		Scars of old abscess of neck and cheek
20	Male	38	"	4 years	30	Improved 80%		" " " " " "
21	"	40	"	2 "	9	Cured		Mainly on face and scalp
22	Female	32	"	2 "	8	Cured and relapse		
23	"	46	Boils and carbuncles	7 "	8	Improved; still under treatment		
24	Male	27	"	1 year	12	Cured		

desirable to have present in toxins from which toxoids for use on human beings are to be prepared."

Toxoid

The exotoxin of the staphylococcus, which is lethal if injected in the crude state, may be robbed of its dangerous properties, but allowed to retain its useful immunizing antigenic properties, by incubation for several days after the addition of a small percentage of formalin. The product thus obtained is known as toxoid, and it has been used in the treatment of chronic staphylococcal infections. By a series of graded injections it is possible to increase the amount of circulating antitoxin in the blood of human beings and animals even to twenty times the original titre. This increase in antitoxin is accompanied by immunity to infection in animals, and by improvement in the clinical condition of humans in a fair percentage of cases.

Treatment by Toxoid Injections

I chose a series of patients suffering from sycosis barbae for treatment, since these patients had resisted all previous attempts at cure, and the majority gave a history of infection for several years.⁵ In addition, I have treated cases of recurrent furunculosis, subcutaneous abscess, and dermatitis infectiosa eczematoides in a seborrhoeic. This last patient was the source of our most potent toxigenic staphylococcus. My practice with the earlier patients treated in 1932 was to use a polyvalent toxoid, to begin with small injections of 0.05 c.cm., and to increase the dose cautiously at weekly intervals. In estimating the dosage I was guided by the clinical condition of the patient and by the measure of circulating antitoxin in his blood. My experience came to agree with that of Dolman⁶ and of Murray,⁷ that the patient's condition and response afford sufficient guidance to the dosage and frequency of injections, for individual patients vary in their response to toxoid. The work in London has been carried out with toxoid prepared by Burroughs Wellcome from a single strain of staphylococcus; whereas Dolman in Canada uses polyvalent toxoid. Murray contends that a graded series of six to eight injections is usually sufficient for the treatment, and that further injections do not increase the amount of circulating antitoxin. In my experience eight injections have sufficed to cure cases of recurrent furunculosis, but patients with sycosis barbae require a long course of treatment to effect a cure. I have given one patient as many as forty injections; the total amount of toxoid injected was 12 c.cm. Dolman has had a similar experience with obstinate infections.⁸

In a small percentage of cases local, focal, and general reactions occur after the early injections of the series. It is wise, therefore, to use very small doses when beginning the series or when resuming injections after an intermission. Unpublished experimental work at the Walter and Eliza Hall Institute in Melbourne on our early toxoid demonstrated that when stored the toxoid deteriorated, so that it lost 40 per cent. of its antigenic power after six months' storage at ice-box temperature. At room temperature the deterioration was more rapid.

Results of Treatment

Of twenty-three cases of sycosis barbae treated with injections of toxoid twelve may be regarded as cured and the remainder much improved, so much so that they have ceased to attend the out-patient clinic (Table I). In Table II are given the results of treatment in chronic staphylococcal conditions other than sycosis barbae. Of twenty-four patients, eighteen were cured and the remainder much improved. Cases of severe seborrhoea with added staphylococcal infections still retain the tendency to seborrhoeic manifestations when the staphylococcus has been dealt with; the same applies to acne.

Cases with a focus of staphylococcal infection, such as an infected sinus or pyelitis, are, as Dolman has pointed out, in a different category, and may need surgical treatment. The dermatologist rarely encounters patients suffering from acute staphylococcal bacteraemia, though this may complicate a severe carbuncle. For such patients, as for those suffering from acute osteomyelitis, antitoxin of high titre has been prepared, and has been used, especially in Canada, in such cases with success. The administration of antitoxin in the acute stage may well be followed during convalescence by injections of toxoid to stimulate and maintain the natural antitoxin of the patient at a high titre.

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X-RAY DIAGNOSIS OF ACUTE INTESTINAL OBSTRUCTION

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In the diagnosis of chronic incomplete obstruction *x-ray* examination after the giving of barium by the mouth or rectum is to-day a standard procedure, and needs no emphasis or comment. In the acute complete obstructions, however, the barium meal and enema are as a rule either impracticable or of little value, and surgeons have in the past relied almost entirely on bedside clinical evidence for their diagnosis. Recently, in an attempt to supplement this evidence, which in the early stages of intestinal obstruction may be slender, there has been a revival of the use of plain *x-ray* examination of the abdomen; that is to say, an examination without any previous administration of radio-opaque substances.

During the past eighteen months we have submitted to plain *x-ray* examination of the abdomen all cases of acute intestinal obstruction or suspected obstruction which we have had the opportunity of investigating. We have also undertaken experiments in the post-mortem room to study the different *x-ray* pictures produced by varying degrees of distension at different intestinal levels. The present paper reports the results of this work, and attempts to assess the value of the test in the diagnosis of acute intestinal obstruction.

Literature

Plain *x-ray* examination of the abdomen as a diagnostic measure in intestinal obstruction was, according to Wangenstein, first described by Schwarz of Vienna in 1911. In 1915 Case in America published a paper on similar lines, and this was followed by a German contribution by Kloiber in 1919. Since 1920 several papers have appeared in America, references to which are given by McIver and by Wangenstein, but in this country the method has not excited much attention.

Method

The basis of the test is that gas and fluid, which can be recognized on plain *x-ray* examination of the abdomen,

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FIGS. 1 and 2.—Sycosis barbae. Case 3, Table I, aged 34: Duration twelve years. Treated by toxoid injections (30 injections). X-ray atrophy of both cheeks. Much improved. Photographed before and after treatment.

FIGS. 3 and 4.—Sycosis barbae. Case 5, Table I, aged 35. Duration three years. Treated by toxoid injections (15 injections). X-ray atrophy of both cheeks. Cured. Photographed before and after treatment.