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REHABILITATION IN THE ROYAL AIR FORCE*

BY

R. WATSON-JONES, M.Ch., F.R.C.S.

Consultant in Orthopaedic Surgery, Royal Air Force

An air gunner was admitted to a civilian orthopaedic hospital in November, 1940, for the treatment of a torn and displaced semilunar cartilage. In August, 1941, no less than ten months after admission, he was still in hospital and still totally incapacitated. Why was recovery so long delayed? What possible explanation could there be? The diagnosis had been correctly made and a skilful operation performed. The wound had healed by first intention; there was no infection, arthritis, or surgical complication. Daily massage had been continued, but the muscles were still wasted and weak. Two manipulations had been performed under anaesthesia, but movement was only half of normal. The gait was slow and hesitant; he limped; he could not run—he had never tried to run. The medical officer blamed him because “he would not co-operate,” because he was disinterested, depressed, and resentful. He was certainly depressed, for after ten months the incapacity was more complete than on the day of admission. He was disinterested because, in his own words, “nobody takes any notice, and it looks as if it is hopeless.” He was resentful because he could not believe that the fault was his. Had he not been told that “the nerve to his knee was cut”?

He was transferred to one of the orthopaedic rehabilitation centres of the R.A.F. Medical Service. He saw the sky, the sea, the open spaces. For many months he had seen only the stone walls of hospital wards, the stone walls of massage rooms, the stone walls of many corridors. In his new surroundings there was a lounge and writing-room; there were tasteful decorations and flowers, a varied menu, and an atmosphere of well-being and contentment. After a few days he smiled. There was sometimes a sparkle in his eye. He sensed a spirit of optimism and was reassured. His difficulties were explained, and he was taught special exercises. He learned to walk and then to run. He became an enthusiast and worked in the gymnasium, played on the fields, swam in the pool, cycled on the track. In the evenings he attended lectures and concerts, or played billiards and table-tennis. Time raced past, for he was busy. He became bronzed and fit. He laughed and was full of the joy of life. In seven weeks he returned to his unit and to full duty. The “nerve in his knee” was forgotten.

Ten months—total incapacity; seven weeks—full recovery: that is the story of rehabilitation in one air gunner. But is this an isolated case from which no conclusion should be drawn? The answer lies in the records of industry, the files of insurance companies, the experiences of H. E. Moore¹, the investigations of the B.M.A. Committee on Fractures², the findings of the Trades Union Congress³,

the reports of the Interdepartmental Committee on Rehabilitation⁴, the publications of the Fabian Society¹², the reports of the Council for the Care of Cripples¹¹, the analyses of H. E. Griffiths⁵, the papers of Kessler³, Middleton⁴, Watson-Jones^{1, 6}, Cunningham⁷, Levy¹², Nicoll¹³, Houlding¹⁴, Malkin¹⁵, and others. These records show that the experience of the air gunner is typical of many patients. In this country, at this moment, there are hundreds of injured men whose surgical treatment was concluded months ago but whose incapacity is still total because minor disuse-changes remain, or because confidence is lacking and morale has been destroyed. Their bodies have been treated, but not their minds. Treatment has been concentrated on the repair of bone and not on the tone and volume of muscles, stability of joints, circulation of limbs, control of oedema, and relief of adhesions. There have been no measurement and graduation of physical activity, no continuation of treatment until the patient recognized for himself that recovery was complete. It has been assumed that union of a fracture was followed promptly by the return of full function, and that when a man left hospital he soon returned to work. But now that members of the Services may not be discharged to out-patients and lost sight of, it is found that a simple cartilage operation may cause more than ten months' incapacity. We have known that a Colles fracture is united in six weeks, but not that this injury may keep a man off work for six months. We knew that fractures of the ankle were healed in twelve weeks, but not that they often incapacitated workmen for twelve months. We never conceived that in one series of 276 men there could be a wastage of no less than 168 working years², and that stiffness, swelling, weakness, and wasting may appear insuperable difficulties to many patients who, being inexperienced, fear that the weakness may be permanent, are terrified of normal strains and hazards, are overwhelmed by the prospect of work, and express their fears in the symptoms of “neurasthenia” and “malingering.”

In December, 1937, the British Medical Association and the Trades Union Congress³, in reporting these facts, recommended the development of rehabilitation services, including (a) functional treatment in hospital wards by regular exercises; (b) treatment in rehabilitation centres by physical and recreational activities designed to overcome residual disuse-changes, restore the confidence of patients in their recovery, and bridge the gap between the exercises of a fracture ward and the stresses of normal work; and (c) vocational retraining for the small proportion of men whose disability is permanent. These recommendations have not yet been generally adopted. In a report recently published¹⁶ it is regretted that “the country does not as yet possess a comprehensive rehabilitation service.” Of the civilian needs of the country it must be admitted that

* An address to the Council for the Development of Orthopaedics in Northern Ireland, delivered in Queen's University, Belfast, September, 1941.

this is true. But there is now evidence of an increasing appreciation of the importance of rehabilitation and of many attempts to introduce this treatment. In the Royal Air Force a comprehensive rehabilitation service has been in existence for two years, serving the needs of R.A.F. hospitals throughout the country, for the treatment of injuries sustained by a large number of men engaged not only in flying and operational duties but also in many forms of industry. The experience now available has very largely confirmed the opinions provisionally submitted some four years ago to the British Medical Association, the Trades Union Congress, and the Interdepartmental Committee on Rehabilitation. It has proved the value of organized treatment in the wards, the undoubted value of rehabilitation centres remote from fracture hospitals, the importance of patients living in the centres, the necessity for swimming-pools, playing-fields, and open spaces, the vital significance of creating the right atmosphere, the need for individual supervision of treatment by medical officers, the smaller part to be played by physical training instructors, the impossibility of one medical officer treating more than fifty patients, the unimportance of remedial workshops, and the limited value of occupational therapy and physiotherapy. Experience has proved that it is difficult and often impossible to fulfil the requirements within the grounds and buildings of a hospital, and that a rehabilitation centre without the right atmosphere is almost worse than no rehabilitation centre at all. A spirit of optimism, an atmosphere of enthusiasm, varied and continuous activities, and individual treatment by medical officers of the right type—these have proved to be the secrets of success.

Rehabilitation in Hospital Wards

The object of functional treatment is not only to cure but also to prevent muscle-wasting, joint stiffness, and other disuse-changes. The treatment must begin early, and certainly in the hospital wards, where every single patient has at least one special exercise to perform. The man with the fractured forearm exercises his fingers and shoulder. The patient with the fractured tibia mobilizes his toes and maintains the tone of his thigh muscles. Every patient with a lower limb in plaster practises quadriceps-muscle drill, even if the plaster extends up to the groin or over the hip-joint and trunk. The man with a fractured spine immobilized in plaster turns on his face and develops the erector spinae. Every patient with a disability of the knee-joint is taught thigh-muscle exercises before operation, and practises them immediately afterwards. Limbs which are not injured are also exercised, in order to promote general fitness and to reduce the difficulties which arise when the man leaves his bed.

Exercise Leaders.—If the exercise is to be of value it must be repeated over and over again, practised hour by hour, and continued persistently despite boredom and weariness. Rehabilitation does not begin with recreation and games; it begins with work, and very hard work. It was found that an enthusiastic surgeon could change the spirit of a ward from one of complete lethargy and despair to one of some activity and life, but it was impossible for him to maintain sufficient continuity and persistence of activity. He was often engaged in the operating theatre, plaster room, out-patient department, or elsewhere. A trial was made of appointing one patient as the exercise leader. At every hour of the day he called his colleagues to attention, and supervised five minutes of special exercise. One sergeant pilot, for example, with two fractured arms, two burnt hands, and ten burnt fingers, inspired others by his own efforts and proved a most successful leader. But patients selected for eagerness and enthusiasm were often the first to recover and pass on; moreover, there was no uniformity in their qualities of leadership. The final solution, which has proved to be of the utmost value, was the posting to every

fracture ward of a specially trained full-time rehabilitation orderly.

Rehabilitation Orderlies.—Groups of nursing orderlies chosen for their enthusiasm and drive, and for the respect they would command by former achievements in games and recreations, were trained in the principles of fracture treatment, given experience in rehabilitation centres, taught the details of active exercises, warned of the dangers of passive stretching, and finally posted, not as masseurs, not as quack practitioners, but as rehabilitation orderlies. The duty of the orderly is to supervise all physical and recreational activities. Under the instruction of the medical officer he teaches every patient his special exercise, insists on hourly repetition throughout the day, coaxing, urging, and goading as may be required, always exercising patience and good humour. Patients call him the "muscle mechanic." He teaches them to walk in plaster, correcting the limp which so quickly becomes ingrained, weaning men from sticks and crutches, and aiming within a few days at a gait which, despite the handicap of plaster, is indistinguishable from normal. Many weeks and even months of disability may be avoided by preventing habit limps from becoming established and teaching men to walk confidently without the aid of sticks. The secondary duty of the orderly is to organize occasional general respiratory, trunk, and limb exercises, promote carpet-making, needlework, and similar activities, encourage wireless observers in Morse-tapping communication across the ward, introduce darts, tenniquoits, and billiards in recreation rooms, arrange simple games in the hospital grounds, and generally promote an atmosphere of enthusiasm. This duty is, however, of secondary importance. Recreational therapy, occupational therapy, and the therapy of intellectual pursuits are valuable in preventing depression and despair, but can never supplant the need for deliberate hard work. The dominant note of treatment must be exercise, not recreation.

Treatment in Rehabilitation Centres

When the fracture has united and the plaster is removed muscle redevelopment must be accelerated and intensified. This might be achieved in any hospital department or gymnasium by static exercises; but greater interest and enthusiasm, and therefore more rapid progress, can be secured by the exercises of movement—running, skipping, cycling, swimming. Consequently it is an advantage from the purely physical point of view that treatment should be completed where there are playing-fields and swimming-pools, squash rackets and tennis courts, bowling-greens and croquet lawns. But there are more subtle reasons for the development of rehabilitation centres remote from general hospitals. The patient whose infected compound fracture has been treated for many weeks or months is satiated with hospital routine. The open air and a change of surroundings are no less important in his convalescence than good food and recreational activities. Moreover, the average man who lies in bed for many weeks, asking for this, ordering that, and commanding the other, becomes the king of a little universe which revolves around him. Here lies the germ of chronic invalidism, and both discipline and a new mode of life are necessary. Finally, nothing can be more certain than that patients whose injuries have been complicated by fears and depressions must be inspired by a new spirit of optimism and enthusiasm, and that complete removal from the hospital atmosphere is imperative. Every patient, no matter what his type, derives benefit when treatment is concluded in a special rehabilitation centre.

Continuity of Treatment.—The R.A.F. Medical Service had adopted this policy. With the exception of patients with less severe injuries, who can return direct to their units, all are transferred to rehabilitation centres when surgical stability has been reached—wounds being healed, new unpadding plasters applied, the position of fragments finally and accurately adjusted, and the union of fractures taking place. X-ray facilities in or near the rehabilitation unit are obviously necessary, and a plaster theatre is also needed for changes of plaster and minor manipu-

lations. But the centre must not become another hospital, and for all major surgical procedures the patient is referred back to the original hospital. Although geographically apart, the fracture unit and the rehabilitation unit are not functionally separated, and there has been no evidence of lack of "continuity of treatment" or imperfect "unity of control." Patients arrive at the rehabilitation centre with a sealed envelope enclosing a complete clinical record, with prints of relevant radiographs, clinical photographs, and detailed notes. At the centre there is a V.A.D. clinical secretary, trained on the same lines as the secretary at the fracture hospital, and also a radiographic printer. The notes are continued, later x-ray prints are incorporated, and, if further treatment at the parent hospital is needed, the up-to-date clinical record accompanies the patient once more. Continuity is also maintained by interchange of medical officers and by regular visits of consultants from the fracture hospital to the rehabilitation centre.

Special Rehabilitation Centres.—The needs of many general hospitals are served by a smaller number of rehabilitation centres. Special centres are available for officers, for air crews, and for skilled technicians, but no attempt has been made to provide a different centre for each industrial activity. It has been suggested that the Crewe railwaymen's centre, the Mansfield miners' centre, and the Greenwich seamen's centre implied the need for special centres for each type of industrial activity, but this is not so. The same exercises, the same recreations, the same atmosphere, apply to the treatment of every case, and the only variation which is needed in accordance with the particular physical requirements of each industry is in the duration of treatment.

Location of Rehabilitation Centres.—The centres in which the necessary atmosphere has been most easily created are those developed in the enclosed grounds and buildings of an evacuated boys' school and a hotel situated in the country, near the sand dunes and the sea but in reasonable proximity to the relaxations of pleasure resorts. The whole life of the patient must be controlled and adjusted, and this is possible only when sleeping-quarters, recreation rooms, gymnasium, playing-fields, and swimming-pool are included within a compact and self-contained unit. In one centre these amenities are scattered, and there has been clear evidence of loss of control. The patient who is most in need of discipline makes it his business to escape, and treatment has thereby suffered. In another centre the gymnasium and swimming-pool are one mile distant from the sleeping and recreational quarters, and the conditions are comparable to those of a non-residential centre where treatment is given only from 9 a.m. to 5 p.m. This difficulty has proved very great, and it has become clear that conditions can never be ideal unless patients are actually in residence and under whole-time supervision.

Number of Patients under One Medical Officer.—Treatment must of necessity be given by a medical officer and not simply by a physical training instructor. It is true that in the later stages of recovery group exercises and games can be supervised by an instructor; but in the earlier stages a patient who is timid and fearful must have supreme confidence in the surgical judgment of his adviser. A physical training instructor is not in a position to reassure a patient that certain symptoms may be ignored and that activity should continue despite discomfort. This reassurance is needed at the moment that symptoms arise, and not once or twice a week on the occasion of routine medical inspections. The medical officer must actually work in the gymnasium side by side with the patient, spending half an hour, an hour, or even several hours in the handling of one individual, becoming personally acquainted with him, searching for his particular difficulties, and dealing equally with psychological and physical handicaps. Obviously one medical officer cannot treat more than a limited number of men, and experience has shown that the maximum is in the region of 50. This was the original estimate in the B.M.A. report, and it is not an underestimate. When attempts were made to meet the shortage of medical officers by increasing the number to 75 or even 100 patients there was an immediate degeneration to mass treatment, and a loss of that intimate contact without which recovery cannot be accelerated. It is believed that even the number of 50 would have been too high if it had not been that every patient is admitted whether his psychological diffi-

culty is great or small, that most are admitted while still in plaster and before functional disturbances are profound, and that they have usually come from hospitals where rehabilitation has already begun. It must also be remembered that if treatment is successful the rate of turnover is rapid and new patients are constantly arriving. The period of treatment ranges from only a few days up to six or eight weeks and the average is in the region of twenty-eight days. In all these circumstances the suggestion which has been made that one medical officer could deal with several hundred patients is very far indeed from the truth.

The Rehabilitation Team.—So far as limited man-power will permit, each group of 50 patients is treated by a team of one medical officer, one physical training instructor, and one masseuse, the members of the team having been selected for their personality and their ability to command respect and loyalty. The masseuse is engaged not only in electrotherapy and massage but also in the teaching of exercises and the correction of limp. The physical training instructors take group exercises, games in the gymnasium, marching and drill, medicine-ball, and similar activities. One of them is of particular value in teaching special exercise, because not only are his muscles superbly developed but he has an uncanny skill in the contraction of any muscle independently of all others—including, for example, one rectus abdominis, the serratus magnus, or the trapezius—a skill which fascinates and almost mesmerizes patients into emulating the expert. At each centre there is an organizer of games—a famous Davis Cup coach for officers and well-known professional footballers for the men. The medical officer is responsible for every activity which concerns his own group of patients, including all necessary surgical procedures such as changes of plaster, special clinical and x-ray tests, and manipulations under anaesthesia. Incidentally, valuable psychological information is often gained during the recovery of a patient from pentothal anaesthesia. Rehabilitation medical officers need not therefore be experienced operators, but they must be well grounded in the principles of orthopaedic and fracture treatment, the interpretation of x-ray films, the technique of plaster, and the art of manipulation. They have also been specially trained by Dr. H. E. Moore, the R.A.F. civilian adviser on rehabilitation, who worked with them day by day, imparting experience which cannot be conveyed by word or letter, but only by practice. Finally they have been encouraged to visit rehabilitation centres elsewhere, notably at Berry Hill, where Mr. Nicoll arranged a number of three-day demonstrations.

The Commanding Officer ("Administrative Superintendent").—If a rehabilitation centre is small enough, the medical officer may also be the medical superintendent. But it is economically sound from the point of view of amenities, and psychologically sound from the point of view of atmosphere, to treat many units of 50 patients under one administration. The commanding officer of the whole centre may be a medical man, but not necessarily so. He must, however, be a man of unusual qualities, inspiring in his leadership, good-humoured in his manner, and tireless in his zeal, a man who at one and the same time commands discipline and devotion. His duties include much more than simple administration; he has the power to create or to destroy the spirit which brings success.

Importance of a Large Gymnasium.—The most important item of equipment is a sufficiently large gymnasium, or for bigger centres more than one gymnasium. A vast covered space is required, so that individual exercises, pulley-and-weight activities, couch work, tuition in walking, gymnastics, hopping, skipping, and organized games can all be pursued simultaneously and under supervision. Concentrated work on individual muscles is, of course, no less essential in the rehabilitation centre than in the hospital ward. This was advocated by Nicoll¹³, whose methods of controlling and graduating muscle contraction and recording muscle power have been used. But the boredom of one long day of activity must be relieved by limiting the duration of static exercises. There must be space for handball, badminton, skittles, quoits, and shuffle-board, and for wall bars, climbing ropes, punch-balls, bicycles, and rowing machines. At one centre the gymnasium space became unequal to the demand, and when movement and progress exercises became increasingly limited, enthusiasm rapidly waned. The smallest useful gymnasium should measure 60 feet by

30 feet, this sufficing for not more than 30 or 40 patients. The optimum size for 100 patients is in the region of 150 to 200 feet long by 70 feet wide, the considerable length being desirable so that many activities can take place side by side across the width of the room.

Massage, Examination Rooms, and Canteen.—Massage cubicles must open direct from the gymnasium or even be situated within it. It is unfortunate if there is an intervening corridor, and the development of a physiotherapy department some distance from the gymnasium is a serious mistake because it encourages the impression that physiotherapy and electrotherapy are independent and self-sufficient measures of treatment. Massage is not an end in itself; it is a means to the end of activity. The patient whose stiff joint has been baked in the massage room exercises it at once in the gymnasium; the patient in the gymnasium who complains of aching and discomfort withdraws for a period of massage; as the indications arise there is constant to-and-fro movement of patients. Paraffin-wax baths, whirlpool baths, radiant heat, and diathermy are all useful provided only that passive measures never take the place of active effort. Similarly, hot and cold showers and foot baths are important additions to the changing-room. The medical officer's examining room, where case sheets and radiographs are filed, should also open direct from the gymnasium. It must be easy for a medical officer to take a patient into his private room for two or three minutes' reassurance, firm handling, or stern criticism, as a simple incident in the course of the day's activity, and with none of the formality of routine inspections. Finally, space in the immediate proximity of the gymnasium should be devoted to the needs of occasional relaxation and refreshment at a canteen or milk bar.

Playing-fields and Swimming-pool.—The routine in one of the centres has been to devote mornings to work in the gymnasium and the swimming-pool and afternoons to croquet, golf, tennis, handball, and squash rackets, with occasional tournaments for the "nearly fit," and some for the "not-so-fit." But this programme has tended to encourage patients in the belief that the work of the day finishes at lunch-time, and special exercises are very often needed for much more than half the day. It is better that gymnasium and playing-field should each be used, both in the mornings and in the afternoons. Moreover, general recreations and games must be organized, and be closely related to the requirements of the individual. He may begin with "standing tennis" or bowls, and graduate through croquet or approach-putting to fives or squash rackets. A swimming-pool is invaluable, particularly for internal derangements of the knee-joint, for which muscles must be developed without weight-bearing strain. One pilot, for example, with an arthroplasty of the knee following infection and ankylosis of the joint, was able to mobilize and stabilize the surgically constructed joint by swimming long before he was fit for gymnastic activities. He succeeded in developing such strength and power of endurance that he is now engaged in transatlantic flights. Patients whose cartilages have been removed are expected to make a complete recovery and to be fit for every type of activity within five or six weeks of operation, an incapacity period which is in marked contrast with the average period when no rehabilitation centre and no swimming-pool are available. Cycling is another non-weight-bearing exercise of the greatest possible value in knee-joint cases. Through the aid of the Red Cross and St. John each rehabilitation centre has been provided with twenty bicycles, some fitted with a variable length of crank shaft by which to accommodate limited ranges of knee movement. One determined sergeant actually mounted his bicycle and took his place in the cycle-polo team despite the handicap of a full-length above-knee plaster.

Evening Recreations.—It might be assumed that after a strenuous day of controlled activities relaxation would be the rule in the evenings. But billiard tables are in constant demand, and men little realize how far they walk in their circuits of a billiard table. Table-tennis, darts, and other recreations are provided. One or two evenings of the week are devoted to dances, concerts, debates, and "brains-trust" meetings.

Occupational Therapy and Workshops.—The arts-and-crafts type of occupational therapy finds its greatest application in hospital wards, where there are many idle hours to fill. Simple

workshop activities such as carpentry, fret-sawing, model aeroplane construction, and basket or rug making, are interesting additions to the amenities of a rehabilitation centre, particularly during the winter months, when outdoor activities are limited. But a remedial workshop is not a rehabilitation centre. Workshops, occupational-therapy benches, and massage cubicles are, like medicine-balls, climbing ropes, and skittles, items of equipment which are sometimes useful but never indispensable. At one R.A.F. centre where skilled technicians are treated, fully developed technical training workshops are available for use during part of the day, the rest of which is devoted to supervised gymnastic and recreational activities exactly as in other centres. The intention was that patients who are capable of ordinary work for limited periods should use the workshops and at the same time continue treatment. It was also intended that men might be tested from time to time under working conditions, in the same way that an air crew centre was equipped with a fuselage by which to test the physical ability of pilots. This combined rehabilitation centre and workshop is continuing experimentally, but it is by no means certain that any advantage has been gained over centres without workshops. The one fact that is clear above all others is that a workshop alone, with the clinical examination of patients once a week, is worthless. I have seen men dealt with in this way. I have seen them after six months. There can be no possible doubt that the danger of patients' being buried in a workshop is even more grave than the former danger of patients' being buried in a massage department.

Vocational Retraining

It has been argued that treatment in rehabilitation centres is unnecessary and wasteful because all injuries fall into one of two groups: (1) those from which full recovery is possible without rehabilitation, and (2) those which cause permanent disability despite rehabilitation. But no surgeon would advance this argument who had shared with me the experience of closely observing the recovery rate in a Service assisted by rehabilitation where 85% of injured men returned to full duty, and at the same time, week after week, of reporting upon scores of workmen who were totally incapacitated, and for many months had remained totally incapacitated, by the disabilities that are so rapidly cured in rehabilitation centres. But more than this, even in men whose disability is inevitably permanent, rehabilitation is an essential phase of treatment. Permanent total incapacity can often be reduced to permanent partial incapacity. Furthermore, it is almost impossible to assess the degree of permanent disability with any accuracy until a patient has been treated and observed in a rehabilitation centre. It then remains the final duty of the rehabilitation medical officer (or the liaison officer working with him) to make contact with the employer and arrange an alternative form of employment, or to make contact with a retraining centre where the man will learn a new trade. The Ministry of Aircraft Production has co-operated with the R.A.F. rehabilitation service and arranged for the immediate employment in a suitable trade of men who are necessarily invalidated and, in doing so, has accepted the recommendation of rehabilitation medical officers who have precise knowledge of the injured man's physical capacity. The teaching of new trades to cripples and men incapacitated by injury has long been undertaken at Oswestry, Leatherhead, and Exeter, and the Ministry of Labour is now engaged in introducing a more ambitious scheme of retraining. It is to be trusted, however, that this phase of rehabilitation will not be accepted as the whole solution of the problem. Retraining is the smallest part of rehabilitation, and from the numerical point of view it is the least important. The complete rehabilitation service by which 85 to 90% of men can be restored to their former trades, and which even in the remaining 10 to 15% is an indispensable prelude to vocational retraining, must also be introduced.

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A CASE OF STAPHYLOCOCCUS ALBUS SEPTICAEMIA

WITH REACTIONS OF 150 STRAINS OF STAPHYLOCOCCI

BY

MARY BARBER, M.D.Lond.

(From the Department of Pathology, British Postgraduate Medical School, Hammersmith Hospital)

It has long been realized that the pigment production of a particular strain of staphylococcus is not wholly reliable as a guide to its pathogenicity. Nevertheless, most laboratories are still content to report a staphylococcus as being albus, aureus, or citreus without further comment. The presence of a zone of haemolysis on a blood-agar plate has little or no significance. Soluble haemolysin production is fairly closely related to pathogenicity, but a reliable test entails growing the organism in an atmosphere containing about 20% carbon dioxide on a semi-solid medium and testing a filtrate of the resultant growth with rabbits' red cells. It is therefore too laborious to be used as a routine laboratory test. Loeb (1903-4) observed that certain strains of staphylococci were capable of clotting citrated plasma. This was also described by Much (1908), who emphasized the correlation of coagulase production and pathogenicity. More recently Cruickshank (1937) correlated coagulase production with fermentation reactions and haemolysin production, and found that the coagulase test was the one most closely related to pathogenicity for the rabbit. Chapman *et al.* (1934) compared haemolysin and coagulase tests as guides to pathogenicity in a large series of strains, and found that the coagulase-positive strains were usually pathogenic. Unfortunately their observations on haemolysis were confined to results obtained on blood-agar plates. In the following case of *Staph. albus* septicaemia no primary focus of infection was discovered, and the first positive finding was the blood culture. It therefore emphasized the need for some means of differentiating between a pathogenic *Staph. albus* and a saprophytic strain from the skin with which the blood culture might have been contaminated. In view of this I have thought it worth while to add to the description of this case a summary of the reactions of 150 strains of staphylococci derived from a variety of sources.

Case Report

The patient, a woman aged 52, was admitted to hospital on September 17, 1941, with a three-weeks history of febrile illness but no special symptoms. Six months previously her legs, up to the knees, had started to swell. The swelling persisted for five months and then passed off in a week, and on her admission was completely absent. On examination her temperature was

98.6° F., pulse 130, and respirations 22. She was flushed and sweating. The most conspicuous feature was skin lesions of an uncommon type. Nodules were present over the right deltoid, on the left upper arm, in the region of the left elbow, over the left hamstrings, in the right popliteal fossa, and on the buttocks. They ranged from 0.5 to 10 cm. in diameter, were dusky red to purple in colour, and a little warmer than the surrounding skin; some were slightly tender. They appeared to be involving the subcutaneous tissues. The teeth were carious, and there was gross pyorrhoea. The knee-jerks and ankle-jerks were absent; owing to the patient's mental confusion it was difficult to test for loss of sensation. Retention of urine was present, and this persisted. There was apparent neck rigidity, which at first suggested meningitis, but, as it later became clear, it was merely part of a general muscular tenderness and rigidity. No other significant physical signs were discovered. The urine contained albumin but was otherwise normal.

The patient ran a swinging temperature between 98° and 102° F. On September 18 a blood count showed: red cells, 5,000,000 per c.mm.; Hb, 80%; colour index, 0.8; white cells, 8,000—polymorphs 78%, lymphocytes 12%, monocytes 10%. The cerebrospinal fluid was under a pressure of 300 mm. but was otherwise normal. Blood cultures taken on September 18, 22, and 23 gave a pure growth of *Staph. albus*. On September 20 a biopsy of one of the cutaneous nodules showed it to consist of pyaemic abscesses of a somewhat chronic type, which contained colonies of staphylococci.

On September 20 oedema was observed over the sacrum, and there was ulceration of the cutaneous nodule over the right buttock. A blood count on the 25th showed that the haemoglobin had fallen to 66%, with 4,300,000 red cells and a colour index of 0.76; the white cells had risen to 24,000—neutrophils 89%, eosinophils 2%, lymphocytes 9%. On the 27th a sinus in the right buttock discharged a large quantity of pus. A culture of this gave a pure growth of *Staph. aureus*. The supuration in this area increased very much, and on the 30th the abscess was widely incised and explored. A large loculated abscess cavity full of pus was found in the subcutaneous tissues, but no evidence of a more deep-rooted lesion, such as osteomyelitis of the sacrum, was detected.

The patient was given a course of sulphathiazole, a total dose of 50 gm. being taken between September 19 and October 4; but her general condition steadily deteriorated, the abscess over the right buttock and sacrum increased in size, and on October 23 she died.

Post-mortem Findings

In the skin and subcutaneous tissues were found multiple abscesses, many of which were healed. A very extensive and foul-smelling abscess was present over the sacrum. It communicated with sinuses in the buttocks and with the pelvic soft tissues, which were inflamed. Thick yellow pus was seen in the extradural space, with collections round the cauda equina. There was no intrathecal inflammation or any evidence of disease in the sacrum or coccyx.

The lungs showed a few small abscesses on both sides and bronchopneumonic consolidation of both bases. The heart was rather small and there was a single circumscribed abscess in the myocardium, but otherwise no gross abnormalities. The kidneys had numerous abscesses in the parenchyma and there was severe bilateral pyelitis. The ureters were double on both sides, the left arising from a double and the right from a single pelvis. They united on each side before entering the bladder, which showed a severe purulent cystitis. The spleen was not enlarged, but appeared rather firm and fleshy. The genitalia were normal except for a chronic cervicitis. No abnormality was seen in the liver or the brain.

Histological section showed that the abscesses were of a rather chronic type, and there was little or no evidence of inflammatory reaction in the surrounding tissues. They contained clumps of staphylococci, but not in very large numbers. The spleen was not grossly abnormal, but the granulocytes were increased. There was a slight excess of polymorphonuclear cells in the sinuses of the liver.

Bacteriological Findings

A pure culture of *Staph. albus* was isolated on three occasions from the blood; *Staph. aureus* was grown from the abscess over