of diet and exercise must be made more slowly and must be carefully adjusted to the individual case. Before beginning treatment it is best to make a patient describe in detail his diet and daily life. This provides a basis which may be gradually modified on the lines mentioned. In cases of heart disease and high blood pressure it may be best in the early stages to use massage as a prelude to increased activity.

Illustrative Cases

The following are examples showing some types of case to which the above methods are applicable:

Case 1.—A general practitioner, aged 47. The patient gave a history of chronic bronchitis with increasing winter cough for five years; breathlessness on exertion, getting worse for six weeks; and pain over the praecordium on exertion, with fluttering sensations in the chest. Examination in April, 1936, showed the presence of chronic bronchitis and some emphysema. Clinically his heart was found to be enlarged and one inch to the left; there were a tick-tack rhythm and frequent extrasystoles; the resting pulse rate was 90. There was slight cyanosis; the blood pressure was 140/90, and the electrocardiogram normal. His weight was 13 st. 12 lb.; height 5 ft. 7 in. The diagnosis was chronic bronchitis and myocardial weakness. Treatment consisted in gradually reducing the diet and increasing exercise, reducing smoking, and ordering the wearing of an abdominal belt. On May 20 the patient was much better and his weight was reduced to 13 st. 5 lb. On July 7 there were no symptoms; his weight was then 12 st. 2 lb., and he was doing much of his practice on a bicycle. The improvement has since been maintained.

Case 2.—A man aged 62 complained on July 31, 1937, of increasing breathlessness on exertion and slight giddiness of several months' duration. Examination revealed arteriosclerosis, a blood pressure of 190/110, and a pulse rate of 46. An electrocardiogram showed a 3:1 heart-block. His weight was 14 st. 3 lb. After ten days' treatment with massage, mild graduated exercises, and a reducing diet his weight had fallen to 13 st. 4 lb. The symptoms of breathlessness and giddiness had disappeared, and he felt much better.

Case 3.—A woman, aged 52, had had increasing noises in the head and breathlessness on exertion for eight months, with a recent gain in weight. Examination revealed arteriosclerosis and a high blood pressure (200/110). Her weight on July 17, 1937, was 12 st. 8 lb. Treatment consisted in reducing the diet and the prescription of half a grain of thyroid extract each day. After three months her weight had fallen to 10 st. 8 lb., the blood pressure was 200/94, the symptoms had disappeared, and she felt well.

Case 4.—This patient, a woman aged 44, complained of pain in the back on exercise and a "bearing-down feeling" in the stomach. On examination her doctor found sugar in the urine. When seen on June 1, 1937, she was very obese, her weight being 16 st. 9 lb. There was a heavy deposit of fat round the shoulders and hips, and the abdomen was protuberant. The urine gave 2 per cent. of sugar, but no acetone. The resting blood sugar was 2 per cent. Treatment took the form of massage and exercises to reduce weight and improve posture and breathing, with a reducing diet, and an abdominal belt was worn. After three months' treatment the symptoms had gone, the urine was sugar-free, the resting blood sugar 0.12 per cent., and the patient's weight 14 st. 6 lb.

Case 5.—A woman, aged 51, stated that following an attack of influenza in February, 1937, she developed shortness of breath and precordial pain on exertion. These symptoms persisted. When examined on May 19, 1937, her heart was not enlarged, but the quality of the sounds was poor; the blood pressure was 150/80. The abdominal wall was lax, with visceroptosis. Her weight was 10 st. 10 lb. and she was rather fat. Treatment was by means of an abdominal belt, massage, and exercises to reduce weight, and a moderate reducing diet. After five months' treatment her weight was 10 st. 1 lb. She was better in every way and her symptoms had almost gone.

Conclusion

By treatment on the above lines it is often possible to delay the effects of degenerative processes that occur after middle life. To be successful, however, such treatment must be begun early and must be thorough. If it is left too late comparatively little can be done. Both the recognition and the treatment are in the hands of the family doctor, whose opportunities are unrivalled.

REFERENCES

- Archer, H. E., and Graham, G. (1936). *Lancet*, 2, 364.
Du Bois, E. F. (1927). *Basal Metabolism in Health and Disease*, p. 238, London.
Harris, L. J., et al. (1935). *Lancet*, 2, 1399.
— and Leong, P. C. (1936). *Ibid.*, 1, 886.
MacLaren, J. P. (1929). *Medical Insurance Examination*, 2nd ed., p. 193, London.
Poulton, E. P. (1931). *Proc. roy. Soc. Med.*, 25, 347.
Proger, S. H., and Dennig, H. (1932). *J. clin. Invest.*, 11, 789.
Robertson, T. B., and Ray, L. A. (1920). *J. biol. Chem.*, 42, 71.
Rolleston, Sir H. D. (1932). *Medical Aspects of Old Age*, p. 69, London.

COAL-TAR NAPHTHA FOR THE DESTRUCTION OF BED-BUGS*

APPLICATION IN DWELLING-HOUSES AND TENEMENTS

BY

S. A. ASHMORE, B.Sc., A.I.C.

Government Laboratory

AND

A. W. MCKENNY HUGHES, D.I.C., F.R.E.S.

British Museum (Natural History)

Attention was first directed to the use of heavy naphtha for the destruction of bed-bugs in a note by us in the *British Medical Journal* (1937, 1, 459) and the *Lancet* (1937, 1, 530). Toxicity experiments with heavy naphtha carried out by Professor G. R. Cameron at the University College Hospital Medical School indicated that danger to man from this substance was not to be apprehended. Extended research employing a wide range of heavy naphthas confirmed the results of the original experiments.

To ensure that only suitable naphthas shall be used the following specification has been drawn up:

Specification for Heavy Coal-tar Naphtha

- 1. Colour.**—Shall not be darker than a freshly prepared solution of 1 ml. of N/10 iodine in 1,000 ml. of distilled water.
- 2. Specific Gravity.**—Not less than 0.835 and not greater than 0.910.
- 3. Water.**—Shall be free from water and other visible impurities at 15.5° C.
- 4. Distillation Range.**—Method as defined in B.S.I. Specification No. 479 for coal-tar naphthas. Up to 160° C. not more than 5 ml.; up to 190° C. not less than 90 ml.
- 5. Flash-point (Abel).**—Not less than 105° F.
- 6. Tar Acids and Tar Bases.**—Not more than 0.25 per cent. of tar acids and 0.25 per cent. of tar bases.

Heavy naphtha complying with this specification may be obtained from all the principal tar distillers throughout the country at prices ranging from 1s. 6d. to 2s. 6d. per gallon, depending partly on the quantity purchased.

* A report to the Bed-bug Infestation Committee of the Medical Research Council.

Experimental Work

In our original experiments heavy naphtha was found to be lethal to the bed-bug through physical contact. In addition the liquid gives off a vapour which at certain concentrations is also lethal to the bed-bug. It is upon the combined action of these two factors, more especially the latter, that the efficacy of heavy naphtha depends.

The first method of using heavy naphtha consisted in spraying walls, ceilings, and floors, particular attention being given to likely harbourages—for example, behind picture rails, skirting-boards, etc. Masks with a suitable filter are worn by the operators. It was found that certain types of paintwork were damaged by naphtha and that painted linoleum was destroyed, but this has largely been overcome by the use of diffusion screens and covering linoleum with blankets where necessary. Rooms were kept sealed for twenty-four hours, and at the end of this period samples of air were taken for the determination of the naphtha vapour concentration. This was found to be 0.1 per cent. by volume, and showed that the air was only one-third saturated with vapour. Doors and windows were now opened, and ventilation was found to be rapid—so much so that rooms could be entered after a few minutes without any discomfort. After eight hours' airing in this way a further sample of air showed a concentration of vapour of only 0.009 per cent. On closing doors and windows for a further fifteen hours an air sample showed a vapour concentration of 0.009 per cent., thus indicating that concentration does not "build up" by gradual release of absorbed vapour from walls, woodwork, etc.

Effect of Temperature on Vapour Concentration

These experiments were continued throughout the autumn of 1936, but with the first cold weather a number of failures occurred. This experience led to an investigation of the effect of temperature on vapour concentration and a determination of the minimum concentration lethal to the bug. The following table shows the concentration of vapour in air at four different temperatures. The figures will, however, vary slightly with different samples of naphtha.

TABLE I

Temperature (° F.)	Concentration (vol./vol.)
50	0.16%
61	0.21%
70	0.29%
75	0.36%

The minimum concentration lethal to the bed-bug was determined in a series of laboratory experiments in which bugs were exposed for twenty-four hours to various concentrations of vapour. Table II is typical of the results obtained with three different samples of naphtha.

TABLE II

Concentration (vol./vol.)	Sample 1	Sample 2	Sample 3
Per cent. 0.05	All alive, some rather sick	As for 1	As for 1
0.10	A few survived but died within 48 hours	"	"
0.15	All dead	All dead	All dead
0.20	"	"	"
0.25	"	"	"
0.30	"	"	"

Controls were all alive. The above concentrations apply equally to eggs.

These results, taken in conjunction with those shown in Table I, indicate that for effective disinfection the tem-

perature should not fall below 50° F., though it is not desirable to use heavy naphtha below 60° F. In winter time it will therefore usually be necessary to heat a house to as high a temperature as is practicable, say 80° F. If an exposed flame is used the heater must be removed before fumigation is started, and smoking or the use of naked lights prohibited while heavy naphtha is being handled. The temperature will inevitably fall, but the rate at which it does so will depend on the outside temperature. It is desirable to heat as long as possible, in order that not only the air but also the walls, etc., shall be warmed.

Loss by Diffusion and Absorption

Unfortunately the concentration figures obtained in the laboratory may not be reproduced in practice. For instance, on fumigating a house in summer at a steady air temperature of 67° F. analysis at the end of twenty-four hours showed a vapour concentration of 0.10 per cent. (or approximately only a third of saturation). There are various physical causes for this—for instance, loss of vapour by diffusion through the fabric of the structure and by absorption in building materials. To counteract these losses blankets were suspended around the walls and sometimes horizontally across the rooms. After the rooms had been sprayed in the usual way these blankets were also sprayed, and analysis of the air after twenty-four hours showed that the vapour concentration was about one-half of saturation. Blankets wetted in this manner formed a reservoir of naphtha ready to vaporize when the concentration dropped below saturation point. While these results were in the right direction they were not entirely satisfactory, and it was found that woollen or shoddy material was not ideal for the purpose. There are exceptions to this. For instance, for maintaining a concentration in a roof space sufficient to kill any bugs which may be there or to prevent them from escaping from lower rooms that have been treated, woollen blankets are laid upon the joists and the whole area is sprayed with naphtha. The slower diffusion from woollen materials is advantageous in a draughty place such as a roof space. Various materials were tried, and finally Egyptian cotton fabrics were chosen. The fabrics had the following characteristics:

	Fabric I	Fabric II
Weight per sq. yd. (oz.)	2	1½
Threads per inch: warp	102	86
weft	90	78

The Use of Diffusion Screens

Naphtha dropped on to the fabric spreads in much the same way as ink spreads on blotting-paper, and when screens are wetted with naphtha and hung near the walls a high concentration of vapour is rapidly produced where it is most needed. Unless treated with a reinforcing dose, which will be described later, the screens are usually dry at the end of a twenty-four-hour fumigation, in marked contrast to the woollen blanket, which always holds a considerable residue of naphtha unvaporized.

The method of suspending these diffusion screens next received attention. Small pin hooks were first tried, but although satisfactory in one way a considerable amount of time was required to fix them. We are indebted to Dr. Macmillan and members of his staff in the health department of the borough of Woolwich for suggesting the use of electric conduit tubing, of half-inch and five-eighths-inch diameter in standardized lengths. This framework is very quickly erected in a room of any size, and by means of distance pieces is kept three inches away from the adjacent walls. The fabric of the diffusion screen is

usually purchased in strips thirty-six inches wide; these are cut into sixteen-foot lengths and thrown double over the top rail of the scaffolding.

From results of analysis of air samples taken from rooms kept under naphtha vapour it was clear that by using the correct type of diffusion screen a considerably increased concentration of vapour was present at the end of twenty-four hours' fumigation. The degree of saturation at the end of twenty-four hours was increased from 33 per cent. to 80 per cent. by the use of cotton diffusion screens, but it was realized that in the unfavourable conditions presented by a leaky house such a high percentage of saturation might not be maintained at the end of twenty-four hours. The need was felt for a reinforcing dose of naphtha to be put in the room about half-way through the twenty-four-hour period without unsealing. The delayed-action sprinkler has been designed for this purpose. This apparatus automatically delivers a charge of naphtha at a prearranged time varying from eight to eleven hours after the room has been sealed. This is effected by means of an alarm-clock mechanism which at a predetermined time allows naphtha to be thrown on to the diffusion screens from a centrifugal sprayer driven by a clockwork motor.

The concentrations obtained when using the technique as outlined are shown in the table giving the results of an experiment in July, 1937. Three similar rooms were treated with equal quantities of washed heavy naphtha (on the basis of one gallon per 750 cubic feet room space). The procedure was as follows:

Room I: Walls, woodwork, etc., sprayed, but no screens in room (old technique). *Room II:* Walls draped with light cotton diffusion screens, room sprayed, and screens thoroughly wetted. *Room III:* As for Room II; but in addition the delayed-action sprinkler, charged with half a gallon of naphtha, was set to deliver a reinforcing charge eleven hours after the room was sealed. A temperature of 67° F. was maintained throughout.

Table showing Concentration of Naphtha Vapour in the Air of the Rooms at the End of Twenty-four Hours

	Concentration (vol./vol.)	Approx. Degree of Saturation
Room I	0.14 per cent.	50 per cent.
Room II	0.22 " "	80 " "
Room III	0.25 " "	90 " "

Minimum lethal concentration (for twenty-four hours' exposure) = 0.15 per cent.
Saturation concentration at 67° F. = 0.27 per cent.

The figures explain themselves, but the following observations are relevant.

(a) The house in which these experiments were carried out was of good construction, and diffusion losses were therefore at a minimum. In an old leaky house the difference in concentration between Room II and Room III would in all probability be much more marked.

(b) The reinforcer enables a second dose of the lighter (or lower-boiling) constituents to be released in the room, and we have reason to believe that these constituents are slightly more toxic to the bed-bug.

Technique for Use of Heavy Naphtha

The technique for using heavy naphtha may thus be summarized as follows:

1. Make a careful examination of the room to be disinfested, for dead spaces. These are frequently boarded in, and in such cases one or more small holes should be drilled to allow easy access of the vapour.

2. Lay wool or shoddy blankets in the roof space on top of the joists and spray these thoroughly with naphtha.

3. Drape walls with light cotton diffusion screens, using the tubular scaffolding as support.

4. Spray walls, woodwork, etc., more especially where there is obvious infestation, and thoroughly wet diffusion screens with naphtha. (Naphtha will remove certain types of paint, and where paintwork is likely to be affected this should not be sprayed.)

5. Set delayed-action sprinkler to deliver a reinforcing charge from nine to eleven hours after the room has been sealed.

6. At the end of twenty-four hours ventilate and remove screens and scaffolding. The screens rapidly dry in the open air, or more quickly in a warm room, and are then available for the next job.

Disinfestation of Furnished Houses

The general practice with regard to furnished and occupied houses varies considerably. In some instances the furniture is removed in a van and treated with cyanide, and the house itself with heavy naphtha, sulphur, or other insecticide. Alternatively the furniture is disinfested in the house by means of some contact insecticide. We have felt for a considerable time that if furniture could be treated effectively *in situ* a great deal of labour and expense would be saved. As with HCN, if heavy naphtha is used alternative accommodation for tenants for one night must be provided. The original experiments in this connexion consisted in the grouping of all the furniture in the middle of the room and covering it over with dust-sheets. The room was then sprayed in the ordinary way. This method has, we understand, been successful in a number of instances, but we are not satisfied that this is the best procedure. The results have not always been satisfactory.

Experiments in two furnished houses have been carried out in Woolwich, and although a few bugs were found afterwards in one room in each house, we consider that the technique, modified as indicated below, will be likely to give satisfactory results. The walls of a furnished room were draped with diffusion screens in the usual way and the furniture grouped together in suitable positions. The delayed-action sprinkler was set down in the middle of a "kiosk" of tubing (as used for erecting the scaffolding around the walls) 3 ft. 6 in. square and 8 ft. high. The four sides of the kiosk were hung with diffusion screens and the floor immediately beneath covered by a blanket. The sprinkler was timed to discharge the naphtha on to the screens ten hours after the rooms had been sealed. The walls and screens were sprayed in the usual way, and the delayed-action sprinkler set to deliver a reinforcing dose as described above.

In these two experiments only one delayed-action sprinkler was available, and in both cases this machine was not used in the rooms where bugs were found subsequently. Having regard to the quantity of absorbent material in a furnished room we consider that a reinforcing dose of naphtha is essential, and it is not unreasonable to assume that if a delayed-action apparatus had been available for each room the results might have been entirely satisfactory. As furnishings and the like absorb the vapour to a large extent we are of the opinion that the initial dose should be increased to, say, 1 gallon to 500 cubic feet of air space. (*The method adopted for using heavy naphtha is of the utmost importance, and the training of personnel in its use is also a prime consideration. Adequate supervision should always be given where houses are being treated with heavy naphtha if satisfactory results are to be obtained.*)

In our experience the workmen have taken kindly to the use of heavy naphtha and complaints have been few. One man found that the constant use of naphtha had a crying effect upon his skin, but this was soon overcome by the use of lanolin. He has had no further trouble.

Disinfestation of Furniture and Clothing : Van Fumigation

This essential part of the procedure in the eradication of bed-bugs has received considerable attention. Our experiments in this direction are not so advanced as with dwelling-houses, but results obtained when using heavy naphtha indicate that this process can be applied to van fumigation in much the same way as HCN.

We are indebted to Dr. Geffen, M.O.H. Enfield, for his help and the interest he has taken in this aspect of the work.

A small pantechicon, metal-lined, was fitted with tubular electric heaters placed beneath a duckboard flooring with the terminals outside. Thermostats ensured that a temperature of 100° F. could be maintained. A tent of blankets was made to fit the inside of the van and was sprayed with heavy naphtha, using a foot-operated pump. The doors were sealed with ordinary sealing-paper and the tubular heaters connected up to the electric power point. A temperature of 100° F. is reached in about three-quarters of an hour and a naphtha concentration of approximately 0.5 per cent. is obtained. This concentration is only a quarter of that of the minimum explosive concentration, so that danger from this source is not to be apprehended. Laboratory experiments have shown that an exposure of four hours at this temperature is sufficient to kill the bug, but to provide a good margin of safety a period of seven hours from the time of switching on the current was decided upon.

To simulate the conditions of bug-infested furniture ten calico bags, each containing ten bugs, were secreted in the folds of upholstered chairs, in a mattress rolled up several times, and in various articles of clothing. This load of furniture and clothing was treated with naphtha vapour for seven hours. At the end of this period the contents of each bag were examined; all the bugs were dead. These experiments were repeated on various occasions, using considerably greater numbers of bugs, and with one exception have been uniformly successful. When bugs were placed in an artificially made air pocket in the middle of a folded feather bed they were not killed.

These experiments open up possibilities of a safe and rapid method of disinfesting furniture in transit. The polish on furniture is not affected by this process, and we are carrying out further investigations as to how soon furniture is sufficiently free from gas to be suitable for return to the tenant. According to indications the period is not a long one, and we do not anticipate any difficulty from the slow desorption of naphtha, not even when bedding is treated by this process.

The Rate of Desorption

An experiment was carried out to test the rate of desorption of naphtha vapour from furniture and bedding disinfested in the van. A typical load of furniture and bedding was kept in naphtha vapour for six hours at 100° F. The van doors were then opened for a few minutes, but no means existed of sweeping the air out of the van. The van was driven to a neighbouring house and the furniture at once unloaded into an upstairs bedroom, the doors and windows of which were kept closed (the fireplace was not sealed). After one hour the room was entered and a sample of air was taken, and a sample was also taken the following morning, at

the end of eighteen hours. The air temperature in the afternoon was 61° F., that of the next morning 55° F. The results of the experiment were as follows:

Concentration of Naphtha Vapour (vol./vol.)	Remarks
After 1 hour : 0.09% ..	.. Atmosphere unpleasant ; irritant action on eyes
After 18 hours : 0.04% ..	.. Smell of naphtha, but no unpleasant symptoms of any kind

The conditions of this experiment were intentionally not those that would be adopted in routine work. The results clearly show that naphtha vapour is rapidly desorbed from furniture. No "building up" occurred, and had doors and windows been left open, as would be the procedure in ordinary circumstances, the naphtha concentration would soon have been reduced to negligible proportions. It will be advisable to have vans fitted with an extractor fan or shutter which can be opened to allow a current of air to sweep through while the van is being driven along the road. The beating of bedding might also be desirable.

In addition to this experiment two mattresses and pillows were placed in the van at the same time and treated in the same way as the furniture mentioned above. They were then removed to a room and were lain on for an hour. In the first half-hour the windows were closed; the door was also closed, but the fireplace was not sealed. In the second half-hour the windows were open. At first there was slight discomfort to the eyes and nose from the gas being released from the pillows and mattresses, but this quickly passed off. The opening of the windows, however, did not noticeably alter the smell of the mattresses and pillows. It is thought that with some ventilation before the mattresses and pillows are returned to the house there would be no discomfort in sleeping on them the same night. The conditions under which this experiment was carried out were purposely made as adverse as possible.

Heavy naphtha has been used in some twelve hundred houses and tenements, mainly empty, in various parts of the country, and experience has been gained in both summer and winter conditions of fumigation. Houses so treated have been subjected to rigid inspection throughout the year, and in one area the treatment has been successful in ninety-nine houses out of every hundred.

Summary

1. *Method of Applying Heavy Naphtha.*—A method of applying naphtha using light cotton diffusion screens and an automatic delayed-action sprinkler for reinforcing has been developed. Using the new technique the gas concentration at the end of twenty-four hours is 60 per cent. higher than that obtainable by the old method of spraying walls, ceiling, woodwork, etc. With the new method the loss of gas concentration by diffusion is largely overcome, and the gas concentration is at all times above the lethal minimum, when the temperature is 50° F. and over. Failures due to loss of vapour should therefore be eliminated, and it is to be hoped that local authorities using naphtha will adopt the improved process in its entirety. The light tubular scaffolding is quick and easy to erect and affords good support for the diffusion screens. It has the advantage over other methods of suspension that no damage is caused to the structure of the building.

2. *Disinfestation of Furnished Houses.*—This is admittedly a difficult problem, but with the new methods and apparatus further work in this connexion is in hand. The delayed-action sprinkler was not perfected until the past few months, and only one machine has been avail-

able. Preliminary results are encouraging, and such a process has manifestly so many advantages that work to this end will be continued.

3. *Disinfestation of Furniture and Clothing.*—A van process of disinfestation, using heavy naphtha, has been developed which promises well. So far it has not had an extended trial, but the preliminary results are satisfactory. Further work is in hand.

4. *Reaction of Workmen using Naphtha in Disinfestation Work.*—Complaints by workmen have been almost negligible. One man developed a slight skin irritation on the hand, but this has been cured by the use of lanolin, and, generally speaking, the men have taken kindly to the use of naphtha as a fumigant.

The earliest experiments with heavy naphtha and much of the subsequent work described in this paper were made possible through the interest and co-operation of Dr. J. Macmillan, medical officer of health for the borough of Woolwich. We wish to express our indebtedness to him for the use of houses, equipment, and the services of members of his staff.

All the work on heavy naphtha has been carried out for the Medical Research Council under the auspices of its Bed-bug Infestation Committee.

THE RECOVERY PERIOD IN ANTERIOR POLIOMYELITIS

BY

NORMAN M. HARRY, M.S., F.R.C.S.

House-Surgeon, Royal National Orthopaedic Hospital,
Stanmore

No big epidemics of anterior poliomyelitis have been recorded in England, yet on an average 640 cases occur annually, and the more severe of them present an important medical and economic problem.

It is well known that many patients improve greatly after the acute illness has subsided. However, observers disagree on the length of the period of recovery when adequate treatment is given. Some state that it is as short as nine months, others as long as four years. There is therefore some uncertainty regarding the proper duration of hospital treatment; and when spinal, abdominal, and lower limb muscles are involved it is even more difficult to decide when patients should be allowed to walk. In order to avoid the possibility of insufficient treatment it is best to err on the side of safety, and keep them in bed while there is any possible hope of improvement. This means that some patients are treated in hospital for a longer time than is afterwards found to be necessary. Economic considerations are involved, for the cost of keeping a patient in hospital is at least two pounds a week, and another person is for the time being deprived of the bed. More accurate information on the length of the recovery period is needed before this essential margin of safety can be reduced.

Although a huge American literature on poliomyelitis has accumulated during the last twenty-five years, most of it is devoted to descriptions of various forms of treatment and comparatively little to analysis of the results. In the Royal National Orthopaedic Hospital, since 1932, the progress of patients with infantile paralysis has been carefully recorded on muscle charts, which have provided the data for this study. The value of these charts in the prognosis and treatment of poliomyelitis has not been sufficiently appreciated in England, and it is to be hoped that they will be more generally used.

In the present investigation I have determined the progress of paretic and paralysed muscles in thirty-six patients all receiving the commonly accepted treatment from the time of the acute infection. The data so obtained are important in arriving at a prognosis regarding the degree of muscle recovery, and when the lower limbs are involved this affords a guide in deciding when to begin ambulatory treatment.

Treatment

During the acute phase of the disease a patient is given absolute rest in either a plaster shell or a complete plaster case. In this way the damaged anterior horn cells are shielded from stimuli on the sensory side and from the patient's desire to move the part. This period of rest during the stage of acute inflammation is in accordance with general pathological principles, and in practice is approved by competent observers who have dealt with many cases. When muscle tenderness has gone one infers that the acute inflammation in the cord is subsiding. Muscle re-education is then started in conjunction with radiant heat and massage, while joints are moved, passively if necessary, to prevent stiffness. Particular care must be taken to avoid fatigue of the recovering muscles, and when exercises are not being carried out, overstretching of the weak muscles is prevented by resting them in plaster shells or splints. Light tasks are imposed on muscles too weak to function against gravity. In many instances the exercises are carried out in warm-water baths, gravity being eliminated thereby, while the heat improves the circulation. In a few instances electrical stimulation is an additional therapeutic measure, valuable when there is one weak muscle in a group the other members of which have the same function but are not paralysed. For example, the biceps femoris, semimembranosus, and semitendinosus are flexors of the knee. When these muscles are involved it may be found that the semimembranosus and semitendinosus are strong enough to flex the leg against gravity, while the biceps shows scarcely a flicker of contraction. Under these circumstances active flexion is performed by the stronger muscles, and the biceps is not used; electrical stimulation of the latter is therefore indicated. But, wherever possible, reliance is placed on voluntary exercise, which is the only true form of muscle re-education.

The Muscle Charts

The progress of cases under treatment was recorded on muscle charts introduced into the hospital by Mr. H. J. Seddon, the resident surgeon. At first charting was done every two months, but is now carried out at intervals of six weeks. The chart here shown is used for the lower extremity. The skeletal muscles are classified into forty groups, and the voluntary power of each is tabulated as N; R+; R-; G-; F; or O. R+ signifies that the muscle will overcome gravity and additional resistance, but is less powerful than normal. R- indicates that it will overcome gravity but not additional resistance. G- is recorded if the muscle will carry out its action only when gravity is eliminated; while F means that there is a flicker of contraction insufficient to move the part. Since the only movement of use to the patient is that which he initiates voluntarily, the recording of voluntary power is a more direct measure of recovery than that obtained by electrical stimulation. Such a chart has the merit of showing improvement or retrogression accurately enough for clinical purposes, without the use of special apparatus such as that devised by Lovett. With a little practice the necessary observations can be made fairly quickly.