

diagnosis he was able to define the exact limits of the disease, to add the mental symptoms and to complete the clinical picture with a sure hand. Let these three be thus honoured together : Haslam, Esquirol, Bayle !

Looking back a hundred years we see in the Paris School of Medicine a wonderful spectacle of great teachers and earnest students. Among the former there stand out Pinel, Esquirol, and Royer-Collard, and among the latter Georget, Foville, Delaye, Calmeil, and Bayle. They all worked hard, and they did not work in vain, for they assisted in drawing aside the veil that concealed the most terrible disease that afflicts humanity. Their successors, after a century, have discovered its cause. It remains for us living at the present day, inspired by their zeal, either to discover a remedy for it, or to prevent it altogether.

Infection in Mental Hospitals, with Special Reference to Floor Treatment.⁽¹⁾ By B. H. SHAW, M.D., Medical Superintendent, County Mental Hospital, Stafford.

THE average mortality from tubercular disease in mental hospitals is over nine times that of the outside population, and as regards dysentery, which is rarely met with among the sane community in this country, the Board of Control state that "during the second half of 1921 some 728 persons were attacked by the disease in mental hospitals and of these 126 died." It is a most serious reflection that consequent on admission to a mental hospital a valuable life may be lost, such as, for instance, that of a young mother suffering from nervous shock after confinement, as a result of infection with one of these pathogenic organisms. It is therefore a matter of most urgent necessity that everything possible shall be done in order to eliminate dysentery from our mental hospitals and to reduce the mortality from tuberculosis; and now that the voluntary boarder principle is likely to be adopted for public mental hospitals it becomes more than ever necessary.

Dealing first with the vitality of the organisms in question, there is considerable variance in the statements of authorities as regards the vitality of the dysentery bacillus. Thus Ledingham and Arkwright (1) say—"the *B. dysenteriae* does not live well outside the body, being readily overpowered by other bacteria. Most experimenters (Lentz, 1909) have only noted survival for a few days on unsterilised

⁽¹⁾ A paper read at the Autumn Meeting of the Northern and Midland Division held at the County Mental Hospital, Stafford, October 26, 1922.

materials." Besson (2) states that "the dysentery bacillus is a somewhat delicate organism. In culture it does not live for more than 3 or 4 weeks, in infected stools it appears to be quickly destroyed by the other micro-organisms present and especially by the action of the colon bacillus so that it cannot be isolated after 48 hours. Direct sunlight and desiccation rapidly destroy the bacillus. In water containing saprophytic organisms the larger the number of such organisms the more quickly does the dysentery bacillus disappear, and at the ordinary temperature it cannot be recovered after 2-10 days."

These authorities do not, however, distinguish between *B. Shiga* and *Flexner* in speaking of vitality. The former is so extremely rarely met with in this country that it can for all practical purposes be ignored. It is undoubtedly a much more delicate organism than *B. Flexner*. There is satisfactory evidence that the Flexner variety, which is without doubt the organism of asylum dysentery, will exist for a considerable time in ordinary soil. Vincent and Muratet (3) state that "soil has the power of preserving the bacillus intact, especially in winter and during the rainy season. In 1890 some troops proceeded to instal themselves in the camp of Chalons and dug the emplacements for their tents in ground where old cesspits full of faecal matter were uncovered—dysentery had prevailed here a year before. These men contracted dysentery; the rest of the troop were unaffected." Again, "In 1894 a battery of artillery was sent to occupy the camp of Hussein Dey near Algiers. In the preceding year there had been an epidemic of dysentery in this camp, after a violent gale which raised whirlwinds of dust and sand and which lasted a week, the men complained that everything they ate and drank was full of earth and sand. A very serious epidemic followed affecting 15 *per cent.* of their effectives. Their drinking water, vegetables and other rations were wholesome."

During the South African War outbreaks of dysentery amongst the troops were considered to be due to dust, and there is no doubt that the greatest increase of dysentery under camp conditions synchronises with the maximum dust.

Early in March, 1922, a number of tubes each containing about 5 grm. of sterile earth were inoculated with *B. Flexner*. A certain number of the tubes contained dry earth and the remainder moist. Some of these tubes, dry and moist, were placed in a rack on a window-sill facing south-east and getting direct sunlight, others in diffuse daylight, and a third set in a dark cupboard. A tube from each set was examined weekly and the results are shown in table on p. 26.

It will be noticed that the organisms in the dry tubes were all dead at the end of the fourth week whether exposed to sunlight, diffuse light or kept in the dark, that moisture kept them alive a week longer

in sunlight and a fortnight longer in the dark, but that moisture and diffuse daylight were by far the most favourable conditions as regards vitality, the organisms remaining alive until the tubes gave out, *viz.*, for three months, and possibly would have done so for a considerably longer period.

Sterile Mould Inoculated with B. Flexner, March 13.

	March 20.	March 27.	April 3.	April 10.	April 17.	April 24.	May 1.	May 8.	May 15.	May 22.	May 29.	June 5.
Sunlight :												
(a) Dry . .	+	+	+	-	-	-						
(b) Moist . .	+	+	+	+	-	-	-					
Diffuse light :												
(a) Dry . .	+	+	+	-	-	-						
(b) Moist . .	+	+	+	+	+	+	+	+	+	+	+	+
Dark :												
(a) Dry . .	+	+	+	-	-	-						
(b) Moist . .	+	+	+	+	+	-	-					

+ = growth ; - = no growth.

Desiccation, sunlight and heat, which help the vital competition of saprophytes, are the most effectual means of destruction of the Flexner bacillus, while humidity, diffuse light and cold are the most important factors in its preservation. Most authorities state that darkness is most favourable to preservation of vitality, but this would not appear to be borne out by my results. Suppose the soil of an airing court is contaminated with the bacillus of dysentery, and it remains in the superficial soil at the foot of a high wall facing north on which the sun never shines directly, we have conditions eminently fitted to help the survival of the organism. During dry weather the patients are almost continually in the court, and they frequently scratch up the surface soil in an aimless fashion and may possibly set free a small focus of infection. The soil of female airing courts would be more readily polluted than that of male.

This cannot, however, be regarded in the light of present knowledge as at all a likely factor in the production of infection in view of the enormous number of saprophytic organisms present in surface soil, the growth of which would be inimical to that of the Flexner bacillus. It is, however, a possibility to be kept in mind.

The vitality of the tubercle bacillus is very different to that of dysentery. F. Griffiths, for the English Commission, found that mammalian or avian tubercle bacilli will maintain their vitality for long periods whether kept in the incubator or at room temperature. Avian bacilli were found alive in one culture tube after 1,067 days

and bovine similarly after 990 days. He also found that no attenuation of the bovine bacillus was caused by residence on artificial media for periods up to 1,487 days. Zilgen (4) mixed some dust with dried tuberculous sputum and exposed the mixture to the action of sunlight. Under these conditions the bacillus retained its virulence for about 140 days. Schottelius found that the bacillus was virulent in tissues which had been buried for two years.

A brief description of a small outbreak of dysentery which occurred in this institution in September, 1921, is of interest, as its investigation emphasises some points in connection with the spread of this disease.

Up to the middle of 1918 dysentery was of fairly common occurrence here. Since the beginning of that year thorough bacteriological investigation of all suspected cases has been carried out, and no case allowed out of quarantine which showed any signs of recent catarrh in the stools and, coincident with clinical recovery, eight consecutive negative laboratory findings—two each week for four weeks.

As regards the recent history of dysentery and diarrhœa in the hospital, two cases of Flexner dysentery occurred on the female side in November, 1919, in a ward (F 9) devoted to epileptics, one being simple diarrhœa and the other clinical dysentery, from each of which *B. Flexner* was isolated.

In September, 1921, a small outbreak occurred limited to one ward (F 7) on the ground floor of the female side. (No case of dysentery had occurred in this ward since November, 1910.) The weather at the time was very warm and dry and there had been extremely little rain during the preceding months of the summer. There was, consequently, a good deal of dust about and more flies than usual. All the patients attacked in this ward, to the number of six, were of degraded and filthy habits, and during the fine weather prevailing they were all in the habit of having their mid-day meal in the airing court attached to the ward. This court had no asphalt or concrete laid down except for a few yards in width on the two sides next the building facing south and east. From the stools of four of these patients (A—, S—, L—, and L. L—) *B. Flexner* was isolated. The fifth (R—) showed much lumpy mucus and a little blood in the stool, from which an actively motile gelatine liquefier, not a proteus, was isolated, which agglutinated with the patient's own serum drawn on the eighth day of illness at a titre of 1 in 300.

From the sixth case (M—), clinically one of slight diarrhœa, a gelatine liquefier was also isolated, which the patient's serum similarly drawn on the eighth day agglutinated at a titre of 1 in 1,600. In spite of several attempts no Flexner group organism was isolated from either of these two cases, and as neither of their sera had a higher titre of agglutination than 1 in 50 to any available Flexner, I do not consider that they were infected by any organism belonging to this group.

The stools of all the patients in the ward were examined in order if possible to locate a carrier, and it was in course of this that in one (L. L—), a patient of degraded habits, who would rarely use a lavatory, *B. Flexner* was found. This patient was always constipated, frequently needing purgatives, and for four days, September 8 to 12, when *B. Flexner* was found in her stool, her motions were relaxed, although only moved five times in the four days in question and slight blood was present intimately mixed with the motion. She had been a patient here for eight years, and during that time was not known to have had any previous diarrhœic attack, nor was the bacillus found again in her stools in spite of frequent examinations. I have no doubt that this case would have passed unnoticed but for the careful bacteriological examination of the stools of all patients in the ward. Towards the end of the month a senile patient (C—) with advanced cardio-vascular degenera-

tion, who had been in bed in a single room in the adjoining ward (F 1) for some months and was gradually failing, suddenly developed severe diarrhoea and died in a few days. *B. Flexner* was isolated from the stool, and the *post-mortem* disclosed two old indurated ulcers in the colon and a recent superficial catarrh of the mucosa. This patient, who had been here for twenty-two years, had had an attack of dysentery eleven years previously and the condition of the ulceration in her colon pointed to a duration of that time.

C—'s bedroom in F 1 ward was 40 yds. distant from F 7 airing court. As she had for some time past used a bed-chair in her room her motions had been under observation, and nothing abnormal was noticed about them up to a few days before her death. As no carrier was detected amongst the patients in ward 7, it was highly probable that the infection was fly-borne from C—'s single room in F 1. If the Flexners isolated from the patients in ward 7 were identical with that of C—'s, it became almost certain.

All these organisms were typical Flexners as regards biochemical reaction and they all fermented maltose.

Serologically using half titre strength of Oxford standard sera all agglutinated with V and Y and were negative to W, X and Z.

Specific agglutinating sera were now made to the Flexners of A—, S—, C—, L. L—, and L—, and cross-agglutination of each with the others isolated resulted in agglutination at full titre in every case. Consequently the same type of Flexner as regards subgroup was responsible in every case. There can be little doubt, therefore, that the infection occurring in F 7 ward in the patients A—, S—, L—, and L. L—, was conveyed by flies, probably a single fly, from C— in ward F 1.

No protozoa or amœbic cysts were detected in any of the stools.

At the time of the outbreak bacteriological examinations were made of flies caught in the airing court, of the surface soil of the airing courts and of the surface drains. So far as the drains were concerned no organisms other than coliforms were isolated, and these were very numerous.

As regards the flies, forty-six organisms were investigated, one of which (F 14) was found to be identical with that isolated from M—'s stool. The agglutination titre of M—'s serum to this organism was 1 in 1,600 while its titre to any variety of Flexner did not exceed 1 in 50. Normal human serum has a fairly high agglutinin content to this organism as evidenced by that of Ca—, a case of dementia præcox, 1/100; P—, a melancholic, 1/200; G—, a secondary dement, 1/200; and S—, an attendant, 1/200; but nothing like the titre shown in the case of M—. This organism, which is actively motile and a rapid liquefier of gelatine, has the following biochemical characteristics: negative on salicin and dulcitol, slight acid on lactose, later becoming alkaline, acid on glucose, mannite, saccharose, maltose and milk, positive indol and voges proskauer. It does not spread over the medium.

It was agglutinated by Flexner Y serum in low dilutions, 1/400, but was not affected by anti-typhoid serum in any dilution. Grown anaerobically or on carbolic agar for six generations it became non-motile, which also occurred after similar sub-culture on fly extract broth. After subsequent sub-culture on ordinary agar under aerobic conditions motility returned, but this was of a sluggish nature and many organisms in the field remained motionless. Intravenous injection in a rabbit produced a serum with a very high agglutinin content, and a fairly large dose resulted in diarrhoea with mucus in the motions and catarrhal enteritis.

The specific agglutinating serum prepared from this organism, titre 1/24,000, agglutinated M—'s organism at the full titre and R—'s organism at 1/3 titre strength. R—'s organism was similar to F 14 as regards carbohydrate reactions with the exception that it was negative on lactose and gave acid and slight gas on maltose. It was also a slower liquefier of gelatine. It produced somewhat similar effects on rabbits, but did not give rise to serum with such a high agglutinin content. An exactly similar organism was isolated from the airing-court soil, and two organisms isolated from the flies were similar serologically and biochemically to organisms found in the soil. Many typical *B. coli* were also present in this soil and on the flies.

No organisms of the Flexner group were detected either on the flies or in the airing-court soil.

In some chance surface soil taken as a control from a portion of the grounds not used by patients an organism was found which, though not a Flexner, had some Flexner-like characteristics and caused enteritis in rabbits.

This investigation illustrates very clearly how an epidemic may start from a single carrier.

That the infection of the patients in ward F 7 with *B. Flexner* was fly-borne from the carrier C— in ward F 1 there can be little doubt, also that C— had been a carrier for eleven years, and although a fairly sane patient, gave no indication of it whatever. She had always been a clean and tidy woman so far as habits were concerned.

Every outbreak of Flexner dysentery is undoubtedly traceable to a carrier, meaning a person with chronic ulceration of the large intestine as a result of infection. It is very questionable whether the so-called healthy carrier exists in this disease.

This tendency to chronicity would undoubtedly be greater in debilitated persons infected with the bacillus than in healthy people. Simon (5) states that 5·7 *per cent.* of 70 soldiers who suffered from dysentery in 1908 were found to be carriers in 1909. Of 935 cases of Flexner dysentery admitted to Addington Park during the twelve months ending May, 1918, Fletcher (6) found that 52 were carriers, that is, 5·56 *per cent.*, and of these 20 *per cent.* were persistent carriers. Taking into account the debilitated state of many patients in mental hospitals it is likely that a considerably higher percentage than this of those who become infected will develop more or less chronic intestinal lesions. Again, as many of the patients by reason of their mental disorder can afford the medical staff little help as far as their symptoms are concerned, and are frequently careless or faulty in their habits, it becomes a matter of much greater difficulty to deal effectively with the carrier problem in an insane community than it is amongst the sane, and consequently efficient laboratory investigation becomes a necessity. The perfunctory habit of sending specimens of stools to a distant laboratory is of little help. The delay and disturbance involved by collection and transit will render a negative result probable, and of no value in view of the rapidity with which the bacillus gets overgrown and destroyed by the growth of other organisms.

Bacteriological examination is most needed in order to detect cases which might be clinically passed over and to determine when affected patients are finally free.

For this it is necessary to have the laboratory at hand and all contacts examined. The case of L. L— in the investigation under consideration is illustrative of the necessity for this. Such symptoms as she had were so slight that no notice would probably have been taken of them but for the routine laboratory investigation of all contacts.

Another point of interest is that an organism isolated from the flies caught in the airing court is shown to have been the infecting agent in one case. Also in another case the organism apparently

causing the dysentery was isolated from the airing-court soil, and organisms were isolated from the flies serologically and biochemically similar to others isolated from this soil.

It is of interest here to call to mind the results of Ballard's (17) well-known investigation many years ago on the relation between diarrhoeal complaints and soil temperature. He found that the summer rise in the diarrhoea death-rate does not commence until the mean temperature of the four-foot soil thermometer has reached 56° F., and he stated "that the essential cause of epidemic diarrhoea resides ordinarily in the superficial layers of the earth, where it is intimately associated with the life processes of some micro-organisms not yet isolated."

It would appear to be advisable that those portions of the surface of airing courts not reached by direct sunlight should have concrete or asphalt laid down, especially in female airing courts devoted to patients of faulty habits, as there is here considerable liability of serious faecal infection of the soil.

Some interesting facts as regards dysentery can be gathered from the Report of the Board of Control for 1920. The daily number of patients resident during that year was 39,987 males and 50,963 females, and the death-rate *per cent.* of average number resident was 10·06 and 7·7 respectively. The total number of cases of dysentery is given as 445 males and 640 females, or 1 case in every 89 men and 79 women, with a case mortality of males 17·7 and females 20·0, whereas the mortality from diarrhoea was males 13·9, females 9·9. The mean of the two added together brings the general mortality of the sexes more alike.

The mortality from dysentery, which ought to be a reliable index to the total incidence of the disease in the two sexes, was 52 males and 114 females. Relatively to total numbers resident, if 52 male deaths are recorded, presuming the mortality rate from dysentery to be the same for each sex, the total female deaths should amount to 63, whereas the actual figure is nearly twice this. This can only mean either that the mortality of females is twice that of males, or that many more cases of unrecognised dysentery occur amongst the females, and consequently that carriers are more numerous amongst them. It will be noticed from the report for 1920 that the highest monthly incidence for both dysentery and diarrhoea occurs in January when the patients are confined to their wards longest, and as women lead a more indoor life than men and are possibly more faulty in their habits as regards faecal infection, it is all the more likely that the mortality figures give a reliable index to the relative amount of dysentery amongst males and females. As far as spread of infection is concerned the influence of floor treatment on it is obviously a matter of much

importance, and an inquiry into the bacteriological content of the dust from various wards with scrubbed and polished floors was undertaken in order to estimate the degree of human contamination existing in it, and also the effect of certain floor treatment on the dust content.

The criteria of contamination of the dust by human excreta were as follows :

- (1) *B. coli* content.
- (2) Content of streptococci and staphylococci.
- (3) *B. Welchii* content.
- (4) Ratio of organisms developing at 38° C. to those at 22° C.
- (5) Ratio of liquefiers to total number grown on gelatine.

Method.—500 mgrm. of dust sealed in test-tube with 5 c.c. ice water and shaken at a definite speed for one minute. Then returned to ice box for a definite period to deposit, the supernatant fluid being examined for bacterial content.

The material between the boards of a polished floor (F 7) and that of a scrubbed floor (F 9) were similarly examined, the specimens being taken from portions of floor most liable to contamination. The results are shown in table on p. 32.

The floor treatment of the wards in question prior to dust examination was as follows :

Waxed and Polished Floors.

	Day-rooms.	Dormitories.	Single rooms.
F 7	. 3 times weekly	. Once weekly	. Scrubbed daily.
M 9	. Once weekly	. Once weekly	. Scrubbed daily.

Scrubbed Floors.

F 9	. 3 times weekly	. Once weekly	. Daily.
M 7	. Once weekly	. Once weekly	. Daily.

All polished floors polished with rubbers twice daily. All floors swept after meals.

These wards were symmetrical on each side and housed the same number and type of patients respectively. Thus F 9 and M 9 are epileptics mainly and F 7 and M 7 excited and violent cases.

With reference to the results under consideration *B. coli* and streptococci are indicative of recent contamination, *B. Welchii* contamination of longer duration. The more the number of organisms grown at 38° C. approximates to or is in excess of that at 22° C. the greater the impurity, and the same may be said of liquefiers to total organisms on gelatine, though this is not considered by some authorities of much value.

It will be seen that the dust of F 9 shows least contamination. F 7, while showing the same content of *B. coli*, streptococci and *B. Welchii*

	<i>B. coli</i> present in c.c.	Streptococci and staphylococci present in c.c.	<i>B. #/Lehii</i> present in c.c.	No. of organisms grown at 38° C. from '0001.	No. of organisms grown at 23° C. from '0001.	Ratio at 38° C. to that at 23° C.	No. of liquefiers from '0001.	Ratio of liquefiers to total on gelatine.
Dust from—								
F7 Polished floor	'1	'0001	'1	90	444	1 to 4'93	30	1 to 148
F9 Scrubbed floor	1'0	'001	'1	207	2,261	1 to 7'61	4	1 to 5,652
M9 Polished floor	'001	'0001	'01	188	22	1 to 11	37	1 to 5'94
M7 Scrubbed floor	'1	'0001	'1	442	55	1 to 12	50	1 to 11
Material between boards								
F7 Polished floor	Not in 1 c.c.	Not in 1 c.c.	'1	13	9	1 to '69	0	—
F9 Scrubbed floor	Not in 1 c.c.	Staphylococci, etc., '001	'01	335	2,044	1 to 6'10	3	1 to 6,810
Dust from bedroom of attendants' private house. Floor-carpet and linoleum	1'0	'0001	'01	2,100	254	1 to 12	120	1 to 21
Dust taken from shelves and floor of pantry, private. Floor tiled, and scrubbed daily	Not in 1 c.c.	'1	1	0	0	—	0	—

as M 7, shows a very much more favourable proportion of organisms grown at 38° to those at 22° and also an improved ratio of liquefiers to total on gelatine, while the dust of M 9 is clearly the most contaminated. It is very evident from these results that dust contamination is directly dependent on floor treatment, *viz.*, that a floor scrubbed with soap and water three times weekly produces the best results, that a day-room floor scrubbed once a week is not quite so efficient as waxing and polishing three times in the same period, and that waxing and polishing once weekly is the least efficient. For comparison an analysis of dust taken from the floor of a bedroom in a well-kept male nurses' home is shown, the floor being covered with carpet and linoleum, and also the dust taken from the shelves and floor of a pantry in a private house, the floor being of tiles and scrubbed daily.

The dust of the floor of F 9 scrubbed three times weekly compares very favourably with that of the bedroom in the male nurses' house, but the coliform contamination of F 7 and M 7 is ten times as bad, and as regards M 9, for every one *B. coli* present in the dust from the private bedroom, although the floor is semi-carpeted, there are one thousand in this dust!

The material taken from between the boards is shown to be of little moment so far as contamination is concerned, that of the scrubbed floors being somewhat more foul than the polished, as is to be expected in view of the difference in moisture.

All the above analyses were made during the third week in March.

The effect of the soap solution used in scrubbing and cleaning is a matter of some interest. The soaps in general use in this institution are carbolic soft soap, mottled soap—both of which are used for scrubbing floors—and ordinary yellow soap. A 20 *per cent.* solution of each was made and autoclaved. 1 c.c. of each of these solutions was added to 5 c.c. of a fresh broth culture of *B. Flexner* and the three tubes allowed to stand overnight on the laboratory bench. Cultures were made from each tube the following morning, with the result that the sub-culture from the tube containing the yellow soap solution showed a free growth, but no growth resulted from either of the others. 5 c.c. of a solution of each soap as in general use in scrubbing and washing was also sterilised and then inoculated with a fresh broth culture of *B. Flexner* (5 c.c. to each tube).

The tubes were allowed to stand at room temperature and sub-cultured on agar after 6, 12 and 24 hours, the results being as follows:

	6 hours.	12 hours.	24 hours.
Carbolic soap sol. . . .	+	—	—
Mottled soap sol. . . .	+	—	—
Yellow soap sol. . . .	+	+	+

This experiment shows very clearly that the ordinary mottled and carbolic soap used for scrubbing have a distinctly lethal effect on the dysentery bacillus.

In this institution certain wards for many years have had scrubbed floors, and I have examined the records for the past twenty years in order to ascertain the incidence of dysentery in these wards

as compared with those having polished floors during that period. The wards are symmetrical on each side as regards size, and the corresponding numbers, male and female, have averaged much the same numbers of patients each.

The following table summarises the results :

Ward.	Average no. of patients.	1901-1921. No. of cases of dysentery.	1901-1921. No. of cases of diarrhoea.	Class of patients.	Floor treatment.
X	75	{ F. 25 M. 24	{ 9 16	Specials, excited, deluded.	{ Polished. " "
IX	75	{ F. 6 M. 2	{ 2 11		
VIII	35	{ F. 13 M. 8	{ 5 13	Infirmary.	Polished.
VII	40	{ F. 14 M. 2	{ 10 0	Noisy and degraded.	{ " " " "
VI	35	{ F. 1 M. 7	{ 1 1	Workers.	Polished.
V	35	{ F. 1 M. 1	{ 2 2	"	"
III	40	{ F. 5 M. 1	{ 4 2	"	"
II	35	{ F. 0 M. 0	{ 2 0	Convalescent.	"
I	40	{ F. 5 M. 1	{ 7 8	Infirm.	"
				"	"

In addition a detached block for male patients to the number of seventy containing two day-rooms with polished floors had only 3 cases of diarrhoea recorded in this period. M 7 and F 7 with the same type of patient, noisy and excited with many of degraded habits, have differed as regards floor treatment, M 7 being scrubbed whereas F 7 is polished. M 7 has had during this period 2 cases of dysentery and none of diarrhoea, while F 7 has had 14 cases of dysentery and 10 of diarrhoea. Four of these dysentery cases, however, were, as I have shown, due to infection from F 1.

The floor of M 9 was for eight years, 1901-1909, scrubbed, and during that period 2 cases of dysentery and 10 of diarrhoea occurred there, but for the past twelve years, 1909-1921, the floor has been polished, and no dysentery has occurred in it and only 1 case of diarrhoea, while the corresponding ward on the female side with a scrubbed floor had in the same period 3 cases of dysentery. These figures are, of course, small, and the possibility of fly-borne infection from other wards must not be lost sight of. Certainly the contrast in the number of cases occurring in F 7 with a polished floor as compared with M 7 with a scrubbed floor, having in view the

exact similarity of the wards in every other respect, is of considerable interest.

It will be noticed from this table that those wards which have had a large amount of dysentery recorded have had a correspondingly large number of cases of diarrhœa. There can be little doubt that very many of these latter cases were really dysenteric in nature although perhaps not clinically so.

There is also a direct relationship between the number of cases of infection and the population of the ward both as regards numbers and prevalence of uncleanly habits.

As regards tubercular infection in this institution, the average death-rate from tuberculosis for the period 1905-1914 inclusive was for males 40·21 per 1,000 resident and for females 33·15, while the average death-rate *per cent.* of total deaths was 27·9 for males and 24·82 for females.

These are appalling figures when one considers that the death-rate per 1,000 living for the general population from the age of 15 upwards during the years 1903 to 1909 inclusive was 1·77, and the average for county and borough asylums for the same period 15·37. It can hardly be expected that the asylum mortality from tuberculosis will ever compare at all favourably with that of the general population in view of the exhausted and debilitated condition of so many persons suffering from nervous breakdown and the associated disordered metabolism, but the very great difference in the mortality figures of various institutions requires investigation.

In his revision of the statistics presented by the Medico-Psychological Committee on Tuberculosis, 1903, Dr. Chapman summarises as follows :

“(1) That infection is one of the strongest causative elements in the prevalence of tuberculosis. (2) That a healthy (dry and well drained) site is of extreme importance. (3) That the causes of tuberculosis in asylums inhere in the asylums themselves and not in the character of the patients sent to them. (4) That time spent out of doors, cubic space indoors, ventilation, etc., all appear on the side of the account one would expect, but by margins usually too small to be very significant. It would seem that probably all these are inadequate even in the ‘better’ asylums, but that on the other hand they are possibly sufficient even in the ‘worse’ asylums if tubercular taint were absent.”

Figures taken from the report of the Board of Control show that while the mortality in mental hospitals is six times as high as that of the general population, that from degenerative conditions is seven times and that from microbic diseases nearly ten times as high.

Now the average mortality from phthisis per 1,000 living for the

five years 1910 to 1914 was for England and Wales 1·12, for Staffordshire 0·80, for Wolverhampton, our principal urban population, 1·02 as compared with 36·67 for this institution.

There can be no reasonable doubt therefore that the infection responsible for this heavy mortality must occur in the institution itself, and merits careful investigation as to its cause. Not only may a patient suffering from mild mental breakdown become infected by tuberculosis consequent on admission to a mental hospital and die while still insane, but a quite likely result might be that he may quickly recover from the nervous breakdown and after discharge act as a focus of infection in his own home.

It is necessary in the first place to inquire to what extent insufficient diet may be responsible. The Medico-Psychological Committee's report on Tuberculosis in Asylums in 1903 enumerates a series of institutions having a low phthisis mortality and another series having a high one.

Twelve mental hospitals were selected from each list with comparable populations—that is either urban, agricultural or mixed—and the medical superintendents kindly supplied me with the dietary scale existing in 1902, in addition to information as to means of isolation of tuberculous patients in these institutions. Comparing the diets of one list with those of the other and with that of this institution, Stafford, so far as breakfast and tea were concerned, headed the list as regards the amount of bread and margarine per patient, and while the quantity of sugar amounted to about the same throughout, Stafford was the second highest on the list as regards the amount of milk, and it and one other were the only hospitals supplying cocoa to the male patients for breakfast.

With respect to dinners the following table is compiled from the returns supplied :

Mortality group.	Bread: Weekly average in ozs.	Meat: Weekly average in ozs.	Potatoes: Weekly average in lbs.	Other vegetables: Average in lbs.	Percentage giving meat pie dinners.	Percentage giving suet pudding dinners.	Percentage giving cheese.	Percentage giving soup.	Percentage giving fish.
High	23·5	26·5	4·7	3·2	33·3	44·4	33·3	77·7	33·3
Low	16·1	28	3·7	4	28·5	85·7	14·2	71·4	28·5
Stafford	40	28	4	4	Supplied	Supplied	Supplied	Supplied	Supplied

A cursory examination of this table will show that the dietary in this institution can hardly be held responsible for the high tuberculosis mortality. It would appear that those mental hospitals

having a low mortality give a higher proportion of suet pudding dinners—the fat used in which is probably of significance having in mind its vitamine A content. Several mental hospitals with a high mortality had a diet scale very similar to others with a low mortality.

One institution with two branches having identical diets had a high tuberculosis mortality at one branch and a low one at the other. As regards calories the daily values for Stafford for the period in question worked out at 3,281 for men and 2,759 for women, whereas those for one asylum taken at random having a low mortality worked out at 2,515 for men and 2,015 for women. W. S. McCann (8) has recently investigated the protein requirement in tuberculosis by determining in ten tuberculous patients the nitrogen balance, the basal metabolism, and the caloric value and composition of the diet. The evidence he has obtained indicates that the optional amount of protein for patients suffering from pulmonary tubercle and confined to bed is from 60 to 80 grm. per diem, with a total caloric value for the diet of 2,500 calories. It is therefore apparent that inadequate diet is in no way responsible for the high tuberculosis mortality obtaining in this institution. As regards the isolation of tuberculous cases in the various mental hospitals there appears to have been little to choose. In only two was there a separate isolation block, and both these mental hospitals had a high tuberculosis death-rate.

I have already drawn attention to the fact that a high ratio of epileptics in mental hospitals is associated with a high tuberculosis mortality, and the Staffordshire mental hospitals have always had a high proportion of epileptics.(9) During the years 1917 and 1918 war conditions had a very marked effect in raising the mental hospital tuberculosis mortality and that of the general public. This is shown in the following table of mortality per 1,000 living, and for most of the figures I am indebted to Dr. Carruthers, the County Medical Officer of Health for Staffordshire.

Average for—	England and Wales.	Staffordshire.	Wolverhampton.	Stafford Borough.	Stafford Mental Hospital.
1910–14 .	1·12 .	0·80 .	1·02 .	1·32 .	36·67
1915 .	1·16 .	0·86 .	1·18 .	1·78 .	24·72
1916 .	1·18 .	0·95 .	1·09 .	1·12 .	21·50
1917 .	1·25 .	0·93 .	1·05 .	0·80 .	59·97
1918 .	1·34 .	0·99 .	1·16 .	1·40 .	84·37
1919 .	0·96 .	0·73 .	1·13 .	0·94 .	43·90
1920 .	0·89 .	0·69 .	0·89 .	1·08 .	18·11
1921 .	— .	0·72 .	0·76 .	1·03 .	15·85

It is to be noted that the sudden influx of 195 war hospital patients here late in 1915 vitiates the figures per 1,000 resident in the mortality rates for 1915 and 1916.

The greatly increased mortality in 1917 and 1918 in this hospital must have been due in varying degrees either to the fact that there was less efficient care of patients and lack of general cleanliness owing to shortage of staff or to the overcrowding consequent on the admission of large numbers of war hospital patients or to diet restrictions. The fact that dysentery became more prevalent points to staff failure, as the spread of this disease is entirely due to inefficiency as regards cleanliness, and in view of this increase in dysentery its continued high incidence in the years following the war was to be expected owing to the increase in the numbers of carriers remaining.

The large increase in tuberculosis mortality in this institution during the year 1918, *viz.*, to 84.72 as compared with that of 36.67 pre-war, taken in conjunction with the fact that in 1921 it fell to 15.85, representing the lowest figure recorded for very many years and a drop of over 50 *per cent.* on the pre-war average, is very significant; and having in view the chronicity of pulmonary tuberculosis and its insidious onset, also the fact that food rationing only began in March, 1917, it is almost certain that the great majority of these cases were infected prior to the period of food deficiency, and that such deficiency merely determined a fatal result more rapidly, the post-war position as regards tuberculosis being in consequence exactly the opposite of that obtaining as regards dysentery: that is, while in the latter case the number of carriers has increased and there is consequently still a high incidence from this disease, as evidenced by the fact that in the second half of 1921, 728 cases occurred as compared with a total of 1,159 in the whole of 1913 and 1,324 in 1914, in the case of tuberculosis, the carriers having diminished, there is as a result a greatly decreased mortality in 1920, in spite of the fact that the full food restrictions continued up to August, 1919, and modified restrictions existed up to August, 1920. It must be recollected that no matter what the diet may be, given the absence of the tubercle bacillus there would be no such thing as tuberculosis, and in view of the decrease in carriers of this disease through the high mortality occasioned in them by war conditions, the present is a most favourable moment to prevent the further spread of tuberculous disease by the adoption of stringent hygienic precautions, such as the isolation as far as possible of known carriers, and the introduction of measures which will effectively lessen the spread of infection by others in whom its diagnosis is a matter of much difficulty owing to the accompanying mental disorder.

In the Medical Research Committee's report (10) on the prevalence of phthisis in the boot and shoe trade it is pointed out that amongst the clickers, as the cutters out are termed, phthisis mortality is unduly high. "The room in which they work," it is stated, "is usually tidy, and the floor is only encumbered with scraps of leather from the day's work. These have a commercial value and are regularly swept

up each day. Too often, however, this sweeping is done during working hours without any precaution to allay dust." "In an industry," the report further states, "in which a large number of individuals, often over one hundred, occupy the same room for 54 hours every week and in which an infectious disease, in this case tuberculosis, is known to be prevalent, opportunities for the transmission of the disease from the infectious to the healthy must occur more often than normally. One instance which came under notice will be sufficient to illustrate the danger: At a factory in many ways in advance of the usual standard of hygiene found in the industry, a clicker, rather a careless man, developed phthisis and was allowed to continue at work; before long four other cases occurred among men working in his immediate vicinity."

This describes in a very mild manner exactly what happens in a mental hospital ward. Every time a consumptive coughs he sprays droplets of sputum a distance of anything up to 2 metres. As many as 430, 573 and 587 tubercle bacilli have been counted in one droplet (11). These droplets rapidly fall to the ground, become dried and pulverised, and such dried sputum is the medium *par excellence* for the propagation of tuberculosis. Cornet suspended cages containing guinea-pigs round the walls of a room in which carpets soiled with dried tubercle-containing sputum were beaten, and out of 48 pigs 47 became tuberculous. Now the weight of evidence goes to show that the tubercle bacillus when inhaled reaches the lung *viâ* the intestine. Van Steenberghe and Grysez (12) showed that when animals are killed after a course of breathing lamp-black, black is found in the nose, mouth, throat and œsophagus, but never in the trachea, bronchi or lungs. Further rabbits in which the œsophagus had been ligatured were made to inhale lamp black for a prolonged period, their lungs remained free while the black penetrated the lungs of other rabbits which had not been interfered with; also one of the large bronchi in certain rabbits were plugged, forming an impenetrable barrier to dust, and after a course of lamp-black breathing the separated lung became just as black as the other. The following simple experiment affords additional proof: A straight glass tube is bent a few times at right angles and coated inside with a thin layer of glycerine; a stream of dust- and microbe-laden air after being driven through such a tube will be found quite sterile as the organisms and dust particles impinge on and adhere to the glycerine. The mucus lining of the nasal and pharyngeal passages serves the same purpose as the glycerine in this tube. It is very probable, therefore, that pulmonary tuberculosis is brought about by the lodgment of the bacillus in the pulmonary tissue *viâ* the blood-stream or lymphatics.

Penetration of dust into the bronchial tubes can only be brought about by very deep breathing, and as shallow breathing is usual in patients suffering from mental disorders, the channel of infection is very probably in them almost always *viâ* the alimentary canal. Dust, therefore, is dangerous, not because it is inhaled, but because

it is swallowed. It is consequently very important that attendants should keep careful note of any patients addicted to coughing or the habit of vigorously clearing the throat while at meals, and that such patients should sit at separate tables.

In the report already referred to of the Medico-Psychological Committee (1903) a table is given showing amongst other details how the floors are treated, that is, whether polished or scrubbed. In a series of 26 "better" asylums with a tubercular death-rate of '3 to 2 *per cent.* of daily average numbers resident, and 23 "worse" asylums with a percentage of 2·1 to 5·9, excluding the "no returns," we get a percentage of 64 of the "better" asylums with polished floors as compared with 70 of the "worse" group, which tends to show that so far as tuberculosis is concerned scrubbed floors are better than polished. It is to be noted that no details are given beyond simply the words polished or scrubbed; as I have shown, there is a difference between scrubbing once a week and three times a week as far as infectivity is concerned and polished floors themselves require frequent scrubbing.

With a view to testing the effect of the use while sweeping floors of damp sawdust and tea-leaves on the microbic content of dust, four wards in this hospital on the male side having polished floors were treated in this manner while being swept, and particular care was taken that no sweeping of any kind took place without such treatment. The dust of each ward prior to the sawdust treatment was analysed as regards bacterial content in the same manner as already mentioned. This floor treatment was continued for a fortnight, and the dust from the first sweeping after the use of sawdust was discontinued similarly analysed. The average out-of-door temperature for the week in which the first analysis was made was 46° F. maximum and 28° F. minimum, and for the week when the final sweepings were collected and analysed 80° F. and 46° F. respectively.

The results are shown in table on p. 41.

In examining these results the great difference in the out-of-door temperature for the periods in question must be borne in mind, that during the week of the second analysis being double that of the first, and this makes it somewhat difficult to assess accurately the value of the results. It would appear that while the treatment with moist sawdust and tea-leaves lessened very definitely the effects of remote contamination, as evidenced by the *B. Welchii* content and the improved ratio of organisms grown at 38° to those at 22° and also the ratio of liquefiers to total on gelatine, the result as far as coliform and streptococcal contamination is concerned was not encouraging. Again, in order to estimate the degree of microbic pollution of the air in a ward as a result of sweeping polished floors with and without the use of damp sawdust and tea-leaves and also as a result of polishing the floors with the usual rubbers and of vacuum cleaning, 9-in. diameter agar Petri dishes were exposed in each instance 1 ft. from the ground for ten minutes and the number of organisms deposited

	<i>B. coli</i> present in c.c.	Streptococci and staphylococci present in c.c.	<i>B. Welchii</i> in c.c.	No. of organisms at 38° C., in '0001 c.c.	No. of organisms at 23° C., in '0001 c.c.	Ratio at 38° C. to that at 23° C.	No. of liquefiers in '001 c.c.	Ratio of liquefiers to total on gelatine.
Prior to sawdust treatment:								
M ₂	.1	.0001	.01	297	125	1 to 0.42	20	1 to 62
M ₃	.01	.0001	.1	127	66	1 to 0.52	35	1 to 19
M ₉	.001	.0001	.01	307	21	1 to 0.07	0	—
M ₁₀	.01	.0001	.1	115	36	1 to 0.31	3	1 to 120
After sawdust treatment:								
M ₂	.001	.000001	1.0	290	601	1 to 2	310	1 to 19
M ₃	.001	.000001	.1	717	755	1 to 1	37	1 to 204
M ₉	.001	.0001	1.0	186	267	1 to 1.4	7	1 to 381
M ₁₀	.001	.000001	.1	280	841	1 to 3	190	1 to 44

in that time counted after subsequent incubation. The plates were exposed in every case in the same place in the centre of the ward, fifteen minutes after disturbance of the floor dust and again three hours later when the air in the ward was still; all draughts were excluded and the ward was not occupied by patients during the intervening period. The results of this investigation are shown in the following table and in the annexed plates :

Floor treatment.	Maximum temperature.	No. of organisms deposited.		No. of organisms deposited 15 minutes after floor disturbance for every 100 when air of ward was still.
		15 minutes after floor treatment.	3 hours after floor treatment.	
Sweeping	52° F.	315	26	1,211
Sweeping with use of damp sawdust and tea-leaves	50° F.	259	18	1,439
Vacuum cleaning and polishing	59° F.	130	57	228
Vacuum cleaning alone	68° F.	69	80	86

I may say that these are not isolated observations. Several plates similarly exposed on other occasions resulted in much the same ratios.

These figures indicate in the first place the relationship of ward temperature to air pollution—the higher the temperature the more organisms are present. It is noted previously that ward 10 in this hospital on each side has been responsible for the greatest amount of dysentery, and it is noteworthy that both these wards are during the summer months much the hottest wards in the place, being afforded less protection from the sun than the others.

Secondly the investigation shows that the use of damp sawdust and tea-leaves while sweeping a large polished floor area is very ineffective as regards reduction of the microbic content of the air in the ward.

Thirdly, that the constant use of rubbers in polishing is a danger, as after their use the air content of organisms is doubled, and finally that the adoption of vacuum cleaning is very desirable. As a result of using the vacuum cleaner the atmosphere in the ward was actually purer as far as its microbic content was concerned—69 organisms being deposited on the Petri dish fifteen minutes after as against 80 three hours later when the air was still. It is very evident that the constant sweeping and rubbing of polished floors is a potent means of contaminating the atmosphere and encouraging infection. It is quite impossible to prevent certain patients expectorating; not long ago I found one leaning over a ward radiator and spitting into the space

between the down pipe and casing. Given a few dements in a ward suffering from early active tubercle and with habits of this kind, myriads of tubercle bacilli must very shortly be present in the dust which every disturbance will distribute into the air. Consider the longevity and retention of virulence of the organisms and the constant accretion of fresh foci of infection, and it is hardly possible to imagine a more efficient environment for the production of pulmonary tuberculosis. Imagine the effect of sweeping up vigorously dust containing these minute organisms (2 to 5 μ in length); the visible particles will be swept along the floor, but the bacteria will only be flicked into the air to settle down gradually again after the sweeping up is over, and this process will go on day after day and year after year with a continuous increase of tubercle bacilli in the atmospheric content. These observations leave little room for doubt that vacuum cleaning must be regarded as the most efficient method of keeping down dust-borne infection to a minimum.

A central system of vacuum extraction is decidedly the best, being much more efficient than the hand machine, more rapid in its action, and involving a minimum of labour.

In order to deal on the most thorough manner possible with tubercular infection in mental hospitals—that is, if expense were no object—it would be necessary to have in addition to vacuum cleaning an isolation block for undoubted cases of tuberculosis and a separate block for suspected cases, but since each such isolation block would have to be a combination of sanatorium and mental hospital in order to be suitable for the various mental types of phthisical cases, their provision, to be thoroughly efficient, would be a very costly matter, and as even with them many carriers would still undoubtedly escape detection, the practical measures to adopt would seem to be as much isolation as possible under existing conditions and the installation of a central dust-extraction system. Arising out of this investigation the following rules regarding floor treatment and ward hygiene are now in force in this hospital:

Scrubbed floors.—Day-rooms to be scrubbed at least three times weekly and oftener if necessary. Single rooms to be scrubbed daily. Dormitories at least once weekly and oftener if necessary.

Polished floors.—Day-rooms to be waxed daily, galleries and dormitories once weekly. All soiled portions to be scrubbed with soap and water before being repolished. All polished floors to be completely scrubbed with soap and water every two months at least and the polished portion of the infirmary ward floor every month at least. No general polishing or sweeping is allowed while the patients occupy the wards. Crumbs, etc., after meals are to be dusted up.

Furniture, etc.—Furniture in sick-rooms to be washed and polished weekly. All polished furniture, including windows and floors, to be washed at least once a month. Pictures to be taken down and dusted weekly. All scrubbed tables to be washed weekly and oftener if necessary. Table-covers to be washed monthly. Curtains to be laundered every two months.

I am glad to say that our tuberculosis mortality has now dropped to a figure only very slightly in excess of the average obtaining at present for asylums generally.

SUMMARY.

1. Recent cases of dysentery should only be considered recovered when negative laboratory returns for one month coincide with clinical recovery for that period.

2. If dysentery breaks out in a ward :

(a) The stools of all contacts should be examined bacteriologically twice weekly for a period of four weeks after the isolation of those affected.

(b) The stools of all patients who have ever had dysentery or diarrhoea should be examined bacteriologically once a week for a period of three months.

The detection of a Flexner carrier is a matter of considerable difficulty, as unlike the carrier of *B. Shiga* he is generally in good health and suffers little or no inconvenience ; also one of the characteristics of persistent infection with this organism is intermission : it will be found in the stools for one or two days and then for some weeks the stools will prove negative, at the end of which time the result will be again positive.

3. Attention should be paid to possible pollution of the soil of airing courts.

4. The rôle of flies as carriers of infection should be borne in mind and the excreta of all bed-ridden patients paid attention to.

5. No patient who has ever had dysentery should be allowed to work in the kitchen or employed in handling food.

6. Scrubbed floors are more hygienic than polished floors.

7. Scrubbing three times weekly would seem to give sufficiently good results for day-rooms.

8. All polished floors should be thoroughly scrubbed at frequent intervals. Should dysentery occur in a ward having a polished floor it should be scrubbed at least three times a week for a month.

9. Floors should only be polished or swept after the patients have gone to bed—on no account while they are in the ward or shortly before they occupy it.

10. Furniture, doors, etc., subject to handling by patients should be regularly scrubbed. Table-covers should be washed at frequent intervals.

11. All cased-in radiators should be thoroughly cleaned periodically.

12. Crumbs, etc., on the floor after meals should be removed by dusting with a damp or oiled cloth under the brush or preferably by meals of a vacuum dust extractor.

13. Care should be exercised with regard to the seating at meals of any patient at all in the habit of coughing or cleaning his throat forcibly. Such patients should sit by themselves at separate tables.

14. Finally in order to reduce infection to a minimum the installation of a central vacuum cleaning system is desirable.

REFERENCES.

- (1) Ledingham and Arkwright.—*The Carrier Problem in Infectious Diseases*, p. 292.
- (2) Besson.—*Bacteriology and Microbiology*, p. 360.
- (3) Vincent and Muratet.—*Dysentery, Cholera and Exanthematic Typhus*.
- (4) Besson.—*Bacteriology and Microbiology*, p. 322.
- (5) Ledingham and Arkwright.—*The Carrier Problem*, p. 289.
- (6) *Med. Research Com. Report*, No. 29.
- (7) *Med.-Chir. Trans.*, vol. 1, li.
- (8) *Arch. Int. Med.*, 1922, vol. xxix, p. 33.
- (9) Shaw.—“Relationship between Epilepsy and Tuberculosis,” *Journ. Ment. Sci.*, July, 1914.
- (10) *Med. Research Com. Report on Phthisis in the Boot and Shoe Industry*.
- (11) *Zeitschrift für Hygiene*, 1907, vol. lvii, p. 50.
- (12) *Annales de l'Institut Pasteur*, t. xx, 1905, xix.

NOTE.—By polishing is meant the use of rubbers; by waxing, the application by hand of liquid polish consisting of wax and its solvent. This application has little if any antiseptic action during the brief period in which it remains fluid on the floor. I have recovered *B. Flexner*, living, after four hours continued immersion in the mixture in general use.

The Inter-reaction of the Endocrine, Sympathetic and Central Nervous Systems in Organismal Toxæmia, with Special Reference to Emotional Disturbance.⁽¹⁾ By DAVID ORR, M.D. Edin., Deputy Medical Superintendent, Lancashire County Asylum, Prestwich.

WHEN approached by the President of the Medico-Psychological Association to give a short address at the Annual Meeting I chose the above title. On reflection, however, I find it is somewhat over-ambitious and cannot be dealt with in the time at our disposal. It would be better, perhaps, if I endeavoured to place before you some

⁽¹⁾ An address at the Annual Meeting in Edinburgh, July, 1922.