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CROSS-INFECTION RISKS IN THE HOSPITALIZATION OF MEASLES PATIENTS*

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A mild catarrh of the aural mucous membranes, due to primary virus infection, is not unusual in the eruptive stage of measles. The serious and permanently damaging conditions, of which suppurative otitis media is the most common, are caused by secondary invading organisms, particularly the haemolytic streptococcus and the pneumococcus. The perforated drum may heal and no further trouble ensue; on the other hand, infection may spread to the mastoid process, the meninges, or the brain. A report by Linford (1936) on the otological examination of 400 unselected measles patients in an L.C.C. fever hospital illustrates the extensive ear damage which may occur. Of these patients 56 (14%) developed otorrhoea, 35 (9%) severe otitis media, 204 (51%) mild otitis media, while 105 (26%) remained normal throughout. Among 100 unselected patients suffering from measles otorrhoea, one developed facial paralysis; one facial paralysis, extradural abscess, and mastoiditis necessitating operation; four required unilateral mastoidectomy; and 12 suffered appreciable destruction of the tympanic membrane.

That haemolytic streptococci may spread in measles wards as a secondary transmissible disease superimposed on the primary virus infection was shown by Allison and Brown (1936). They found that among 43 patients admitted to a measles ward 51% became cross-infected by haemolytic streptococci and that as a result 19% of the 43 patients developed otorrhoea. Wright, Cruickshank, and Gunn (1944) confirmed the findings of Allison and Brown and suggested that dust particles derived from bed-clothes and garments are possibly the chief means by which streptococci spread in measles wards.

Scope of the Investigation.—The present report falls into two sections: (A) A detailed study, with bacteriological examination and clinical observation, of the measles patients in one ward for 12 weeks in March, April, and May, 1943. This ward served as a control in the experiment reported by Wright *et al.* (1944). (B) An analysis of the case histories of all measles patients admitted to the North-Western Hospital from Dec. 1, 1942, to May 31, 1943.

Investigation A

Ward Arrangements.—(1) The normal bed complement of the ward was 18 and the normal bed-spacing 12 feet between bed-centres. During the 12 weeks of the investigation two extra beds and during two weeks four extra beds were put up, with a corresponding reduction of bed-spacing. (2) Sulphonamides were given prophylactically to all patients unless there was any contraindication. During the first three weeks of the work a number of different drugs were used, in varying doses and for varying times. An intensive scheme was then introduced and alternate patients admitted to the ward received sulphanilamide or sulphathiazole. The dosage, according to age, was 1 to 2 g. on admission, 3 to 7.5 g. daily for 3 days, followed by 1.25 to 3.75 g. daily until the day before discharge. (3) On admission prophylactic mixed scarlet fever and diphtheria antitoxin was injected into 54 (70.1%) of the 77 patients admitted. (4) Mattress, pillows, and blankets of each patient were disinfected in the hospital disinfectant (5-lb. pressure for 30 minutes) on his discharge or

transfer from the ward. (5) Four patients with middle-ear suppuration remained in the ward until discharged and were barrier-nursed. Other patients with otitis media were removed to isolation elsewhere in the hospital.

Routine Procedure.—At the start of the investigation nose and throat swabs were taken from all patients in the ward. Subsequently swabs were obtained from the nose and throat and from any suppurative lesion—e.g., ear discharge, impetigo—of every new patient immediately before admission to the ward and then once weekly. Nose and throat swabs were taken from each member of the ward staff once monthly, and also on development of any upper respiratory tract infection. Swabs were plated on gentian violet blood-agar plates and incubated aerobically for 18 hours at 37° C. Representative colonial forms of haemolytic streptococci were tested for their serological type by the Griffith agglutination method. Cross-infection was judged to have occurred if a patient, free from haemolytic streptococci on admission, acquired these organisms in the nose or throat; or if a patient who carried haemolytic streptococci on admission acquired haemolytic streptococci of different type in the nose or throat. In assessing the cross-infection rate the Type 6 streptococcus was adopted as the "indicator organism," since more than 90% of the cross-infections were due to this type. For completeness, however, cross-infections with other types are recorded.

Complication Rate.—A daily round of all patients in the ward was made and any complication or rise of temperature noted. Appropriate swabs were taken and plated on blood agar, and/or gentian violet blood agar, and/or tellurite medium, according to the nature of the complication. Ear and mastoid swabs were investigated for the presence of haemolytic streptococci, pneumococci, staphylococci, and diphtheria bacilli. Any haemolytic streptococci isolated from patients with complications were tested for serological type.

Results of Investigation A

Cross-infection Rate.—At the start of the investigation 8 (36.4%) of the 22 patients in the ward had Type 6 streptococci in the nose and/or throat; one patient had Type 2 and one Type 27 streptococci. During the ensuing 12 weeks 47 (72%) of the 65 patients at risk acquired Type 6 streptococci in the nose and/or throat. One patient acquired Type 2 and one Group C streptococci.

Of the 47 cross-infections of the upper respiratory tract 21 (44.7%) occurred within the first week of hospitalization, and 16 (34%) in the second. The average day on which cross-infection was discovered was the 10th, with a range from the 3rd to the 34th. (The date on which the cross-infection actually occurred may have been earlier than the date on which it was discovered, as swabs were not taken until the routine weekly swabbing day unless there was clinical evidence to suggest cross-infection.) In 30 instances the cross-infecting Type 6 streptococcus was first discovered in both nose and throat at the same swabbing, in 8 in the nose only, and in 7 in the throat only. In most of the "positive" patients the streptococci were present in abundance.

Among children under the age of 9 years the cross-infections were fairly evenly distributed as to age group. Of 38 patients under the age of 3 years, 29 (76.3%) became cross-infected with Type 6 streptococci; of 14 from 3 to 5 years, 9 (64.3%); and of 9 from 6 to 8 years, 8 (88.9%). Of the 4 patients of 9 years or over, only one acquired Type 6 streptococci.

* A report to the Medical Research Council.

Complications

Middle-ear Suppuration.—Of the 65 patients exposed to risk, 12 (18.5%) developed middle-ear suppuration due to Type 6 streptococcal cross-infection; 4 of this number required mastoidectomy, and Type 6 streptococci were in each case recovered from the mastoid. Six of the 12 patients had some history of previous ear infection, but 5 of these were free from otorrhoea on admission, and the 6th, admitted with otorrhoea, had no haemolytic streptococci in the ear discharge. Histories obtained at the home are not necessarily reliable; they suggested, however, that children with previous ear infection are particularly liable to develop ear complications if cross-infected. Six typical histories are as follows:

H. A.: 1 year 11 months.—Admitted March 5, 1943, with uncomplicated measles. 1st day, no h.s. (haemolytic streptococci) in nose or throat. 6th day, few Type 6 h.s. in nose. 13th day, fair number Type 6 h.s. in nose and throat. 17th day, right suppurative otitis media; abundant Type 6 h.s. in ear discharge. 65th day, left hospital.

D. B.: 1 year 2 months.—Admitted March 12, 1943, with measles and bronchopneumonia. 1st day, no h.s. in nose or throat. 6th day, right suppurative otitis media; abundant Type 6 h.s. in nose, throat, and ear discharge. 34th day, left hospital.

C. D.: 1 year.—Admitted March 16, 1943, with uncomplicated measles. 1st day, no h.s. in nose or throat. 7th day, abundant Type 6 h.s. in nose. 17th day, right suppurative otitis media; abundant Type 6 h.s. in ear discharge; gastro-enteritis. 23rd day, child extremely ill and dehydrated. 24th day, bilateral mastoidectomy; abundant Type 6 h.s. in both mastoids; extensive disease with necrosis found on both sides. 68th day, rubella. 86th to 95th day, boils of forehead and abdomen. 130th day, left hospital.

N. H.: 7 years.—Admitted April 4, 1943, with uncomplicated measles. 1st day, no h.s. in nose or throat. 7th day, abundant Type 6 h.s. in nose and throat. 8th day, right suppurative otitis media; abundant Type 6 h.s. in ear discharge. 39th day, left hospital.

T. R.: 6 years.—Admitted March 28, 1943, with measles. History: otitis media on previous day; otorrhoea at 1½ years. Examination on admission: old perforation of right drum; no right or left otorrhoea. 1st and 10th days, no h.s. in nose or throat. 14th day, left suppurative otitis media; abundant Type 6 h.s. in ear discharge. 15th day, pustules on hands and feet; abundant Type 6 h.s. in pus. 54th day, left hospital.

B. P.: 10 months.—Admitted March 5, 1943, with measles. History: ear discharge on previous day. Examination on admission: no right or left otorrhoea. 1st day, no h.s. in nose or throat. 6th day, abundant Type 6 h.s. in nose and throat. 8th day, right purulent conjunctivitis; abundant Type 6 h.s. in eye discharge. 18th day, left mastoidectomy; left extradural abscess of middle fossa; abundant Type 6 h.s. in mastoid. 76th day, left hospital.

The average day of onset of suppurative otitis media was the 15th hospital day, with a range from the 6th to the 30th. In three of the 12 patients the onset of Type 6 streptococcal cross-infection and consequent otorrhoea occurred within the first week in hospital. This finding disproves the common belief that otorrhoea which develops within the first week in hospital is due to pre-existing infection. In addition to these 12 patients, two of the 8 patients who harboured Type 6 streptococci at the start of the investigation later developed suppurative otitis media. Abundant Type 6 streptococci were found in the ear discharges, and it may reasonably be assumed that they had been acquired by cross-infection.

Skin Infections.—Of the 77 patients either present at the start of the investigation or subsequently admitted to the ward, 20 (or 26%) developed infections of the skin. Among the 20 patients there were 26 skin infections: impetigo of face, 13 cases; boils of buttocks, 6 cases; septic fingers or toes, 4 cases; boils of head, abdomen, or anterior auditory meatus, 3 cases. Skin lesions of only 11 of the patients were examined bacteriologically; in seven instances Type 6 streptococci were isolated in abundance and in four cases *Staph. aureus*.

Other Complications.—One child admitted with laryngitis died with bronchopneumonia on the 9th day in hospital. Her nose and throat swabs on admission had yielded no haemolytic streptococci. From her larynx and pharynx at necropsy Type 6 streptococci were isolated, and these organisms may have contributed to her death. Five children developed bronchopneumonia after admission. Two had no haemolytic streptococci in the upper respiratory tract; the other three had Type 6

streptococci in the nose and throat, but it was not determined whether these caused the pneumonia.

Prolongation of Hospital Stay due to Cross-infection

If an allowance of 14 days' stay is made for a normal measles case the excess time spent in hospital by the 14 patients with middle-ear suppuration (additionally complicated in six by skin infections and in one by rubella) amounted to 89 weeks. Excess time spent by the 14 children with skin infections amounted to 40 weeks. Hospital infection among the children admitted to only one ward during a period of 12 weeks led, therefore, to an excess stay totalling 129 weeks.

Investigation B

Investigation A showed by combined bacteriological and clinical examination that a high rate of middle-ear suppuration due to streptococcal cross-infection prevailed in one ward during the spring of 1943. To find out if this occurrence was limited to one ward or to one season, an analysis was made of the middle-ear complications among all measles patients admitted to the hospital from Dec. 1, 1942, to May 31, 1943. The analysis was made according to a scheme drawn up in the light of the bacteriological work recorded in Investigation A. The scheme, with reasons where called for, was as follows:

1. The case-history sheets were carefully searched for evidence of complications. (The summary occasionally omits some important complication.)

2. The date of onset of a complication was referred to the month of admission—e.g., a patient admitted in February who developed a complication in March was placed in the February group.

3. All patients suffering from measles on admission to hospital were included; those who developed it after admission were excluded.

4. The day of admission was counted as the first hospital day, even if the time of admission was afternoon or evening.

5. Cases of middle-ear suppuration were classified as follows:—(a) *Early*: Present on admission, or developed on or before the 5th hospital day. (b) *Late*: Developed on or after the 6th hospital day. Patient was included in series however long the interval between the onset of measles and the onset of the complication, even if a second infection—e.g., chickenpox—had occurred in the meantime. (The division into "early" and "late" was set between the 5th and 6th days because the bacteriological work in Investigation A had shown that streptococcal cross-infection could cause middle-ear suppuration as early as the 6th hospital day—see Case-history D. B. above. All cases of middle-ear suppuration which develop after the 5th day in hospital should be regarded as due to cross-infection unless the contrary can be proved.)

6. All patients with a history of previous otitis media, otorrhoea, or "ear trouble" were included in the analysis. (Evidence from Investigation A suggested that a patient with a history of middle-ear infection is more liable than others to suffer from the consequences of cross-infection; exclusion of such patients from an analysis, as is sometimes done, leads to an underestimate of the risks of cross-infection.)

TABLE 1.—Incidence of Early and Late Middle-ear Suppuration (M.E.S.) by Month of Admission and by Age Group.

	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Under 3 years:							
No. of patients	18	40	54	71	38	17	238
" early M.E.S.	0	2	1	4	2	1	10
" late "	4	4	11	12	3	0	34
3 to 5 years:							
No. of patients	14	29	40	33	12	9	137
" early M.E.S.	1	1	1	2	1	2	8
" late "	3	3	6	6	0	1	19
6 to 8 years:							
No. of patients	10	12	14	10	7	6	59
" early M.E.S.	0	0	0	0	0	0	0
" late "	2	2	5	1	1	0	11
Over 9 years:							
No. of patients	4	15	15	14	10	4	62
" early M.E.S.	0	0	0	0	0	0	0
" late "	0	1	1	0	0	0	2
Total { No. of patients	46	96	123	128	67	36	496
" early M.E.S.	1	3	2	6	3	3	18
" late "	9	10	23	19	4	1	66

7. If middle-ear suppuration developed in one ear on or before the 5th hospital day and in the other ear after the 5th hospital day the case was placed in the "early" group.

8. According to this scheme, figures were analysed by age group, by month, and by ward. (a) The age groups were: under 3 years, 3 to 5 years (i.e., 3-, 4-, and 5-year-olds), 6 to 8 years, and 9 years or over. (b) The months were Dec., 1942, to May, 1943, inclusive. (This covered the epidemic period in London.) (c) Analysis by wards depended on admission to the ward at the onset of measles; any subsequent transfer—e.g., to isolation units—was disregarded. A certain number of patients, including 35 of 9 years or over, were admitted and nursed throughout in isolation accommodation. These were not included in the ward analysis.

The following points emerge from the analysis:

1. The total percentage of patients who suffered from "early" middle-ear suppuration was 3.6 and from "late" 13.3, showing how much in excess over the early ear complications were the late ones, due to cross-infection in the wards. (Actually the latter figure would probably have proved to be 1 to 2% higher if in one ward, for 9 weeks, dust-borne infection had not been controlled by means of oil-treated bed-clothes and garments (Wright *et al.*, 1944).) The average hospital day on which late middle-ear suppuration developed was the 14th, with a range from the 6th to the 48th. In 21 cases the complication was bilateral and in 45 unilateral.

2. The percentage of early and late middle-ear suppuration cases in the four age groups was as follows:

	Early	Late	Total
Under 3 years	4.2	14.3	18.5
3 to 5	5.8	13.9	19.7
6 to 8	0	18.6	18.6
Over 9	0	3.2	3.2

The percentage of late middle-ear suppuration cases did not vary greatly in the three groups under the age of 9 years. The figures for the 6-to-8-year group show a particularly marked excess of late complications over early. In this group no child was admitted with otitis media or developed it before the 6th day; but nearly one in every five children was a victim of late middle-ear suppuration, presumably due to cross-infection. The percentage incidence of middle-ear suppuration was considerably lower in patients of 9 years and over. This would be due partly to increased resistance and partly to reduced exposure to infection, since nearly 60% of the patients of this group were nursed in isolation accommodation.

3. The percentage incidence of early and late middle-ear suppuration by month was as follows:

	Early	Late	Total
Dec., 1942	2.2	19.6	21.7
Jan., 1943	3.1	10.4	13.5
Feb.,	1.6	18.7	20.3
March,	4.7	14.9	19.5
April,	4.5	6.0	10.5
May,	8.3	2.8	11.1

During December and February the high rates of 19.6 and 18.7% were recorded for late middle-ear suppuration. If the less susceptible group of "9 years and over" is omitted, the incidence for these two months becomes 21.4 and 20.4% respectively. The late middle-ear suppuration rate was less among patients admitted in April and May than among those who were admitted in the winter months.

4. The percentage incidence of late middle-ear suppuration cases in the three open wards of the hospital were: Ward A, 18.8%; Ward B, 17.2%; and Ward C, 12.9%. The highest rate was in Ward A, the figures for which were given in detail in Investigation A. The lower figure for the identical ward—Ward C—was largely accounted for by the fact that during a period of nine weeks the cross-infection rate was reduced by the use of oil-treated bed-clothes and garments. If for this period the figures for Ward A are substituted for those of Ward C, the correct percentage for the whole period of 6 months for Ward C becomes 17.9. Wards A and C were of an old-fashioned type, but this apparently was not the factor responsible for their high complication rate, since the rate was nearly equalled by that of Ward B, an "open" ward of the ordinary fever hospital pattern.

Table II shows how the remote effects and serious consequences of cross-infection fell most heavily on the children

under 3 years of age. In this group of 238 children, 11 (4.6%) underwent mastoid operations—i.e., nearly one-third of the 34 who developed late otorrhoea. Among the total number of 496 measles patients admitted to the hospital, 14 required

TABLE II.—Complications following Late Middle-ear Suppuration

Case	Age in Years	Day of Onset of Otorrhoea	Day of Onset and Particulars of Further Complications
1	2 9/12	15th, right otorrhoea	51st, scarlet fever
2	5 6/12	14th, left "	24th, " "
3	9/12	24th, bilateral "	32nd, retropharyngeal abscess
4	1 4/12	17th, left "	69th, gastro-enteritis
5	8	6th, right "	78th, bilateral mastoidectomy
6	2 4/12	15th, " "	84th, death
7	10/12	17th, " "	23rd, right mastoidectomy
8	1	17th, " "	30th, impetigo of face
9	5/12	9th, " "	15th, left mastoidectomy
10	2	10th, left "	20th, left mastoidectomy and extracranial abscess
11	1 2/12	7th, right "	17th, gastro-enteritis
12	3	21st, " "	24th, bilateral mastoidectomy
13	5	22nd, left "	15th, gastro-enteritis
14	1 10/12	8th, right "	30th, bilateral mastoidectomy
15	7/12	10th, left "	10th, " "
16	2 6/12	30th, right "	23rd, " "
17	2 6/12	6th, " "	94th, right mastoidectomy
18	1 6/12	18th, bilateral "	75th, " "
		29th, left "	32nd, bilateral mastoidectomy
		11th, " "	8th, orbital cellulitis
		17th, right "	15th, bronchopneumonia
			21st, extensive pemphigous eruption
			86th, right mastoidectomy
			35th, right suppurative parotitis
			45th, left mastoidectomy
			35th, bilateral mastoidectomy

mastoidectomy; of these, 11 (78.6%) were under 3 years of age. Gastro-enteritis attacked three of these young children; one died as a result.

Forty-five infants under 1 year of age were admitted with measles; the incidence of 13.3% for late middle-ear suppuration among them was no higher than that among children of other age groups. Of the 6 infants who developed late otorrhoea, however, four suffered very serious further complications—namely, retropharyngeal abscess (one case), extracranial abscess and mastoidectomy (one case), bilateral mastoidectomy and gastro-enteritis (one case), and orbital cellulitis, bronchopneumonia, and right mastoidectomy (one case).

Prolongation of Hospital Stay due to Late Middle-ear Suppuration and its Sequelae.—Allowing 14 days as the normal stay in hospital for an uncomplicated measles case, the excess time spent by the 66 patients with late middle-ear suppuration and its sequelae amounted to 432 weeks. At an average weekly cost of £5 per patient, the extra expense for these patients, detained in the main as a result of cross-infection, would amount to £2,160.

Discussion

The prevention of middle-ear complications in measles is important for two reasons: (a) Suppurative otitis media in young children is liable to cause permanent impairment of hearing. Kerridge (1936) found in a London special school that the starting-point of deafness among 18% of the children was a specific fever, and that, among the fevers causing deafness, measles led with a figure of 43%. (b) The high measles attack rate during each epidemic results in large numbers of young children being exposed to the risk of ear infection.

In Investigation A bacteriological and clinical observations were made over the same period in one ward. The results showed that where middle-ear suppuration developed after admission to hospital it was in the great majority of cases due to streptococcal cross-infection. It demonstrated, further, that complications due to cross-infection may occur sooner than is commonly supposed—namely, as early as the 6th hospital day. Banks (1944) stated that the high figures presented in Investigation A were apt to give a false impression of the magnitude of the problem. The figures of Investigation B show, however, that a high incidence of measles otitis media prevailed in all three "open" wards of the hospital from the beginning of December to the end of March. Whether the incidence of ear complications in this hospital was higher than that in others it is impossible to say, as no comparable figures

have been published. Accurate comparison of the figures for different hospitals would require the undertaking of analyses in accordance with an inflexible scheme such as that drawn up in Investigation B. Otherwise it is possible that in some hospitals (a) the figures for measles otitis media may be estimated after the exclusion of patients with a history of previous ear trouble, (b) the dividing day between "early" and "late" otitis media may differ. In interpreting the results of "short-stay" hospitals it should be taken into consideration that patients may develop complications, due to hospital infection, after returning home. It is important that any analyses made should be undertaken by medically qualified persons and not by clerical staff.

The dangers of hospitalizing measles patients are clearly stated in the L.C.C. Report on the Measles Epidemic of 1931-2: "Measles is not a disease which lends itself to mass treatment, and is not very suitable for hospital treatment for various reasons. . . . If the home conditions are suitable, it is better for the patient to be treated at home, where, if medical assistance is available and the child is put to bed in a well-ordered, well-ventilated, and airy room, there need be no risk of complications." The figures presented in this paper show that the risk of serious complications due to hospital life are still present. Nevertheless, during every epidemic the fever hospitals of London are flooded with measles cases. The comparative risk of infection by haemolytic streptococci in a hospital or in a home may be shown by a few figures. In a measles ward each patient may be exposed to 20 fellow-patients, over 60% of whom may be carriers of streptococci of epidemic type in profuse numbers; to 10 staff members, one or two of whom may be streptococcal carriers; to infected dust particles in the air; and to grossly contaminated ward articles and toys. In a home a measles patient has a good chance of not encountering any haemolytic streptococci at all. Home visiting by doctor and nurse is best for the treatment and nursing of uncomplicated measles. After over five years of war, home nursing is not always practicable; but the fact remains that too many patients whose circumstances would permit home nursing are without due inquiry taken into hospital. So far as is possible measles patients who can be cared for at home should remain at home, and hospital accommodation be reserved for those who are actually in need of hospital care. For the protection of those patients who must be admitted to hospital certain recommendations may be made in the light of the findings of Investigations A and B.

Recommendations for the Nursing of Measles Patients in Hospital

(a) *Avoidance of Overcrowding.*—A distance of 12 feet between bed-centres should be strictly adhered to. In the long run no economy in accommodation or staff is gained by overcrowding, since this leads to complications which in turn prolong the average stay in hospital.

(b) *Protection of the Most Susceptible Groups.*—Infants under 1 year of age incur the highest risk of serious complications due to cross-infection, and should accordingly be given priority of isolation accommodation. The next claimants to special consideration are children of any age with a history of previous otitis media, because they are particularly susceptible to further attacks.

(c) *Preventing the Entry of Haemolytic Streptococci to the Ward.*—Patients with a suspected haemolytic streptococcal infection should be nursed in isolation units until they are proved to be free from streptococci. Patients should not be moved direct from one open ward to another open ward, since by so doing an epidemic streptococcal strain may be spread.

Patients under (b) and (c) for whom isolation accommodation cannot be found should be barrier-nursed in the open ward. In making the analysis for Investigation B it was found that 29 patients over 18 years of age were nursed in isolation units. Since adults run little risk of cross-infection they should not, for reasons of their comfort alone, be allocated to accommodation required for the protection of infants and children.

(d) *Control of Dust-borne Infection.*—Blankets, sheets, pillow-slips, and patients' garments may be treated with technical white oil during the laundering process. The method

of Harwood, Powney, and Edwards (1944) is practicable in a well-conducted hospital laundry. This recommendation rests on the marked fall in cross-infection which followed the introduction of oil-treated articles into a highly contaminated measles ward, and on the inference that dust is an important means of streptococcal spread (Wright *et al.*, 1944). If oiling of bed-clothes is not practicable, bed-making rounds should be abolished and the beds made individually as required, with the least possible disturbance. This avoids a sudden large increase in aerial contamination. Beds should preferably be made during hours of good ventilation and not during "dim-out" hours. Floors, if of wood or covered with linoleum, should be treated with spindle oil (see M.R.C. War Memorandum No. 11, Appendix E). Children should not be placed on the floor or on a blanket on the floor, as is sometimes done while beds are being made or when convalescents are playing.

(e) *Control of Contact Infection.*—*Nasal toilet:*—In Investigation A it was found that in doing the nasal toilets the nurses' fingers and the vaseline became contaminated, often heavily, with the prevalent Type 6 streptococci. The procedure was to clean the nostrils with cotton-wool rolled at the bedside on to orange sticks and then to smear the face with vaseline; streptococci were thus implanted direct into the nose and on to the face. Individual equipment consisting of previously prepared sterile cotton-wool pledgets on orange sticks, individual vaseline-pots, and discard jars should be provided at each bedside. Nurses should wash their hands each time after attending to a patient's nasal toilet. This is important in preventing the spread of impetigo as well as respiratory infection. *Bedpans and chamber-pots:*—These should be disinfected between each use (see M.R.C. War Memorandum No. 11, Appendix A). *Mugs, spoons, and forks:*—These articles should be boiled between each use. *Dressings:*—The "no-touch" technique should be followed (see M.R.C. War Memorandums No. 6 and No. 11, Appendix D). Discharging ears should be covered, and pus should not be allowed to run on to pillows and bed-clothes. *Toys and books:*—These proved a prolific source of haemolytic streptococci. In measles, which normally is a short-stay fever, children will suffer no undue hardship if they are denied toys and books. *Barrier-nursing:*—This should be immediately introduced for any patient who develops, or who is under suspicion of, an intercurrent infection of the respiratory tract, gastro-intestinal tract, or skin. If isolation accommodation is not available for such a patient, barrier-nursing should be maintained until bacteriological investigation proves him to be free from infection.

(f) *Control of Droplet-borne Infection.*—All members of the staff should wear masks while attending to measles patients. The fact that masking is enforced in bed-isolation wards indicates that it is not impracticable in measles wards. Staff members who develop upper respiratory tract infection should immediately be taken off duty and should not nurse measles patients until they have fully recovered.

(g) *Convalescent Patients.*—The control of convalescent measles patients provides a difficult problem. The risk of their becoming cross-infected is high unless strict measures are taken for their protection. The procedure which is followed in bed-isolation wards should be adopted—i.e., the patient when up should be restricted to his own bed-area and should not be allowed to gather with others at a meal-table or round the fire.

(h) *Chemoprophylaxis.*—Prophylactic sulphonamide administration has been advocated by Banks (1944); he did not, however, include a control group among patients of the same epidemic. That chemoprophylaxis is not necessarily an effective measure is shown by the high cross-infection and complication rates at the North-Western Hospital among patients who received, as a routine, sulphonamides in high dosage throughout their stay. In two wards the epidemic Type 6 streptococcus was found by *in vitro* tests to be sulphonamide-resistant (Wright *et al.*, 1944). Discrepancies in the evaluation of chemoprophylaxis in measles are possibly due to varying degrees of sensitivity and resistance of the particular streptococcal strains involved. Prophylactic sulphonamides are not always effective, they involve the risk of engendering drug-fast strains, and they are time-consuming and worrying for

the nursing staff to administer. For these reasons it is probably wiser to reserve sulphonamides for therapeutic purposes.

Summary

The results are recorded of two investigations made among measles patients admitted to the North-Western Hospital during the epidemic of 1942-3.

1. In Investigation A an intensive study of the bacteriological and clinical conditions in one ward for a period of 12 weeks showed that: (a) 72% of the 65 patients at risk became cross-infected with Type 6 haemolytic streptococci; (b) as a result of Type 6 streptococcal cross-infection 12 patients (18.5%) developed middle-ear suppuration—of these 12, 4 underwent mastoid operations; (c) 26% of the patients developed skin infections, mainly impetigo; (d) allowing 14 days as the normal stay for an uncomplicated measles case, excess stay in hospital amounted to two and a half years.

2. In Investigation B an analysis was made, in accordance with a set scheme, of the middle-ear-suppurative cases among all the measles patients admitted to the hospital from Dec., 1942, to May, 1943, inclusive. This showed that: (a) Among the 496 patients 3.6% suffered from "early" (i.e., on or before the 5th hospital day) middle-ear suppuration, and 13.3% from "late" (i.e., on or after the 6th hospital day). In view of the findings in Investigation A, it could be assumed that the great majority of the late middle-ear complications were due to cross-infection. (b) Among children under the age of 9 years the percentage incidence of late middle-ear suppuration did not vary greatly in the three age groups. Under 3 years of age the incidence was 14.3%, in the 3-to-5-year group 13.9%, and in the 6-to-8-year group 18.6%. Among patients of 9 years or over the rate was much lower, being 3.2%. (c) The late middle-ear-suppurative rate was considerably lower among patients admitted in April and May than among those admitted in the winter months. (d) The incidence of late middle-ear suppuration did not vary greatly in the three "open" wards of the hospital, being in Ward A 18.8%, in Ward B 17.2%, and in Ward C 17.9% (corrected figure). (e) The percentage incidence of ear complications was not higher among children under 3 years of age, but the seriously damaging effects of cross-infection fell most heavily upon them. Of the 238 children in this group, 11 (4.6%) underwent mastoidectomy, and one of these died. Infants under 1 year of age suffered particularly severely; 6 of the 45 infants admitted to the hospital developed late middle-ear suppuration, and in 4 cases this was followed by further complications—namely, in one by retropharyngeal abscess, in one by extradural abscess and mastoidectomy, in one by bilateral mastoidectomy, and in the last by orbital cellulitis, bronchopneumonia, and mastoidectomy.

3. In view of the high complication rate due to cross-infection, treatment at home rather than in hospital is advocated for patients with uncomplicated measles.

4. For the protection of measles patients who must be admitted to hospital, recommendations are made for the control of cross-infection and for improvements in administrative and nursing procedures.

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Dorothy M. Horstmann, Robert Ward, and Joseph L. Melnick (*J. Amer. med. Ass.*, Dec. 23, 1944, p. 1061) report a study undertaken at the New Haven Hospital, Connecticut, to determine the average duration of excretion of poliomyelitis virus in stools of patients who had had acute infection. The stools were examined of 61 patients in whom a clinical diagnosis of poliomyelitis had been established. It was found that 61% excreted virus during the first two weeks after onset of the disease; 50% during the third and fourth weeks; 27% at the fifth and sixth weeks; 12.5% at the seventh and eight weeks. Between the ninth and twenty-fourth weeks virus was detected in only one of 52 specimens tested; this was excreted by a boy in the twelfth week of paralytic disease. Not one of the 61 patients followed up was demonstrated to become a persistent carrier of poliomyelitis virus.

CHANGES IN PERSONALITY AFTER CEREBROSPINAL FEVER

BY

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Literature on the neuro-psychiatric residuals and changes in personality after cerebrospinal fever (C.S.F.) is very meagre, and most of the papers on this subject record observations made chiefly on children. Among the papers dealing with adults are 12 English, 4 American, 6 French, 1 Russian, 1 Spanish, and 7 German. There is, however, no unanimity in their findings. Some writers—notably Rolleston and Ronaldson (1940), Rundle (1929), and others—say that a few patients with predisposition to neuroses may during convalescence suffer from neurasthenia and occasionally from mental deterioration (Brain, 1940). Others, including Netter and Debré (1911) and Foster and Gaskell, are emphatic that after recovery from the acute illness and in the absence of internal hydrocephalus no mental changes occur. In 1918 Rosanoff described a uniform syndrome as a result of observations made on 26 adults at the U.S. Army Hospital for War Neurosis at Plattsburg Barracks. The symptoms in order of frequency were limitation of flexion of the spine; undue fatigue; pains in the back, legs, and head; tendency towards dizziness and faintness; muscular weakness; tendency towards blurring of vision associated with photophobia; and, lastly, impairment of appetite and sleep associated with a state of undernutrition. These findings have not been confirmed by subsequent writers.

From a study of patients who gave a history of C.S.F. in adult years one finds that some who have apparently recovered from the acute stage may continue to complain of symptoms which incapacitate them for work for prolonged periods. Some of them wander from hospital to hospital, and on account of negative findings are finally labelled "neurotics," which only adds to their hardship by depriving them of the sympathetic consideration of their employers. Anxiety state resulting from prolonged unemployment and financial insecurity may obscure the picture before a psychiatrist is consulted. It is therefore essential that symptoms due to external stress should be clearly differentiated from those due to the meningococcal infection. The criteria to be used in these cases have already been discussed elsewhere (Pai, 1944).

Independent and extensive inquiries were made to obtain reliable information on patients' personality, previous illness, disposition to neurotic or psychotic illness, intellectual level, and capacity for work before and since meningitis. Letters from relatives, reports of psychiatric social workers, and, in Service patients, personality and efficiency reports by the officers commanding units were available in most cases. On the basis of this information the patients were considered in three groups according to whether their previous personality was (1) good (i.e., well organized and stable), (2) fairly good, or (3) poor (i.e., neurotic or psychopathic).

Symptomatology

When the symptoms were studied in the light of information obtained from various sources it was found that some symptoms appeared to be purely functional in origin and to be precipitated by psychological factors such as domestic and financial stress or unsuitable employment in their units. Among such symptoms were stutter, amblyopia, and hysterical paraplegia (Hurst, 1918) and disorders of gait, and these began after varying intervals of complete freedom from symptoms. As was only to be expected, such symptoms were predominant in patients of the second and third groups, indicating that functional symptoms were more common where disposition to neurosis existed before the meningococcal infection. Some of these patients had actually suffered from somewhat similar symptoms before the onset of cerebrospinal fever, and their present psychiatric disorders more or less conformed to their previous pattern of behaviour to stress.