

CROSS-INFECTION IN SCARLET-FEVER BED ISOLATION WARDS

BY W. STEWART STALKER, M.D., D.P.H.,
Hendon Isolation Hospital

ELIZABETH WHATLEY, M.B. AND JOYCE WRIGHT, D.M.,
University College Hospital Medical School, London

ALLISON & BROWN (1937) found that 70·2% of scarlet-fever patients in a multiple bed ward became cross-infected with a Griffith type of *Streptococcus pyogenes* different from that causing the primary disease. Of the thirty-three patients cross-infected, eighteen developed clinical complications as a result of the added infection. In view of these observations the importance of preventing the spread of *Str. pyogenes* among scarlet-fever patients in multiple bed wards was apparent. The primary object of this work was to see if this could be effected by bed isolation nursing, a method practised by Rundle & Burton (1912). For this purpose, the incidence of cross-infection with *Str. pyogenes* was compared in two groups of patients, one nursed by the bed isolation method and the other by the ordinary method in current use for multiple bed wards.

WARD ARRANGEMENT

Block A. Ordinary nursing

This block consisted of two twelve-bed wards, one for males and one for females, united by a central section comprising kitchen and laundry store. The distance between bed centres was 12 ft., that between bed heads across the width of the ward was 21 ft., and the floor area per bed was 144 sq. ft. The ordinary method of nursing was used.

Block B. Bed isolation nursing

The general lay-out of these wards was similar to that of block A. Each contained a central hand-basin, the taps of which were operated by foot-pedals. The following rules for bed isolation nursing were drawn up after consultation with the staff of a fever hospital in which the method had been used for many years.

Rules for bed isolation nursing

1. Windows and ventilators are to be open as freely as possible, day and night, winter and summer.
2. Head of bed is to be 18 in. from wall, and locker 24 in. from bed. Patient is not to touch wall or locker. Articles belonging to patient are not to stand on locker.
3. New patient is to be received by nurse wearing fresh gown, afterwards to be nurses' gown for that patient's bed. Reception blanket is to be kept in patient's locker and, if not soiled, to be used as his bath blanket.

4. After touching patient, patient's bed, charts, thermometer, pulse-glass or any article used in his case, or any article in general use that has not been sterilized, the nurse or doctor must go to the central hand-basin, wash hands and forearms with soap and water, scrub finger nails, rinse off soap and dry on clean towel. Water used to wash must be tepid, since too cold or too hot water is apt to chap the hands. If a nurse's hands chap, she is to report to sister at once. Nurses are to keep their hands in as good condition as possible, and their nails short.

5. Levers for turning water on and off are to be worked with foot pedals, never with hand or arm.

6. Nurses are to work bare-armed. If by any chance a nurse touches a patient when not wearing a gown, or if her apron or dress becomes soiled by discharge, it is to be changed at once.

7. Each gown, when not in use, is to be on its proper hook by the bed. No nurse is to attend a patient, or touch a bed or articles at a bed, without putting on the gown reserved for the patient in that bed.

8. Each patient is to have his own thermometer, pulse-glass and pencil. If thermometer or pulse-glass is broken, it is to be replaced at once. Pulse-glass and pencil are always to be attached to board on wall behind patient's bed. Knife used to sharpen pencil is to be sterilized immediately after use.

9. Patient's papers and holder are never to be taken away from bed. All charting is to be done with pencil attached to board.

10. Meals are to be carried into ward on tray and distributed from centre cabinet. All articles after use are to be collected with long forceps and placed in tray of china sterilizer. Tray is to be taken to kitchen, scraps scraped off into refuse pail, and plates, etc., sterilized by boiling for 10 min. They are then washed up by maid.

11. Bedpans and urinals are to be well cleaned in sluice, jet being worked by foot-pedal, and then placed in disinfectant. Stethoscope and other instruments used are to be sterilized as the Medical Officer directs. When boiled, articles are to be entirely under water for fully 10 min.

12. When taking used linen from bed to bunker, the nurse must wear gown belonging to bed and return it at once to its proper hook. When counting linen a special gown reserved for the purpose is to be worn.

13. When linen is stained with discharge and has to be removed, nurse is to place fresh linen at bed. She is then to put on gown reserved for that case, take stained linen from bed, fold stained part inside and, while still wearing gown, take linen to pail in sink room. She is always to lift lid of this pail with hook provided for that purpose. She must then return to patient's bed at once, and finish arranging it.

14. Flannel articles are to be sent to laundry in the usual way. They are not to be sent to be stoved or put in foul tank. If any article is soiled by faeces, soiled part is to be washed in a bowl, dried and sent to laundry with ordinary washing.

15. After patient has been discharged from ward, nurse wearing gown belonging to case is to strip bed, take linen and blankets to bunker, and pack pillows under mattress cover. Mattress and pillows are to be taken at once to be stoved. Bed mackintosh, batiste pillow cover, hair comb, metal paper-holder, thermometer and its glass holder and glass part of pulse-glass are to be soaked in Lysol, $\frac{1}{2}$ oz. to 1 pint of water, for 1 hr. Soap, face flannel, pencil and string are to be destroyed. Soap dish and metal part of pulse-glass are to be boiled for 5 min. Patient's card and papers are to be stoved. Nurse is to put used gown in bunker, scrub hands, put on fresh gown and wash down bed with Lysol, 1 oz. to 1 pint of water. Gown is then taken to bunker. Maid is to wash floor under and around bed. Bed is to be made up for new patient with stoved mattress and pillow, and fresh bedclothes.

16. All dusting is to be done with dusters soaked in Lysol, 1 oz. to 1 pint of water,

a separate duster being provided for dusting locker, wall board, wall behind bed, and chair of each patient, and the common ward duster being used for window ledges, tables, etc.

17. Floors are to be swept with 'Dusmo', or vacuum-cleaned.

18. Patients are to have no playthings, books or papers.

19. Convalescent patients are to be instructed to walk to middle of ward and then straight out to fresh air. When sitting up, a convalescent patient is not to go more than 4½ ft. from his bedside.

20. All the above precautions may be rendered useless by slight acts of carelessness on the part of the staff. The rules must therefore be stringently obeyed. For the safety of the patients, the sister must report to the matron any infringement of the rules. If the sister considers that, as a result of the infringement, a particular patient or patients have been cross-infected, she is to report the matter to the medical superintendent also.

ROUTINE OF INVESTIGATION

As far as possible, alternate patients were admitted to block A and to block B.

From all patients and members of the ward staff, swabs were taken from the throat and from any suppurative lesion found (*a*) on admission, (*b*) at a routine weekly swabbing, and (*c*) at the onset of any complication.

Blood-agar plates, inoculated with the swabs, were examined for colonies of haemolytic streptococci after 18 hr. incubation aerobically at 37° C. One colony from each plate was suitably subcultured for examination by the slide agglutination method of Griffith (1934), and assigned, where possible, to one of his thirty serological types. Where more than one colonial form of haemolytic *Streptococcus* were observed, one of each form was picked for serological testing.

RESULTS OF INVESTIGATION

A summary of the results of the investigation for the period from 19 January to 18 May 1938, during which time both blocks A and B were in use, is given in Table 1. The criterion of a cross-infection was taken to be the appearance in a particular patient of a Griffith type of *Str. pyogenes* different from that present on admission.

Table 1. *Incidence of cross-infection by Str. pyogenes among scarlet-fever patients nursed by ordinary methods (block A) and by bed isolation methods (block B)*

	Block A ordinary	Block B bed isolation
No. of patients in block	74	62
No. of patients cross-infected once	10	12
No. of patients cross-infected twice	4	2
No. of patients cross-infected thrice	1	0
Percentage of patients cross-infected	20.3	22.6

Table 1 indicates that the bed isolation nursing of scarlet-fever patients in block B was not effective in reducing the incidence of cross-infection below that in block A, nursed by the ordinary method. The mode of spread of *Str. pyogenes* could not be ascertained, since at the time of each cross-infection

there were among the patients more than one possible source of the added type. It did not appear that the throats of the ward staff, 25% of whom were carriers of *Str. pyogenes* at some time during the investigation, played an important part in the spread of the infection. Although one nurse in the bed isolation block was an intermittent carrier of Type 3 *Str. pyogenes*, only four cases of cross-infection with Type 3 occurred in that block. Since this was a common type among the patients at the time, it was not possible to tell whether the infection had been spread by the nurse or by the patients. Otherwise the types causing cross-infection among the patients were not represented in the throats of the staff at the time of the cross-infection.

The failure to reduce the incidence of cross-infection led us to consider whether some factor, uncontrolled by bed isolation nursing, was more important than contact infection in the spread of *Str. pyogenes*. Our attention turned to the ward dust as a possible infecting agent. Blood-agar plates planted with very small quantities of dry dust from the floor of the scarlet-fever wards showed confluent haemolysis due to streptococci of Griffith types represented among the patients at the time of sampling. In view of this finding, we decided to repeat the investigation in the bed isolation block during the first 6 months of 1939, instituting, as an additional precaution against dust-borne infection, vacuum cleaning instead of sweeping the floors. A more detailed survey was made, both nose and throat swabs being taken twice weekly from the patients and ward staff. Unfortunately, this work was not completed, as the strains of haemolytic streptococci isolated were destroyed as a precautionary measure at the outbreak of war, when only about half of them had been typed serologically. The incomplete results sufficed, however, to demonstrate that cross-infection was still occurring in the bed isolation block, although we could not tell in what degree.

DISCUSSION

The incidence of cross-infection among scarlet-fever patients in our bed isolation wards was not reduced below that in our ordinary wards. We must conclude therefore that the bed isolation nursing technique practised in our wards was not effective in reducing cross-infection. So far as we are aware the rules for bed isolation nursing were conscientiously carried out by the nursing staff. These rules were designed to eliminate the occurrence of contact infection, but we must ask ourselves in retrospect whether they were adequate to cover every eventuality in the ward life. The opportunity afforded during the war of scrutinizing the nursing practice in a surgical ward at every hour of the night and day makes us hesitate to state that our rules served to meet every need. It is obvious now that a bacteriologist should, for some days at least, have acted as a 'ward observer', being active particularly during the busiest ward hours, for example, from 5 to 9 a.m. when washing, bedmaking, sweeping, dusting and breakfasting are in full swing. Such an investigation might have pointed to useful adjustments in the 'bacteriological weighting'

of the rules. It might have been found that some of the rules could with safety be relaxed, while others should be more strictly enforced. Additional precautions might have appeared advisable.

Even if, however, all channels for contact infection in a scarlet-fever ward are effectually closed, it must be remembered that other, possibly more important, channels still remain open. Droplet-borne and dust-borne infection must be considered. With regard to the former, a bed spacing of 12 ft., as was the case in our wards, would seem to preclude its being an important mode of transference from patient to patient, since droplets expelled in speaking or coughing do not, according to Hare (1940), travel more than 18–24 in. in a horizontal direction, but describe a curved path downwards. The nurses' throats did not appear to play an important part in the dissemination of infection in our wards, but they must be regarded as a potential risk. Undoubtedly the dust was heavily infected with *Str. pyogenes*, which would be disseminated into the ward air by sweeping and possibly by vacuum cleaning. In addition, at bedmaking times *Str. pyogenes* in large numbers would be scattered into the ward air, for, as Thomas & van den Ende (1941) have shown, these organisms accumulate upon the bedclothes of any patient with a *Str. pyogenes* infection of the upper respiratory tract and are showered off when the bed is made.

The question arises whether cross-infection can be eliminated in a multiple-bed scarlet-fever ward by the precautionary methods at our present disposal, or whether structural subdivisions must be resorted to. To enable a decision to be reached an investigation into the incidence of cross-infection in a multiple-bed ward, in which all modes of spread of *Str. pyogenes* are controlled, would be necessary. The following conditions would require to be fulfilled.

(1) *Control of contact infection*

- (a) The patients should be nursed by the bed isolation method.
- (b) Before and during the work, the nursing technique should be critically examined by a bacteriologist and any flaws remedied. The bacteriologist should preferably work in a side laboratory off the ward in order to have easy access to it at all times.

(2) *Control of air-borne infection*

- (a) Bedclothes should be treated with liquid paraffin (van den Ende, Edward & Lush, 1941; Thomas & van den Ende, 1941) or with technical white oil (van den Ende & Thomas, 1941) in order to reduce the numbers of *Str. pyogenes* scattered into the air during bedmaking.
- (b) Floors of ward and passages should be treated with spindle oil in order to reduce the amount of infective dust raised by sweeping (van den Ende, Lush & Edward, 1940; Thomas, 1941).
- (c) All dusting should be done with damp dusters.
- (d) The mattress and pillow of each bed should be steam sterilized at the beginning of the work and after each discharge of a patient from the bed.

(3) *Control of droplet infection*

- (a) Overcrowding of patients should be avoided, a minimum of 12 ft. between bed centres being maintained.

(b) Ward staff should wear masks while on duty in the ward.

(c) Convalescent patients should pass directly to the open air; at other times they should be restricted to their bed area.

Since the question of hospital design will arise during the period of post-war reconstruction, it is of great importance to decide whether the multiple-bed scarlet-fever ward can be made proof against cross-infection. Similar problems arise with regard to the nursing of diphtheria patients, among whom cross-infection has also been demonstrated (Glass & Wright, 1938), though it occurred in reduced amount under bed isolation conditions (Wright, Shone & Tucker, 1941).

SUMMARY AND CONCLUSIONS

1. The incidence of cross-infection with *Str. pyogenes* during a period of four months was compared in two blocks occupied by scarlet-fever patients. One block was nursed by the bed isolation method and the other by the ordinary method in current use for multiple-bed wards.

2. The rules for the bed isolation block are given.

3. The incidence of cross-infection with *Str. pyogenes* among patients in the bed isolation block was 20.3%, that among patients in the ordinary block 22.6%.

4. We concluded that the bed isolation nursing technique practised was not effective in reducing cross-infection with *Str. pyogenes* among scarlet-fever patients.

5. A further test of bed isolation nursing was made for six months, using the extra precaution of vacuum-cleaning the floors. We found that cross-infection was still occurring, but the incidence could not be estimated since the *Str. pyogenes* strains isolated had to be destroyed at the outbreak of war. At this time the serological typing had not been completed.

6. The importance of dust-borne and droplet-borne infection in addition to that of contact infection is discussed. The type of investigation required to decide whether cross-infection in multiple-bed scarlet-fever wards can be eliminated by the methods at our present disposal is outlined.

The investigation was suggested to us by Drs S. D. Elliott and S. L. Wright, and the late Prof. C. C. Okell, all of whom gave us much help and encouragement. Dr A. Fairgrieve Adamson kindly allowed the ward work to be undertaken at the Hendon Isolation Hospital and Prof. A. A. Miles the bacteriological work at University College Hospital Medical School, London. The late Dr F. Griffith provided us with the streptococcal sera and gave us much helpful advice with the typing. We are especially indebted to the Matron of the Hospital and the Sisters and Nurses of the wards for their enthusiasm and co-operation.

We are indebted to the Medical Research Council for a Fellowship in Clinical Science held by one of us (J. W.) and for a personal grant made to another (E. W.).

REFERENCES

- ALLISON, V. D. & BROWN, W. A. (1937). Reinfection as a cause of complications in scarlet fever wards. *J. Hyg., Camb.*, **37**, 153-71.
- GLASS, V. & WRIGHT, H. D. (1938). Cross-infection in diphtheria wards. *J. Hyg., Camb.*, **38**, 248-54.
- GRIFFITH, F. (1934). Serological classification of *Streptococcus pyogenes*. *J. Hyg., Camb.*, **34**, 542-84.
- HARE, R. (1940). The expulsion of haemolytic streptococci by nasopharyngeal carriers. *Canad. Publ. Hlth J.* **31**, 539-55.
- RUNDLE, C. & BURTON, A. H. G. (1912). The bed isolation of cases of infectious disease. *Lancet*, **1**, 720-1.
- THOMAS, J. C. (1941). Reduction of dust-borne bacteria by oiling floors. *Lancet*, **2**, 123-7.
- THOMAS, J. C. & VAN DEN ENDE, M. (1941). The reduction of dust-borne bacteria in the air of hospital wards by liquid paraffin treatment of bedclothes. *Brit. Med. J.* **1**, 953-8.
- VAN DEN ENDE, M., EDWARD, D. G. FF. & LUSH, D. (1941). Reduction of dust-borne infection by treatment of bedclothes. *Lancet*, **1**, 716-18.
- VAN DEN ENDE, M., LUSH, D. & EDWARD, D. G. FF. (1940). Reduction of dust-borne bacteria by treating floors. *Lancet*, **2**, 133-4.
- VAN DEN ENDE, M. & THOMAS, J. C. (1941). Treatment of bedclothes with dust-laying oils. *Lancet*, **2**, 755-9.
- WRIGHT, H. D., SHONE, H. R. & TUCKER, J. R. (1941). Cross-infection in diphtheria wards. *J. Path. Bact.* **52**, 111-28.

(MS. received for publication 19. I. 42.—Ed.)