PRIVY COUNCIL

MEDICAL RESEARCH COUNCIL
MEMORANDUM
No. 11
(*Revised Edition*, 1951)

The Control of Cross Infection in Hospitals

BY

THE CROSS INFECTION IN HOSPITALS COMMITTEE
OF THE MEDICAL RESEARCH COUNCIL

LONDON
HER MAJESTY'S STATIONERY OFFICE
THREE SHILLINGS NET

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THE CONTROL OF CROSS INFECTION IN HOSPITALS

BY

THE CROSS INFECTION IN HOSPITALS COMMITTEE OF THE MEDICAL RESEARCH COUNCIL

INTRODUCTION

THE Subcommittee on Cross Infection in Hospital Wards, appointed by the Preventive Medicine Committee of the Medical Research Council in 1939, made the preparation of a special report on the control of cross infection one of its first objectives. It found, however, that many of the proposed recommendations, particularly with regard to the structure of hospitals, were impracticable under war conditions. A War Memorandum (No. 11) was accordingly prepared instead, in the hope that, in face of the many difficulties, some attempt would be made to reduce the incidence of infections contracted unnecessarily in hospital.

Since the Memorandum first appeared in 1944, the Subcommittee responsible for its preparation has been reconstituted as the Committee on Cross Infection in Hospitals. The present revision is the work of this Committee and has been chiefly concerned with points of practical detail and the amplification of certain specific procedures. It has not affected the main recommendation for the control of cross infection. The observations made by Sir Wilson Jameson (then Chief Medical Officer of the Ministry of Health and Chairman of the Preventive Medicine Committee) in the introduction to the earlier edition are therefore equally applicable here, and they are repeated below to all intents and purposes without change.

Cross infection is most apparent and most dangerous amongst infants and juvenile patients, and the Memorandum deals mainly with children's wards in general hospitals and hospitals for infectious diseases. But although adults have acquired relative immunity to the common infections of childhood they are none the less vulnerable to certain pyogenic and other micro-organisms, and many of the infections of wounds, burns, and the placental site are contracted in hospital. The principles of the spread of cross infections, and the measures advocated for their control, therefore apply to all hospital wards. The risks are greatest in wards for the treatment of infectious diseases and of ear, nose, and throat conditions, where sources of cross infection are inevitably present, but precautions must be taken in every ward, not excepting those containing "clean" (e.g. maternity and non-infected surgical) cases.

Factors of obvious importance are proper building and sufficient equipment, but alterations and improvements in these respects may in many instances have to wait until labour and material are available. Given good ventilation and bed spacing, the control of cross infection turns largely on three things: adequate isolation accommodation, adequate sterilization and disinfection equipment, and sufficient trained staff to maintain a meticulously careful technique. Serious deficiencies in one or more of these essentials exist in many hospitals, but the Committee believes that conditions could be improved. For example, the best

use should be made of all trained staff, and they should not waste on unskilled tasks effort better spent on acquiring and practising a good technique. Bad tools may be an excuse for bad work and much valuable time is lost on account of insufficient and inefficient equipment. Deficiencies should be recognized and, when replacements cannot be procured, necessity may beget invention. Much can be done by improvisation with the help of hospital engineers and carpenters.

Every hospital should have a clear idea of its working procedure in the control of cross infection. The scheme will depend upon numerous local considerations—for example, the design and scope of work of the hospital, and whether it is a short-stay or long-stay hospital. Such a scheme might well be prepared by a committee representing doctors, nurses, laboratory workers, and administrators (for cross infection affects the work of all), and it should be the basis for standing orders which all hospital personnel would be required to know and obey. The committee might also make plans for the detection and investigation of outbreaks, and for arranging courses of instruction for the staff. In hospitals where such courses have been given, the nurses have shown much interest in them. They have welcomed particularly the laboratory demonstrations and practical classes because these have given them an explanation and understanding of practices that they had previously learnt only by rule-of-thumb. The present Memorandum may well serve as a guide for the instruction of nurses and students, and it contains, in an Appendix, suggestions for the demonstration in the laboratory of certain problems of cross infection.

Hospital committees and administrators are reminded that cross infection is a steady drain on the hospital purse and efficiency. Overhead expenses continue and admissions are delayed while wards are in quarantine. Individual patients detained on account of intercurrent disease may even die, and are, in any case, a continuing source of anxiety and expense. For these reasons, requests for improvements and equipment calculated to lessen the risk should receive careful attention. When building is contemplated, the prevention of cross infection should be an overriding consideration, and expert advice should be sought.

The Committee on Cross Infection in Hospitals is indebted to many medical superintendents, medical officers of health, resident medical officers, matrons, ward sisters, and nurses for their help and advice, and in particular, it thanks the Sister Tutor Section of the Royal College of Nursing, whose special Advisory Subcommittee has given great assistance.

I. PREVALENCE AND CONSEQUENCES OF CROSS INFECTION

WHEREVER healthy children congregate, whether in home, school, or nursery, there is always a danger that infection may spread among them. Additional risks arise when sick children are housed together in hospital, for they are liable, by reason of their primary disorder, to suffer more seriously than healthy children, should they become infected. Moreover, some of them are certain to be sources of infection to others.

Medical officers of infectious diseases hospitals have long been keenly aware of the risks of cross infection with specific fevers, and have taken measures to minimize their spread. The danger, however, is not limited to fevers that present a clear-cut clinical picture and a predictable epidemiological pattern. The problem today also includes those cross infections which are less easily recognizable as such, and which do not produce unmistakable clinical effects. These may occur both in general and in infectious diseases hospitals, and are particularly insidious among groups of infants and young children. Recent bacteriological advances have linked into a chain of connected events many infections which, on account of their varied clinical manifestations, had previously appeared unrelated. The meaning of the term "cross infection" has become wider and it now includes this miscellany of non-specific infections, as well as the specific fevers; it covers today any infection acquired in the hospital environment.

Clinically, cross infection is manifested as respiratory, gastro-intestinal, wound, skin, or mucous membrane infection, arising during the course of another disease. Bacteriologically it implies the acquisition by a patient of pathogenic micro-organisms not present on admission to hospital.

RESPIRATORY INFECTION

The most prevalent type of cross infection is respiratory. It takes a variety of forms, e.g. the common cold and other forms of nasopharyngitis, sinusitis, tonsillitis, otitis media, bronchitis, and pneumonia. If tonsillitis due to haemolytic streptococci is accompanied by a rash, it is known as scarlet fever. In infants, respiratory infection may not assume one of these definite forms, but gastro-intestinal disturbances may predominate and lead to wasting, with otitis media, pneumonia, pyuria or skin sepsis. Respiratory infection accounts for much of the sickness (McKhann, Steeger, and Long, 1938) and many of the deaths among infants in hospital.

Haemolytic streptococci, pneumococci, and staphylococci are the most frequent causal bacteria. The classification of haemolytic streptococci into Lancefield groups A-O and the identification of serological types of these organisms (Griffith, 1934) have made it possible to trace their spread, and surveys in wards have repeatedly disclosed successions of outbreaks, each due to a particular serological type of streptococcus. The clinical effects produced by one and the same type vary from patient to patient, and, in addition to respiratory conditions, they may include wound sepsis, puerperal sepsis, erysipelas, impetigo, etc. (Keevil and Camps, 1937; Bradley, 1938). In multiple-bed scarlet fever wards, as many as 70 per cent of the patients may become cross-infected with a type of haemolytic streptococcus different from that of the primary disease, and these cross infections are responsible for many of the

late complications and second attacks (Allison and Brown, 1937). A survey in a measles ward revealed that 50 per cent of the patients acquired haemolytic streptococci during their time in hospital and that, as a result, 19 per cent of all the patients developed otitis media (Allison, 1938).

Cases of diphtheria occur in general and infectious disease wards for children. Bacteriological cross infection by *gravis*, *intermedius*, and *mitis* types of diphtheria bacilli occurs in diphtheria wards (Wright, Shone, and Tucker, 1941). Though without clinical significance, this leads to delay in obtaining negative discharge swabs, owing to prolongation of the carrier state.

The viruses of measles and chickenpox gain entrance through the upper respiratory tract. Owing to their high infectivity, they frequently cause outbreaks which are difficult to control. Outbreaks of whooping cough, rubella, infective hepatitis and mumps also occur, but less frequently.

Thrush may spread among newly born infants in maternity wards and has been known to prove fatal (*British Medical Journal*, 1950).

GASTRO-INTESTINAL INFECTION

The spread of gastro-enteritis in wards may be responsible for a high morbidity and fatality rate among bottle-fed infants in hospital (Royal Society of Medicine, 1941). Weakly or premature infants are particularly susceptible, but healthy infants admitted, for example, for minor operations may also become infected. The case fatality rate may reach 70 per cent, but prompt and adequate treatment will reduce the deaths to a comparatively low figure (Alexander, 1948; Medical Research Council, 1952). Primary gastro-enteritis of infants behaves as if caused by a specific micro-organism infecting the bowel and excreted in the stools. Dysentery and salmonella bacilli (Mushin, 1948) have been isolated from some of the patients, but in the majority no pathogenic organism has been found. Attention has been directed during recent years to a close association of two serological types of *Bact. coli* with cases of infective infantile gastro-enteritis (Bray, 1945; Giles, Sangster, and Smith, 1949; Taylor, Powell, and Wright, 1949). Secondary gastro-enteritis of infants is associated with and possibly caused by infection elsewhere in the body, usually of the respiratory or urinary tract and produced by a diversity of bacteria.

Epidemic diarrhoea of the newborn occurs among infants in maternity units. It is a highly fatal infection. Several outbreaks have been recorded in this country (Ormiston, 1941; Sakula, 1943; Kirby, Hall, and Coackley, 1950) and many in the United States (Rice, Best, Frant, and Abramson, 1937; Abramson, 1950). No specific causal agent has been isolated, in spite of careful bacteriological investigation (Crowley, Downie, Fulton, and Wilson, 1941). Outbreaks of diarrhoea affecting both mothers and infants in maternity units have also been reported (Cook and Marmion, 1947). This infection is usually mild and its aetiology is probably different from that of epidemic diarrhoea of the newborn.

Bacillary dysentery not uncommonly spreads in children's wards. It may prove fatal to infants and young children, especially if they are wasted or weakly. Older children usually suffer from a mild attack of diarrhoea, with or without blood and mucus in the stools, and recover in a few days. Missed cases and carriers, both convalescent and contact (see p. 10), are common. The causal organism is most commonly *Bact. sonnei* (Pygott, 1938) and less frequently *Bact. flexneri*. Enteritis associated with *Giardia lamblia* is probably more frequent than has previously been believed (Brown, 1948).

Outbreaks of typhoid and paratyphoid fevers occasionally occur (Simpson, 1939). They are usually due to the use of food, milk, or ice infected by a carrier among the food-handling staff either of the hospital or the suppliers. They may also result from the transfer of infection from a convalescent or carrier patient, or especially from a mild unrecognized case. Outbreaks of food poisoning (Wilson, 1949) affecting patients or nursing staff, or both, may also occur. The two main types are (*a*) the infection type due to salmonellae and (*b*) the toxin type due to staphylococcal enterotoxin. Salmonella food poisoning may be due to the ingestion of food from infected animals (duck eggs, pork products, milk) or contaminated by human carriers or infected rodents. Secondary cases may occur through cross infection in hospital (Garrod and McIlroy, 1949). Staphylococcal food poisoning arises from contamination of food with enterotoxin-producing staphylococci derived from the nose or hands of carriers. Food infected with salmonellae is rendered innocuous by thorough cooking but staphylococcal enterotoxin is not destroyed by boiling. Both salmonellae and staphylococci multiply in the contaminated food if it is kept in a warm place. Foods such as made-up meat and fish dishes and sweets containing custard, ice cream, cream or milk are particularly favourable to bacterial growth.

WOUND INFECTION

Pathogenic bacteria may be introduced to a clean wound (Miles, Schwabacher, Cunliffe, Ross, Spooner, Pilcher, and Wright, 1940; Williams, Clayton-Cooper, Howat, and Miles, 1945) or burn (Medical Research Council, 1944a; Colebrook, Duncan, and Ross, 1948) or to an already infected wound or abscess. The resulting infection may cause delay in healing, abscess formation, erysipelas, cellulitis, or septicaemia. The breaking down of a wound, e.g. a cleft palate incision or a skin graft, may nullify the expected benefit of the operation. The tonsillar and adenoidal beds after operation are especially liable to infection, which may lead to otitis media or mastoiditis (Okell and Elliott, 1936). Haemolytic streptococci, staphylococci, and Gram-negative bacilli, including the coliform group, *Proteus*, and *Ps. pyocyanea*, are the commonest organisms causing cross infection of wounds (Medical Research Council, 1941; Florey, Ross, and Turton, 1947). One or other of the serological types of haemolytic streptococci may produce an outbreak of concurrent respiratory and wound infection.

SKIN AND MUCOUS MEMBRANE INFECTION

Impetigo, ringworm of the hairy scalp, scabies, and pediculosis are liable to spread in wards. In maternity units, outbreaks, which may be serious, of pemphigus due to staphylococci are not uncommon among newly born infants. Staphylococci often cause infections, such as mastitis, among the mothers, and other infections, such as conjunctivitis, among the infants. Serological and bacteriophage typing of staphylococci are adding to our knowledge of the sources and paths of spread of these organisms (Allison and Hobbs, 1947; Barber, Hayhoe, and Whitehead, 1949).

Of mucous membrane infections other than those of the upper respiratory tract, conjunctivitis and vulvo-vaginitis are the most important. Vulvo-vaginitis may be caused by a number of organisms, including haemolytic streptococci and gonococci. Gonococcal vulvo-vaginitis is not common, but it tends to spread rapidly unless stringent precautions are taken (London County Council, 1938).

II. SOURCES AND MODES OF INFECTION

1. THE sources of infection in a hospital may be listed as follows:

(*a*) The clinical case in which the infection is evident by its signs and symptoms.

(*b*) The missed case in which, owing to the triviality of the symptoms or to lack of proper care, infection fails to be recognized.

(*c*) The patient in the incubation period of an infection, who may be infectious before the onset of the disease.

(*d*) The carrier. A person either convalescent from a clinical infection (convalescent carrier) or having no obvious disturbance of health (contact or "healthy" carrier) may harbour infectious organisms. The symptomless carriers in outbreaks of certain infectious diseases not uncommonly outnumber the clinical cases. They are a danger to others because their infection passes unrecognized unless discovered by bacteriological investigation. Most of the convalescent and symptomless carriers are temporary carriers, but in certain infections a small proportion persist and are known as chronic carriers.

2. The spread of infection is by the secretions, excretions, and discharges of patients, staff, and visitors:

(*a*) Respiratory: nose and throat secretions; ear and mastoid discharges; sputum.

(*b*) Gastro-intestinal and urinary: faeces; vomit; urine.

(*c*) Cutaneous: discharges from septic skin lesions; discharges from mucous membranes, e.g. conjunctiva, vagina.

(*d*) Wounds: discharges from septic wounds, burns, and abscesses.

3. The modes of spread of infection in a hospital are by direct contact, by a variety of vectors ("mediate infection"), by droplets, and by dust.

CONTACT AND MEDIATE INFECTION

By persons. The skin, particularly of the fingers and hands, of patients and staff is liable to contamination by contact with their own and other persons' infected secretions, excretions, and discharges; with articles contaminated by these; and with dust from furniture, floor, personal clothes, etc. Bacteriological tests have shown that fingers and hair bear upon them organisms identical with those found in the throat and nose of the individual examined (Hare, 1941). Nurses, on account of their work, are especially liable to respiratory tract infections and septic skin conditions, such as boils and whitlows (Court, 1949); infective pus from these lesions may be carried on the fingers.

By clothes. Personal clothes of hospital staff may become contaminated with discharges, etc., during their ward duties, and may thus carry infection to others. Widespread contamination of the clothing of persons harbouring pathogenic bacteria, e.g. haemolytic streptococci, in the throat (Hare, 1941), and more particularly in the nose (Hamburger and Green, 1946), has been demonstrated. Handkerchiefs (Dumbell, Lovelock, and Lowbury, 1948), and the pockets in which they are carried, become heavily contaminated with naso-pharyngeal organisms.

By ward articles. Every article in a ward, unless it has been sterilized, has living bacteria upon it. This contamination may be due to settling of infected

dust, to handling by persons, or to contamination by infected excretions, etc., of the patients or staff.

Organisms from the respiratory tract—e.g. haemolytic streptococci, diphtheria bacilli, pneumococci, tubercle bacilli—may be carried on thermometers (Green and Penfold, 1947), china, cutlery, pencils, toys, sputum mugs, spatulas, nasal and throat instruments, etc.

Organisms from the gastro-intestinal and urinary tracts—e.g. coliform, dysentery, paratyphoid, typhoid bacilli—may be carried on bedpans,

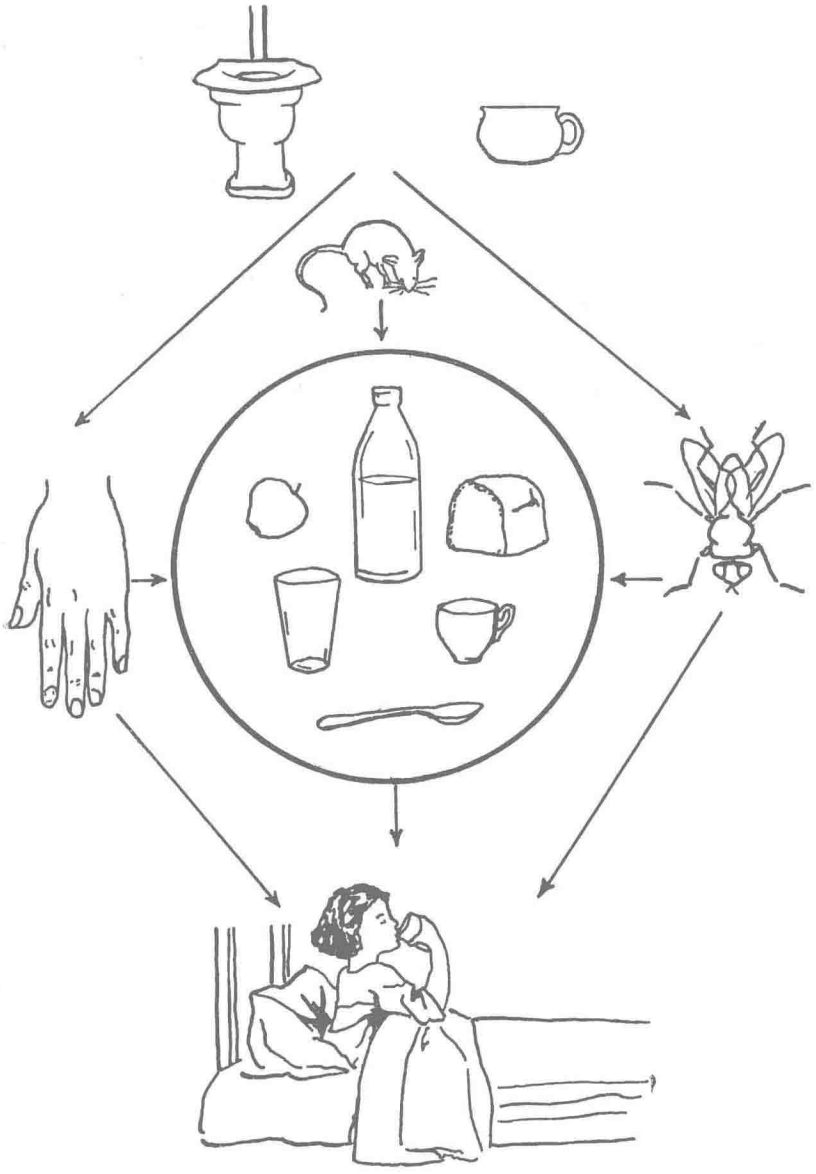

FIG. 1. Diagram illustrating the spread of gastro-intestinal infection

urine bottles, chambers, infants' napkins, vomit bowls, rectal thermometers, etc.

Organisms from wounds and abscesses—e.g. staphylococci, haemolytic streptococci—may be carried on surgical instruments, dressings, bandages, plasters over wounds, etc.

If articles are not disinfected between each use by different patients, there is a risk that they may transfer pathogenic organisms from one person to another.

By food. Unless food and milk are stored in scrupulously clean, covered containers, they are liable to contamination. Since they promote bacterial growth, their bacterial content increases with storage, unless they are kept in a cool place.

By insects. Flies and other insects may act as mechanical vectors of pathogenic organisms. They may transfer gastro-intestinal bacteria from faecal matter to food and milk.

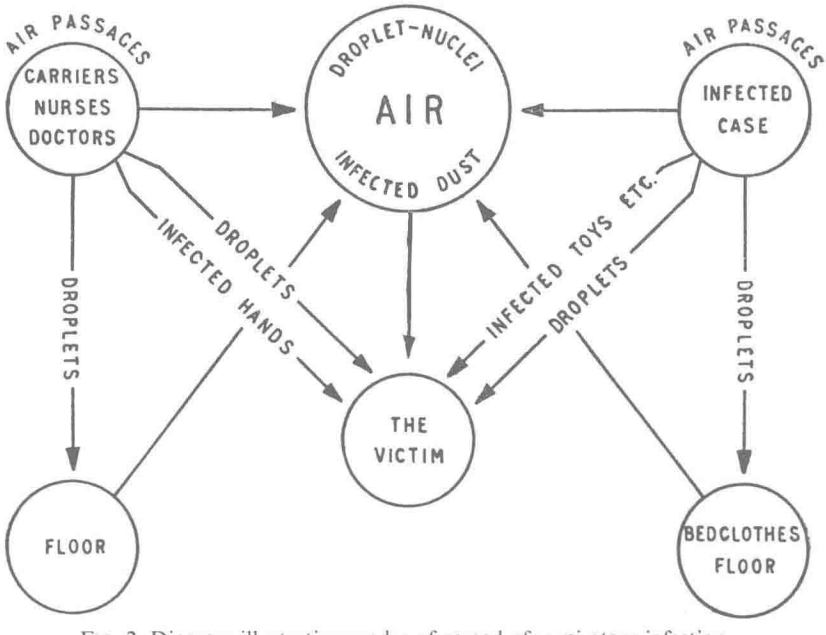

FIG. 2. Diagram illustrating modes of spread of respiratory infection

DROPLET-BORNE INFECTION

Minute droplets containing bacteria are projected from the mouth and nose for 2 to 6 feet through the air during talking, coughing, or sneezing (Hare, 1940; Bourdillon and Lidwell, 1941). The larger droplets describe a curved path downwards and may directly infect the nose, throat, eye, or wound of a person in close proximity. Alternatively, they may fall on ward equipment, e.g. a dressing trolley, and infect sterile materials or instruments upon it. Often they fall on bedclothes, personal clothes, or on to the floor of the ward, where they dry and may finally contribute to the bacterial content of the ward dust. Smaller droplets may evaporate, and leave suspended in the air minute infected particles, known as droplet nuclei (Wells and Wells, 1936). These may transmit infection for a considerable distance.

DUST-BORNE INFECTION

Bacterial counts of ward air always show considerable rises at the time when the dust content is highest, i.e. at bedmaking and sweeping times (Brown and Allison, 1937, and see Figs. 3 and 4).

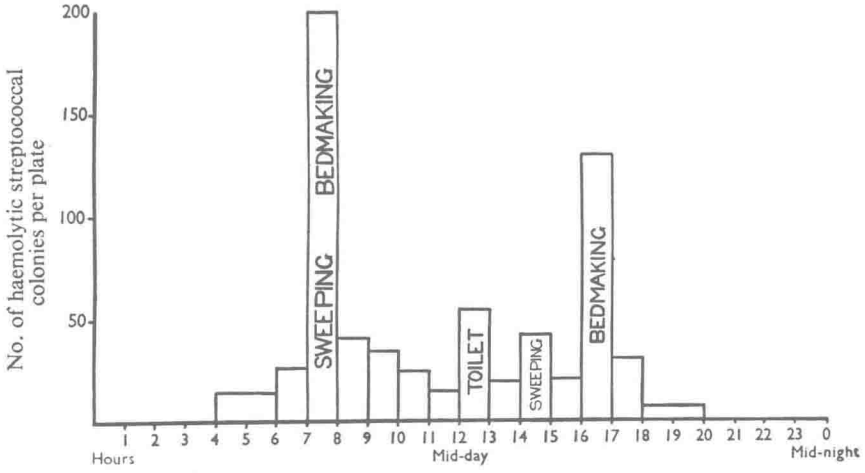

FIG. 3. Variations in the numbers of haemolytic streptococci in ward air during 24 hours

Dry sweeping raises the dust and therefore increases the bacterial content of the air. The dust eventually settles on the furniture of the ward, on the patients themselves and on their bedclothes, food, toys, crockery, etc. It is actively inhaled into the respiratory tract of persons in the ward, and bacteria may thus become implanted on susceptible tissues and set up infection (Cruickshank and Godber, 1939).

Floor dust often contains large numbers of pathogenic bacteria, which may remain alive and infective for weeks, or even months, in a dry state. They are especially abundant in the dust of wards where patients with upper respiratory tract infections are being nursed. Nasal infections with streptococci lead to a heavier contamination of the environment than do throat infections (Hamburger

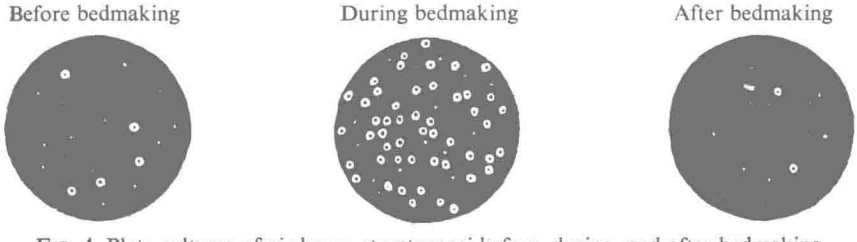

FIG. 4. Plate cultures of air-borne streptococci before, during, and after bedmaking

and Green, 1946). It has been estimated that in the floor sweepings of an ear, nose, and throat ward 100,000,000 haemolytic streptococci were present (Thomas and van den Ende, 1941). Large numbers of virulent diphtheria bacilli have been isolated from the floor dust of diphtheria wards (Crosbie and Wright, 1941).