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# A study of Door Pulls on Isolation Carts in a General Hospital for Evidence of Contamination

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# A STUDY OF DOOR PULLS ON ISOLATION CARTS IN A GENERAL HOSPITAL FOR EVIDENCE OF CONTAMINATION

by

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Each person whose signature appears below certifies that he has read this thesis and that in his opinion it is adequate, in scope and quality, as a thesis for the degree of Master of Science.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# CHAPTER I

## THE PROBLEM AND DEFINITIONS OF TERMS USED

Hospital infection is a problem common to institutions for the sick throughout the world.[1] It is not unique to hospitals of this country. This fact is in evidence by the number of articles in medical journals dealing with this topic. This new surge of interest is quite recent even though hospital infections have been on the increase in the past ten years.[2] This is "the big--and unfortunate--story of medicine today."[3]

With the discovery of antibiotics about twenty-two years ago came the inevitable let-down of standards of aseptic technique.[4] A false sense of security was seen in the medical and nursing ranks. This false sense of security was relatively short lived as the statistics revealed a steady increase in hospital infections.

Attention has now returned to methods by which infections can be prevented from spreading. The most important factor in this regimen is maintenance of isolation of the patient with all that such a regimen

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[1]Ralph Adams, "Prevention of Infections in Hospitals," American Journal of Nursing, 58:344, March, 1958.

[2]Helen Harder and Margaret Panuska, "Staphylococcal Infections," American Journal of Nursing, 58:349, March, 1958.

[3]"Hospital Infections," American Journal of Nursing, 58:343, March, 1958.

[4]Carolee Balcom and Helen Palmer, "Responsibility of the Nurse in the Control of Cross-Infections," Canadian Nurse, 58:138, February, 1962.

entails.[5] "We know and know, positively, that it is the only proven way to prevent cross-contamination."[6]

The procedure of isolation is of utmost value in preventing the spread of contamination to other patients as well as to protect the isolated patient; and this value is completely lost if all concerned with the patient do not rigidly follow aseptic technique. The isolation procedure is only as strong as its weakest link.[7]

## I. NEED FOR STUDY

Most hospital infections have their source in infected patients.[8] Wysham and Kirby feel that this is possibly "the most serious current communicable disease problem."[9] In an attempt to control such a situation, most authorities on the subject agree that isolation of the infected person, combined with strict asepsis in working with these patients, is one of the major ways of preventing the further spread of infections.[10]

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[5]Adams, op. cit., p. 347; and Henry J. Sinn, "The Case for Individual Isolation: Its Use in Infectious Diseases and in the Care of Infants," Medical Journal of Australia, 1:4-11, January 7, 1939.

[6]Sister Mary Florence, "Nursing Administration's Role in the Problem of Hospital Infections," Nursing Outlook, 7:646, November, 1959.

[7]Elsie Mattson, "The Communicable Disease Patient," American Journal of Nursing, 41:27, January, 1941.

[8]W. A. Altemeier, "Prevention and Control of Infections in Hospitals," Hospitals, 37:66, May 16, 1963.

[9]Adams, op. cit., p. 344.

[10]Ibid., p. 347; J. J. Golub, "Infections in Hospitals--What the Administrator Should Do Toward Their Control," Hospitals, 14:37, May, 1940; Frank Bradley, "A Six Year Report on Care of Communicable Diseases," Hospitals, 24:62, May 1950; "Hospital Infections," American Journal of Nursing, 58:343, March, 1958; Mattson, loc. cit.; and Altemeier, loc. cit.

Most hospitals have therefore developed some method by which patients with communicable diseases and infections are isolated, depending in part on the physical structure of the institution. Because of this increase in hospital infections, the nursing staff is demanding better techniques and methods. "We need to sit back and evaluate ourselves, take time out to really review our techniques."[11] In order to establish new and better methods of isolation, it is necessary to analyze present day standards.[12] Objects that were once considered clean are now seen to be heavily contaminated.[13] The "classical barriers of accepted isolation technique" have been circumvented by the infectious organisms.[14]

Besides studying the human carrier, consideration must be given to the environment of the hospitalized patient. This includes fomites. "Only through such study can we make real progress toward elimination of the problem."[15]

Altemeier strongly recommended that isolation techniques "be restudied." This would be in the interest of controlling the infections.[16]

The American Hospital Association recommended that aseptic technique used for patients with infections be studied and changes be made to

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[11]Florence, loc. cit.

[12]Ibid., p. 645.

[13]Charles T. Uyeda, "Successful Ways of Controlling Infections," Hospitals, 37:80, July 1, 1963.

[14]Donald Vesley and Marion Brask, "Environmental Implications in the Control of Hospital Acquired Infections," Nursing Outlook, 8:742, December, 1961.

[15]Ibid.

[16]Altemeier, loc. cit.

improve the technique.[17]

Consideration must be given the procedures which are taken for granted. This can only be done by continually evaluating present methods and techniques.

Recently isolation carts have come into use. These carts contain all the clean gowns and other equipment that the nurse might need while giving patient care. It is usually kept outside of the patient's room and considered to be clean, not contaminated. In order to maintain the cleanliness of the cart, aseptic techniques must be rigidly followed; otherwise the cart could well be a source of cross infection. It is, therefore, the intent of this study to find out if the isolation cart is as effective as it is generally considered to be.

## II. THE PROBLEM

### Purpose of the Study

It was the purpose of this study to investigate one aspect of the total picture of the patient isolated with an infection. It was hoped that this would shed new light on evaluating the effectiveness of the isolation cart. Ultimately the purpose of the study was seen in developing a safer environment for the patient, hospital personnel and community.

### Statement of the Problem

The problem was to find out if the door pulls on the isolation cart contained any contamination which could serve as a source of cross infection on a hospital unit.

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[17]"AHA's Recommendations on Prevention and Control of Staphylococcus Infections in Hospitals," American Journal of Nursing, 58:1099, August, 1958.

Hypothesis

The hypothesis for this study was that a clean isolation cart was actually contaminated within a forty-eight hour period after use.

Assumptions

1. The hospital laboratory results were assumed to be correct as the specimens were processed and read in the standard manner for the selected hospital's laboratory.

2. Pathogenic organisms were not introduced by those involved in obtaining and processing the specimens.

3. It was also assumed that the nursing staff did not purposely contaminate the door pulls.

Limitations

1. The study was limited in that only one part of the isolation cart was cultured.

2. The time interval set for forty-eight hours imposed a limitation.

3. Isolation carts in only one hospital were studied.

4. Also as a limiting factor was the length of time in which data were collected--that is, the study extended only over a three-month period.

5. In those patients isolated with infections, no effort was made to find the source of infection--whether it was hospital acquired or not.

## III. DEFINITION OF TERMS

Clean. The absence of pathogenic organisms.

Contaminated. The presence of pathogenic organisms.

Cross infection. The transfer of pathogenic organisms from one person to others with the resultant infective process.

Culture. The process involved in obtaining and growing micro-organisms.

Door pulls. That part of the isolation cart which was used to open and close the sliding doors.

Epidemic. Appearance of infectious disease which attacks many people at the same time in the same area.

Hospital infection. Those infections acquired by patients during hospitalization, their source being in the hospital environment.

Infection. The injurious effects in the body by the invasion of pathogenic organisms.

Isolation cart. That part of the isolation procedure set-up which contained the clean supplies necessary to simplify the technique. It was kept outside of the isolation patient's room.

Specimen. The sample obtained or obtainable from the door pulls on the isolation cart which was representative of any growth.

## IV. METHOD OF STUDY

The descriptive survey was the method chosen for this study. All patients which were isolated for a forty-eight hour period in one selected hospital were used. Cultures were taken from the door pulls of the isolation cart before it was put into use by the nursing staff and then after forty-eight hours of use. The specimens were then processed in the standard manner for the hospital laboratory.

The study extended over a three month interval. Permission was secured from the administration of the selected hospital to conduct the study.

Chapter II contains the review of related literature. Because of the wealth of information regarding infections and their control, it was limited to the past five years. Chapter III tells about the specifics involved in the method of solving the problem. It also contains the analysis and interpretation of the findings of the study. Summarizations, conclusions and suggestions for further study are made in the final chapter.

## V. SUMMARY

With the advent of antibiotics, standards of asepsis were given rein. Many felt that the newly discovered antibiotics removed the need for rigidly upholding such standards. But this thinking was soon found to be erroneous. Hospital infections began increasing in spite of the wonder drugs. Authorities now recommend a return to the basic principles of asepsis with emphasis on developing more effective methods of dealing with infections. It was, therefore, the purpose of this paper to study one aspect of the total regimen involved in the isolation procedure of infection cases. More specifically it was designed to find out if pathogenic organisms were present on the door pulls of the isolation carts used in one hospital.

Assumptions and limitations were established; and the descriptive survey was chosen as the method of study. Appropriate words were defined as were used in the study followed by a preview of succeeding chapters.

## CHAPTER II

## REVIEW OF LITERATURE

Because of the tremendous volume of material written on hospital infections, it was decided to limit the review of literature to the past five years. Possible sources of cross infection as seen on the hospital unit was the guide in developing this chapter. Hinton, Orr, Maltman and Blair felt that an index to the degree of contamination and effectiveness of aseptic control measures could be obtained by establishing the bacterial count on articles within the hospital ward.[18]

It is estimated that anywhere from two to ten percent of the patients on medical services develop staphylococcal infections.[19] On surgical services the lowest expected rate is five-tenths of a percent, the high being ten percent.[20]

### I. INFECTION RESERVOIRS IN THE HOSPITAL UNIT

#### Introduction

Dissemination of pathogenic microorganisms have been categorized by the mode of transmission. These categories are: direct and indirect

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[18]Norman A. Hinton, J. R. Maltman, and J. H. Orr, "The Effect of Desiccation on the Ability of Staphylococcus Pyogenes to Produce Disease in Mice," American Journal of Hygiene, 72:348, November, 1960; and Eugene B. Blair, "Laboratory Surveillance of Hospital Staphylococcal Problems," Medical Annals of the District of Columbia, 30:715, December, 1961.

[19]David E. Rogers, "Staphylococcal Disease on General Medical Service," American Journal of Nursing, 59:843, June, 1959; and Stanford M. Farrer and Colin M. MacLeod, "Staphylococcal Infections in a General Hospital," American Journal of Hygiene, 72:38, July, 1960.

[20]Adams, loc. cit.

contact; droplets, as caused by sneezing and coughing; droplet nuclei which is the remainder of the evaporated droplet; and dust.[21] Hudson, Sanger and Sproul[22] felt that there was insufficient evidence available to say that one of these modes of transmission was more important in increasing hospital infection than is another. Dowling believed that the spread of pathogens was mostly by direct contact and the airborne route but added that there was no proof of this. He suggested closing "all avenues of spread as completely as possible."[23] Altemeier and Wells[24] stated that dissemination took place principally by direct contact and to a lesser degree by inanimate reservoirs. Walter added air currents to direct contact in pinpointing the chief means of transmission of pathogens.[25]

Patients with open infections have been shown to rapidly contaminate their room environment. Wells[26] stated this took place in a matter of a few hours.

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[21]Charles Uyeda, op. cit., p. 79-80; Joseph J. McDade and Lawrence B. Hall, "Survival of Staphylococcus Aureus in the Environment," American Journal of Hygiene, 78:330, November, 1963; and Andre J. Nahmias and Theodore C. Eickhoff, "Staphylococcal Infections in Hospitals (Concluded)," New England Journal of Medicine, 265:178, July 27, 1961.

[22]Perry B. Hudson, Grant Sanger, and Edith E. Sproul, "A System for Control of Pathogenic Bacteria in the Hospital Environment," Medical Annals of the District of Columbia, 28:68, February, 1959.

[23]Harry F. Dowling, "Present-Day Problems of Staphylococcal Infections," General Practioner, 19:135, March, 1959.

[24]W. A. Altemeier, "Surgeons Diagnose the Problem of Infections," Modern Hospital, 92:162, March, 1959; and Arthur Wells, "Staphylococcic Sepsis in Hospitals," Minnesota Medicine, 42:1221, September, 1959.

[25]Carl W. Walter, "Isolation Technic for Containment or Exclusion of Bacteria," Hospital Topics, 42:57, January, 1964.

[26]Wells, loc. cit.

Blankets

When epidemics occur on the hospital unit, blankets are usually among the first items in the environment to be suspected of harboring the causative organism. Gohr suggested that "perhaps the most controversial area in the whole cross-infection problem is the matter of blankets."[27]

Adams, Fahlman, and Gohr felt that blankets should be freed from pathogenic organisms prior to their use by another patient.[28] To avoid confusion with used blankets, Farringer recommended that individual blankets be sealed in plastic after being laundered and returned to the unit this way.[29]

Under nonepidemic conditions, Howe, Silva, Marston, and Woo[30] studied the part that blankets played in cross infection. The degree of contamination with Staphylococcus aureus was not heavy, most of the results showing only one to ten colonies per sweep plate. Over an eight week period of use, the contamination with Staphylococcus aureus increased progressively from five to seventy-nine percent. One month later a check up revealed that the degree of contamination had not progressed further. The majority of the group of patients using the blankets were elderly and

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[27]Frank Gohr, "Hospital Sanitation, Part III," Hospital Management, 91:37, May, 1961.

[28]Adams, op. cit., p. 345; Ralph Adams, and others, "Control of Infections within Hospitals," Journal of the American Medical Association, 169:1559, April 4, 1959; and Gohr, loc. cit.

[29]J. L. Farringer, "Control of Hospital Infections," Journal of the Tennessee State Medical Association, 53:508, December, 1960.

[30]Chester Howe, and others, "Staphylococcal Contamination of Mattresses and Blankets on a Surgical Ward Under Nonepidemic Conditions," New England Journal of Medicine, 264:631-632, March 30, 1961.

debilitated; however, none of the patients contracted a staphylococcal infection that could be attributed to a blanket.

Simulating typical clinical conditions, Anderson and Sheppard[31] demonstrated the dissemination of Staphylococcus aureus type 80/81 from an infected woolen blanket. The blanket was lightly shaken over culture plates which resulted in the growth of the organism on all four exposed plates. Following the shaking of the blanket, the authors gently swept a new broom in the area where the blanket was shaken. This action resulted in the growth of the test organism in two out of four plates which were at a distance of eight feet. Finally, culture plates were placed at bed level and the blanket was shaken four feet away. Of the four plates exposed, three yielded colonies of Staphylococcus aureus type 80/81. The test blanket was then stored at room temperature for two weeks. Using the sweep plate technique, colonies of the test organism could still be recovered from the blanket.

Harold Caplan[32] showed how a longstanding severe invasion of a surgical unit with Staphylococcus aureus, Proteus vulgaris, and Pseudomonas pyocyanea was eliminated by regular disinfection of the blankets with formaldehyde vapour. They found that the routine laundry processing of blankets was not adequate in destroying pathogenic organisms. Four heavily contaminated blankets of a mixed growth of organisms were subjected to formalinisation following which only two colonies of Bacillus subtilis could be grown. Thereafter formalinisation of all blankets became routine.

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[31]K. F. Anderson and R. A. W. Sheppard, "Dissemination of Staphylococcus Aureus from Woollen Blankets," Lancet, 1:514-515, March 7, 1959.

[32]Harold Caplan, "Control of Cross-Infection by Formaldehyde Disinfection of Blankets," Lancet, 1:1088-1089, May 23, 1959.

Following the institution of this procedure, there was not a single wound infection for three months. Twelve months later there were five wound infections as compared to thirty-seven in the preceeding twelve months.

The U. S. Naval Hospital at San Diego, California, became concerned about the relationship of blankets and cross infection. Dunbar[33] studied forty-four blankets at the hospital. Of these forty-four, sixteen were treated with five percent orthophenylphenol; sixteen with 1:1000 benzalkonium chloride; eight were clean, washed, untreated; and four were control blankets. The blankets were distributed at random on the units and sampled three times per week. The result was that marked reduction of bacterial count occurred in the treated blankets as compared to the clean, washed, and untreated blankets. No significant difference was seen in the different solutions used.

Hare and Cooke[34] stated that the importance of blankets as reservoirs of staphylococci has been "greatly exaggerated." They tested blankets used by carriers of staphylococci. Two of the six tested blankets showed staphylococcal growth. From this the authors concluded that although some blankets used by patients with unprotected infections may be heavily contaminated, by and large blankets have few colonies of Staphylococcus aureus on them. Little was to be gained by using antiseptics in laundering blankets.

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[33]Edward S. Dunbar, "Control of Micro-organisms on Blankets," Hospital Management, 92:45, August, 1961.

[34]Ronald Hare and E. M. Cooke, "Self-Contamination of Patients with Staphylococcal Infections," British Medical Journal, 2:334-335, August 5, 1961.

Schreck[35] has tested blankets immediately after being dried on which standard laundry procedures were used. He has shown only zero to forty colonies per plate. Schreck also reported that in studying one hundred blankets over a three month period, only one colony of Staphylococcus aureus coagulase positive was grown.

Stratford, Christie and Dixon[36] made two beds in a four bed ward with blankets treated with 1:100 chlorhexidine digluconate added to the routine washing procedure. The remaining two beds were made with untreated, routinely washed blankets. Samples were then taken every twenty-four, forty-eight, and seventy-two hours after the blankets were put into use. It was found that chlorhexidine digluconate 1:100 or 1:40,000 conferred no lasting sterility as compared to the routine method of laundering. However, the researchers suggested that in spite of their findings, blankets should be routinely disinfected as part of the overall attack on eliminating possible reservoirs of Staphylococcus aureus.

At the Hitchin Hospitals, J. R. B. Williams, Talbot and Maughan[37] reported that blankets washed with a detergent yielded a mean growth of three and a half colonies of staphylococcus which indicated laundering methods were effective.

Comparison of staphylococcal counts on blankets found in hospitals

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[35]Kenneth M. Schreck, "Medical Aspects in the Control of Hospital Acquired Staphylococcal Infections," American Journal of the Medical Sciences, 237:155, February, 1959.

[36]Bryan C. Stratford, R. Christie, and Shirley Dixon, "The Disinfection of Hospital Blankets," Medical Journal of Australia, 2:621, October 15, 1960.

[37]J. R. B. Williams, E. C. S. Talbot, and Elizabeth Maughan, "Hospital Outbreak of Cross Infection Due to Staphylococcus Pyogenes Phage Type 80," British Medical Journal, 1:1375, May 30, 1959.

and blankets found in trains and hotels were made by Colbeck.[38] The counts of hospital blankets were much higher than those in trains and hotels.

Paper blankets are being developed and may replace conventional wool and cotton ones. These paper blankets have the advantage of being disposable once the patients are discharged or at regular intervals for patients with chronic diseases. They are made out of twenty layers of soft crepe paper placed inside a linen sheet-like cover and can be produced for approximately forty cents each.[39]

Pillows

Gohr recommended that pillows used by patients with infections be autoclaved; however, if the equipment was available, "they should be laundered with treatment of the feathers by live steam."[40]

Since "a considerable percentage" of patients become carriers of pathogenic organisms, Haas[41] considered it reasonable to assume that patients' pillows will eventually become infected. After pillows are infected, they expell the pathogens every time the patient moves his head and every time the nurse fluffs the pillow for him. Because of this, Haas recommended that the pillows either be washed or protected so that they cannot become infected.

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[38]John C. Colbeck, "Environmental Aspects of Staphylococcal Infections Acquired in Hospitals," American Journal of Public Health, 50:469, April, 1960.

[39]"Paper Blankets," Journal of the American Medical Association, 176:164, April 15, 1961.

[40]Gohr, op. cit., p. 38.

[41]Wolfgang Haas, "Patients and Pillows Infect Each Other," Modern Hospital, 94:152, June, 1960.

Mattresses

Mattresses were not an important reservoir of staphylococci concluded Howe, Silva, Marston, and Woo[42] from their studies on the role of the mattress and cross infection. Under nonepidemic conditions, plastic covered mattresses of twenty-seven patients with draining Staphylococcus aureus lesions were cultured. Only once was the mattress contaminated with the same strain of staphylococcus as the patient occupying the bed. Five of fifty-two cultures on the plastic mattress cover showed contamination with staphylococcus. In four staphylococcus infected post operative wound infection cases, this organism was not cultured from the mattresses the day of surgery.

Colbeck[43] noticed that patients occupying certain rooms appeared to have more boils and similar infections. After disinfection of the mattresses and blankets, this infective process ceased. It was concluded that pathogens passed through the sheets to the mattress and vice versa, thus cumulating and becoming a reservoir of infection.

Sterilization by exposure to gaseous ethylene oxide is recommended by Walter[44] for mattresses. McLean[45] suggested the use of a mattress cover that could be washed with a detergent-disinfectant.

Adams, Fahlman, Read, Dube and Dube[46] reported that large numbers of bacteria were cultured from repeated random sampling of mattresses.

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[42]Howe, op. cit., p. 632.

[43]Colbeck, op. cit., pp. 469 and 472.

[44]Walter, loc. cit.

[45]James C. McLean, "The Control of Nosocomial Infections," Hospital Management, 88:81, November, 1959.

[46]Adams, loc. cit.

"Body excretions--sweat, urine, and the like--from the 'average' patient leaves a heritage of staphylococcal growth on mattresses no different from that to be found on used linen" stated Adams.[47]

At the hospital at the University of Saskatchewan, an attempt was made to grow Staphylococcus aureus in foam rubber. The bactericidal action of foam rubber prevented the growth of organisms. This bactericidal action is most effective in the presence of moisture, therefore suggesting that foam rubber mattresses could be sterilized by spraying them with water. Even after four years of use, Swanson, Davy and Dempster still found considerable bactericidal action.[48]

Linen

At the Institutes of Medical and Veterinary Science in South Australia, Anderson, Coulter, and Looke[49] experimented with two artificially infected beds with staphylococci. A simple bed-making routine led to the conclusion that considerable numbers of organisms are disseminated. After seventy-two hours the number of viable organisms recovered from the artificially infected bedding was reduced by ninety percent.

Stauffer[50] felt that usual laundry operations were adequate in handling infected linen but cast doubt on the adequacy of handling linen once cleaned. He contended that it often becomes reinfected before it

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[47] Ibid.

[48] A. L. Swanson, Irene Davy, and G. Dempster, "Problem of the Mattress in Cross-Infection," Canadian Hospital, 36:39, 41, February, 1959.

[49] Kevin Anderson, John Coulter, and Ene Looke, "Transfer of Staphylococcus Pyogenes from Infected to Non-Infected Hospital Beds," British Medical Journal, 1:1926-1927, June 25, 1960.

[50] Lee D. Stauffer, "How Linen Handling Methods Affect Cross Infection Rate," Hospitals, 33:82, 84, June 16, 1959.

reaches another patient. He advocated that to reduce exposure of laundry employees to infected linen, one person should be responsible for placing contaminated linen into the washing machine.

"The combination of detergents, hot liquids, bleaches, drying and ironing" as routine in laundering linens is effective in sterilizing them stated McLean.[51]

McLean, Stauffer, Walter, and Farringer all recommended that known infected linen be placed directly into well marked bags in the patient's room. Walter and McLean especially emphasized the minimum handling of the infected linen and abhorred the practice of fanning it into the air.[52]

In Hamburg, Germany, Rogers and Slater[53] observed an altogether different method of handling infected linen and described it thus:

> The canvas bags used for collecting the linen had one side sewn together with an alginate thread; and, after being filled, they were closed with a strong elastic band round the top. On arriving at the laundry they were thrown into a solution which caused the alginate thread to break and facilitate the removal of adherent proteinous material. After a suitable time the temperature in the washing machine was raised to 80° C. to kill the non-sporing organisms. The linen and the open bags were then laundered, after which the bags were sewn together again with alginate thread.

Towels and wash cloths coming from a patient with an open, draining wound infection are "seething with staphylococci." Vigorous washing and ironing usually sterilizes them from a practical point of view.[54]

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[51]McLean, loc. cit.

[52]Ibid.; Stauffer, op. cit., p. 84; Walter, op. cit., p. 59; and Farringer, loc. cit.

[53]K. B. Rogers and Noel A. J. Slater, "The Disposal of Infected Linen," Lancet, 2:592, September 9, 1961.

[54]Adams, op. cit., pp. 344-345.

Floors and Other Surfaces

Walter[55] prescribed a three-step procedure to be followed in cleaning floors. The first step is the removal of trash and objects. This is followed by soaking and scrubbing the floor with a germicide to remove dried soil. In the final step the floor is flooded with a germicide and picked up by a wet pick-up vacuum cleaner. He recommended that the bacterial count on the unused surface be less than five organisms per square centimeter after twelve hours. There should be no dust.

Vacuum cleaners of the filtration type are the only types that met the approval of Adams.[56] McLean also felt this way--as long as the exhaust air is not disseminated into the hospital atmosphere. He also recommended the use of wet pick-up machines.[57]

At Kennestone Hospital in Marietta, Georgia, Sherrer demonstrated that damp mopping is ineffective in reducing bacterial counts on floors, even when a powerful detergent-germicide is used. Wet-mopping proved to be far more effective.[58]

Steingold compared dry sweeping, sweeping powder, and vacuum cleaning. He found that dry sweeping was least effective and stirred up much of the bacteria on the floor into the air to a count of approximately ninety-eight organisms per cubic foot of air. Sweeping powder raised

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[55]Carl W. Walter, "Disinfection of the Floor to Prevent Cross Infection," Hospital Topics, 37:81, September, 1959.

[56]Ralph Adams, and others, "Control of Infections within Hospitals," Journal of the American Medical Association, 169:1559, April 4, 1959.

[57]McLean, op. cit., p. 69.

[58]Armour W. Sherrer, "Methods Are as Important as Materials in Controlling Infections in Hospitals," Modern Hospital, 96:150, February, 1961.

about forty organisms per cubic foot into the air, while vacuum cleaning was most effective raising less than ten organisms per cubic foot of air.[59]

Ten vacuum cleaners and three suction floor-polishers commonly used in hospitals were evaluated by Bate. He found that "exhaust from all but one of the vacuum cleaners contained not more than one bacteria-carrying particle in five cubic feet, which seemed unlikely to constitute a cross infection hazard." The exhaust from suction floor-polishers was unsatisfactory and it was recommended their filtering systems be redesigned. Bate observed that room air was disturbed by the open exhaust jets of the vacuum cleaners and suggested they be modified to diffuse this exhaust. He also brought out the danger to personnel in emptying the bags in vacuum cleaners. Unless these are disposable, they could well be a source of contamination for employees and air.[60]

Horizontal surfaces such as floors and table tops become much more readily contaminated with microorganisms than do vertical surfaces such as walls stated Vesley and Brask.[61] Surfaces which are routinely exposed to contaminated objects will become contaminated more quickly than those which are not. For example, a frequented hallway will have a greater degree of contamination than a floor which is seldom used. Likewise the wall of a patient's room will not become as quickly contaminated as the wall around a laundry chute.

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[59]L. Steingold, "Cleaning and Cross-Infection," Hospital and Health Management, 24:52-55, February, 1961.

[60]J. G. Bate, "Bacteriological Investigation of Exhaust Air from Hospital Vacuum Cleaners," Lancet, 1:161, January 21, 1961.

[61]Vesley, op. cit., p. 743.

Dry sweeping and dust mopping are taboo according to McLean. He brought special attention to bacteria in dust and dirt which is found in corners and edges, utility closets, around toilet fixtures, etc.[62]

Simon[63] predicted the eventual use of a wax containing a bacteriostat to be applied to the floor periodically, maintaining a hygienically clean floor.

Hare and Cooke[64] felt little was to be gained by treatment of floors with oil because this affected such a small part of the environment. In contrast, Walter and Knudsin demonstrated that the floor could not be ignored epidemiologically. Settling bacteria are readily accommodated on floors. "Floor cultures are excellent indicators of the bacteriologic types of infection prevailing, reflect qualitatively the bacteriology of the room's occupant, and are an index of the infectivity of the environment." The wet pick-up technique in cleaning floors was recommended. Waxes containing germicides did not change the bacterial count of the floor. The advantage of a wax containing a germicide was useful in storage of wax. This prevented the contamination of the wax.[65]

Air

There exist two schools of thought concerning the importance of airborne contamination in contributing to cross infection. One is that this

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[62]McLean, loc. cit.

[63]Len Simon, "Nosocomial Infections--Is Bacteriostasis the Answer?" Hospital Management, 87:117, February, 1959.

[64]Hare, op. cit., p. 335.

[65]Carl W. Walter and Ruth B. Knudsin, "The Floor as a Reservoir of Hospital Infection," Surgery, Gynecology and Obstetrics, 111:412-422, October, 1960.

route plays an important role while the other contends that cross infection "requires a higher concentration of organisms introduced into the infection site than is possible by aerial dispersion."[66]

Among the first areas within the hospital to be air conditioned were operating rooms. The need has not changed, but rather has been expanded to now include patient care areas. The criteria suggested for any air conditioning system is that it must control temperature, humidity, and remove dust and bacteria from the air.[67]

Avery stated that "the best way to sanitize air is to remove microscopic particles containing viable organisms from ventilating air." In the case of the patient in isolation, the flow of air must not be allowed to circulate in the room and then throughout the unit. A negative pressure must be maintained in rooms used for isolation. The supply and exhaust air must be filtered for these rooms. In the hospital unit, ventilation should be under a positive pressure "so that bacteria do not infiltrate from adjacent rooms or corridors." Avery recommended that the clean air should enter at the ceiling, flow downward and be removed by ducts located at the base of the walls of the room.[68]

At Rhode Island Hospital, Young and Porter[69] did studies to find

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[66]Frank Gohr, "Hospital Sanitation, Part II," Hospital Management, 91:33, April, 1961.

[67]Robert H. Avery, "Hospital-Clean Air," Hospital Topics, 41:104, May, 1963.

[68]Ibid., p. 105.

[69]Raymond M. Young and Arnold Porter, "Air Treatment Helps Filter Out Infection," Modern Hospital, 95:95, November, 1960.

out the effectiveness of air filtration in reducing bacterial content. Usual housekeeping procedures were continued, the only change being in filtration of fresh and recirculated air. The filters used were made of a bonded blend of acetate fibers impregnated with a permanent germicide. Culture media was exposed for one hour during periods of increased activity on two floors. After three weeks a seventy percent bacterial reduction on one floor and a fifty-nine percent bacterial reduction on another was seen. Following this, specific counts for Staphylococcus aureus were made over a fifteen day period. On the first floor a seventy-six percent reduction and on the second floor an eighty-eight percent reduction was demonstrated. Young and Porter concluded that patients harboring Staphylococcus aureus readily disseminate large numbers of it into the air.

To further demonstrate this dissemination, Young and Porter gave the illustration of a patient with extensive eczematous dermatitis infected with large numbers of coagulase positive hemolytic Staphylococcus aureus who was placed in a private room having a negative air culture for this organism.[70]

> After 24 hours the total count in this room was 247 on one plate about 12 feet from the patient. Of these, 200 colonies were the coagulase positive Staphylococcus aureus strain. The second placed at about 20 feet from the patient showed a total count of 251, of which 172 colonies were coagulase positive Staphylococcus aureus.
>
> On the day when the count was elevated, counts in the adjacent rooms and in the corridor area in front of the door to the patient's room showed a definite rise in number. On 4 plates placed in the corridor about 25 to 30 feet apart, the 2 nearest this patient's room showed 26 and 30 colonies of coagulase positive Staphylococcus aureus on the day of the high count. The other 2 plates showed 10 and 15 coagulase positive Staphylococcus aureus colonies.

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[70] Ibid., p. 98.

Infection can be transported through the air by droplets, droplet nuclei, or dust and is not confined to the immediate vicinity of the patient, but rather dispersed throughout the area. This can be controlled by ventilation and disinfection of the air according to Riley.[71]

Dust particles are thought to settle out of the air at a rate of one to two feet per minute in still air; however, some may remain suspended. Allen also recommended some type of filtration system through which air must flow before being recirculated. A supply of clean air cannot alone eliminate infection.[72]

Riley and associates[73] performed air studies in relation to resultant infection developed in guinea pigs. For two years an average of 156 guinea pigs were continuously exposed to air contaminated by patients with active pulmonary tuberculosis in a six bed ward. Seventy-one of the guinea pigs became infected with tuberculosis leading to the conclusion even a small amount of air-borne tuberculosis is sufficient to account for the spread of pulmonary tuberculosis in human beings.

While studying blanket contamination, Dunbar also studied air contamination. He suggested that "handling of blankets incident to culture contributed to increased contamination of the environment."[74]

Staphylococcus aureus phage type 80/81 was isolated from a post-operative wound infection from a patient who had recently undergone surgery.

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[71]Richard L. Riley, "Air-borne Infections," American Journal of Nursing, 60:1246, 1248, September, 1960.

[72]Henry F. Allen, "Air Hygiene for Hospitals," Journal of the American Medical Association, 170:262, 267, May 16, 1959.

[73]R. L. Riley, and others, "Aerial Dissemination of Pulmonary Tuberculosis," American Journal of Hygiene, 70:196, September, 1959.

[74]Dunbar, loc. cit.

This same organism was present in the air of the operating room during the operation which suggested a relationship between contaminated air and wound infection.[75]

Excessive importance is given aerial route of infection dissemination according to Colbeck. The importance of aerial infection depends on the production of nasal carriers who then infect their skin and environment. He feels that a patient is much more likely to become infected by contaminated linen, etc., than by air. Colbeck further demonstrated his point by air samples taken from rooms of septic and carrier patients. In both instances very low counts of coagulase positive staphylococci were noted. In rooms with no marked movement of bed clothes, twenty-four colonies of this organism were grown. This was doubled when blankets were rapidly moved to the foot of the bed and back each minute during the five minute sampling periods.[76]

Walter attributed dissemination of bacteria throughout the hospital to the recirculation of air within its confines. He stated that "ventilation with clean air at a rate of ten changes an hour will reduce the count of airborne bacteria in a room 67% during periods of activity simply by purging them into the exhaust system." As walls serve as physical boundaries that function as barriers to the movement of airborne bacteria, so may a curtain of ultra violet radiation. Such a curtain could be used across a doorway in a private room or surrounding a patient in a multibed ward. The curtain of ultra violet is three inches

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[75]Harold W. Wolf, Mervin M. Harris, and Lawrence B. Hall, "Open Operating Room Doors and Staphylococcus Aureus," Hospitals, 35:57, March, 16, 1961.

[76]Colbeck, op. cit., p. 470.

thick and will destroy bacteria, isolating a patient bacteriologically.[77]

Walter suggested the following criteria for bacterial counts in the air of a hospital unit: less than ten to twenty organisms per cubic foot.[78]

Gohr[79] pointed out the defects of aerosols by stating that they were only effective under ideal conditions and thus not suited for practical use.

Visible dirt and dust serve as a proportional index to the rate and amount of air contamination. Effective housekeeping will lower air pollution; however, the level of air pollution will rise where ever there are large numbers of people gathered.[80]

Schreck found thirty-two colonies of coagulase positive staphylococci isolated from 485 cubic feet of air. Of this number, only sixteen were the epidemic strain, "which meant that the airborne particles carrying the epidemic strain was present in a concentration of only one particle per thirty cubic feet of air.[81]

Altemeier emphasized the importance of aerial infections in the debilitated or burned patient.[82]

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[77]Carl W. Walter, "Isolation Technic for Containment or Exclusion of Bacteria," Hospital Topics, 42:57-58, January, 1964.

[78]Gohr, op. cit., p. 35.

[79]Ibid.

[80]Adams, op. cit., pp. 1558-1559.

[81]Kenneth M. Schreck, "Medical Aspects in the Control of Hospital Acquired Staphylococcal Infections," American Journal of the Medical Sciences, 237:155, February, 1959.

[82]Altemeier, loc. cit.

From the Proceedings of the Conference on Airborne Infection, ample evidence exists to indicate that the airborne route plays a major role in a number of infectious diseases of man and a secondary role in many others.[83]

Cluff maintains that there is a lack of properly controlled research studies showing the relationship between aerial contamination and staphylococcal infection.[84]

Avery reports that a new type of glass-asbestos filter suitable for hospital use has a National Bureau of Standards Atmospheric Dust Spot efficiency of ninety-nine percent and "is essentially 100% effective in removing bacteria attached to dust particles. It has been 97% efficient in removing staphylococcus from an aersol spray."[85]

Walls

Wypkema and Alder conducted a study to find out if walls were a source of cross contamination. They concluded that even though walls may be visibly dirty, they are unlikely to promote cross infection. The floors were found to be much more heavily contaminated than the walls and led to the conclusion that "since the part played by dusty floors in the spread of wound infection is probably small, the role of dusty walls must apparently be even smaller. Washing the walls of a ward therefore is unlikely to contribute much to the control of cross infection."[86]

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[83]"Proceedings of the Conference on Airborne Infection," Bacteriological Reviews, 25:173-382, September, 1961.

[84]Leighton Cluff, "Staphylococcal Infection," Maryland State Medical Journal, 10:67, February, 1961.

[85]Avery, op. cit., p. 105.

[86]W. Wypkema and V. G. Alder, "Hospital Cross-Infection and Dirty Walls," Lancet, 2:1068, November 24, 1962.

Laundry Chute

McLean stated that laundry chutes can become grossly contaminated.[87]

Adams demonstrated that this was definitely the case with the laundry chutes at Huggins Hospital and presumed that such findings were representative of many other hospitals.[88]

Dressing Carts and Trays

Many hospitals make use of dressing carts. One example is the Huggins Hospital in New Hampshire. To prevent their cart from becoming a source of cross infection, the dressing cart is stripped and cleaned once daily.[89]

Farringer recommended that special dressing trays be provided for patients with known staphylococcal infections.[90]

In a hospital in England an epidemic of Staphylococcus aureus infections was present. In an effort to find the source of the spread of infection, dressing trollys were cultured. Staphylococcus aureus was found twenty-two out of forty-five times.[91]

Infected dressings should be placed in polyethylene bags that can be sealed by twisting a paper-wire tie about them and then discarded.[92]

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[87]McLean, op. cit., p. 81.

[88]Adams, op. cit., p. 1558.

[89]Ralph Adams, "Prevention of Infections in Hospitals," American Journal of Nursing, 58:347, March, 1958.

[90]Farringer, loc. cit.

[91]Phyllis M. Rountree, and others, "Staphylococcal Wound Infection in a Surgical Unit," Lancet, 2:4, July 2, 1960.

[92]Walter, op. cit., p. 59.

Clothing

The commonly accepted standard of clothing is represented in Farringer's[93] recommendation that all personnel entering isolation rooms wear masks and gowns. He enlarged this to include the use of gloves if handling the patient or fomites.

The use of shoe coverings when entering a sterile area is strongly recommended by Adams. If not worn, shoes will collect and disseminate bacteria where ever the wearer goes.[94] Walter suggested this tracking of bacteria could be prevented by "treading on a mat of plastic foam kept moist with a germicide in a shallow pan located at the doorway" of the area to be protected.[95]

At Brooke Army Medical Center, Ft. Sam Houston, Texas, studies were done to evaluate the effectiveness of paper-base material which could be used in making gowns, caps, floor uniforms, boots, gloves, masks and possibly bed linens which may eventually find their place in hospitals.[96]

Bathrooms and Furniture

Under carefully controlled conditions Colbeck demonstrated how either a patient with an infection or a staphylococcal carrier quickly contaminated different articles of furniture in his room and in the

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[93]Farringer, loc. cit.

[94]Ralph Adams, and others, "Control of Infections within Hospitals," Journal of the American Medical Association, 169:1559, April 4, 1959.

[95]Walter, op. cit., p. 58.

[96]"They Make Paper Work," Modern Hospital, 93:6, September, 1959.

adjoining bathroom. A disinfected bath used once by a patient with boils was seen to contain hundreds of staphylococci.[97] Because showers offer less possibility of contamination, Colbeck encouraged the use of them in preference to tubs.[98]

Gohr recommended a twice-a-day regimen of cleaning key or infected areas with an acceptable germicidal detergent. This would include baths, showers, toilet seats, etc.[99]

Furniture can be disinfected by steam cleaning or by being sprayed with a germicide.[100]

Miscellaneous

Housekeeping practices. Concerning the methods of cleaning utilized by the housekeeping department, Allen commented: "as is often the case, the number of opinions about the effectiveness of different methods exceeds the number of controlled studies on which such opinions could reasonably be based."[101]

Telephones. At Henry County General Hospital, Paris, Tennessee, Stout cultured the mouthpiece of fifty telephones throughout the hospital. Results showed thirty-eight were positive cultures of Staphylococcus aureus. Of the thirty-eight, twelve were pathogenic strains.

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[97]Colbeck, op. cit., p. 470.

[98]Gohr, op. cit., p. 33.

[99]Ibid.

[100]Walter, op. cit., p. 57.

[101]Henry F. Allen, "Air Hygiene for Hospitals," Journal of the American Medical Association, 169:553, February 7, 1959.

These same telephones were then fitted with an antiseptic guard made of three layers of surgical gauze saturated with a special formula containing diphenylmethane G-11 which snapped over the mouthpiece. After thirty days of use there was no bacterial browth. Following forty days of use, two were positive for Staphylococcus aureus. There was no other bacterial growth. During this test period, many phones were used by patients with upper respiratory disease.[102]

Curtains. Caplan gave the example of two post operative prostatectomy patients separated by a curtain from which coagulase positive staphylococci and Pseudomonas pyocyanea was grown. One of the patients had a Proteus vulgaris urinary infection and the other a Pseudomonas pyocyaneous infection. Five days later both staphylococci and pseudomonas were cultured from the urine of the first patient.[103]

Heitman suggested that draperies, curtains and shades be cleaned daily.[104] Use of curtains should be avoided according to Walter. Bacteria accumulate on them and are readily dispersed when used.[105]

Soap Dispenser. Farringer recommended that a foot operated soap dispenser be placed in those rooms used for isolation.[106]

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[102]William J. Stout, "How to Keep Staph Off the Telephone," Modern Hospital, 99:104, December, 1962.

[103]Caplan, op. cit., p. 1088.

[104]Gohr, loc. cit.

[105]Walter, loc. cit.

[106]Farringer, loc. cit.

Ward and Semiprivate Rooms. In studying staphylococcal disease at the University of Pennsylvania Hospital, Farrer and MacLeod found that their infection rate was higher among ward patients and lowest among semi-private patients. This suggested that "cross infection on the open wards was an important factor in the epidemiology of staphylococcal infection in the hospital."[107]

Shooter and associates surveyed staphylococcal sepsis at St. Bartholomew's Hospital, London, for one year. The unit consisted of twenty-four beds in the open ward and two in side rooms. Nine patients out of 349 were admitted with sepsis and thirteen developed it. "Only 2 patients were infected with any one type of staphylococcus." There was no evidence that infection spread from one patient to another.[108]

Others. An alcoholic solution of germicide is recommended by Walter to disinfect electrocardiograph leads, x-ray machines, scales, etc.[109]

The use of disposable dishes helps to prevent cross infection in instances where there are only central dishwashing facilities.[110]

The Cycle. Through the interrelation of these sources of cross infection, the infection is spread. For instance, droplet nuclei suspended in the air may be inhaled by persons or they may eventually settle

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[107]Farrer, op. cit., p. 38.

[108]R. A. Shooter, and others, "Staphylococcal Infection in a Medical Ward," British Medical Journal, 1:1924, June 25, 1960.

[109]Walter, op. cit., p. 59.

[110]Ibid.

out, contaminating various different fomites. Those settling out are incorporated in dust and lint. They become airborne again due to activity or imperceptible air currents.[111]

Using indicator bacteria, Vesley and Brask have demonstrated that polluted air readily contaminates clothing; from clothing bacteria are shed wherever the person may travel. Analogy is drawn from this study to indicate how patient or personnel contaminated linen and trash may disseminate bacteria into the air while being handled.[112]

## II. CARRIER STATES

### Prevalence of Carrier States

Hospital Prevalence. Wells stated that "20 to 60% of the personnel of hospitals are ambulatory carriers in close and frequent contact with patients is basic." He added that the "average patient entering the average general hospital has approximately a 20 to 50% chance of having his nasal mucous membranes colonized by antibiotic resistent, virulent staphylococci in from 48 to 72 hours." His chances are greatly increased if he has a break in his skin, a chronic debilitating disease or some iatrogenic alteration.[113]

Carrier rates in patients and hospital personnel appear to be higher than in the population not within the hospital environment. The

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[111]Carl W. Walter, "Disinfection of the Floor to Prevent Cross Infection," Hospital Topics, 37:80, September, 1959; Avery, op. cit., p. 103; and Vesley, loc. cit.

[112]Vesley, op. cit., p. 744.

[113]Wells, op. cit., pp. 1221, 1223.

degree of contamination of the environment bears a relation to this fact, since it is greater in the hospital.[114]

In most hospitals well over half of the staff are carriers of staphylococci according to Green. About twenty nurses in a hundred are never carriers; approximately the same number are persistent carriers; while the remainder are carriers for given intervals of time.[115]

Within the first twenty-four hours after admission, most patients have acquired the common strains of hospital organisms in their nasal passages. This would include the staphylococci that are resistent to the antibiotics to which they have been exposed.[116]

Community Prevalence. Once an infection caused by Staphylococcus aureus has manifest itself in a family member, there is one chance in four that other family members will become infected.[117]

Grogan and associates surveyed the community of Jackson, Mississippi in an effort to find what proportion were coagulase positive staphylococcal carriers as compared to the hospital population. This was done by obtaining nose and throat cultures of 547 families. In twenty-two percent of the families, all members were carriers, and in eighty-four percent at least one member was a carrier. Nine percent of the families

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[114]Hinton, op. cit., pp. 347-348.

[115]Kenneth Green, "The Role of the Carrier in Staphylococcal Disease," Lancet, 2:921, October 21, 1961.

[116]Ralph Adams, "Prevention of Infections in Hospitals," American Journal of Nursing, 58:344, March, 1958.

[117]Winslow Bashe Jr., Adah L. Miller, and Frederick H. Wentworth, "Community Staphylococcal Infection--Relationship to the Hospital Problem," American Journal of Public Health, 52:1815, November, 1962.

harbored Staphylococcus aureus phage type 80/81.[118]

A similar study was conducted by Knudsin and associates in a community of young married graduate students with a high proportion of children. Thirty-one percent of the infections were in families with children under two years of age. The rate was ten percent in families with no children or older children. From 388 individuals nasal cultures were obtained; fifty-seven percent were reported to be carriers of Staphylococcus aureus.[119]

Approximately fifty percent of any population of adults in a temperate climate will reveal coagulase positive staphylococci. In infants the percentage reaches approximately ninety. Dowling further contends that nearly everyone at one time or another will carry this organism.[120]

Self-inflicted Infections

Rountrée and associates reported that nine percent of seventy-six surgery patients carrying Staphylococcus aureus had self-inflicted wounds.[121]

On admission, nasal swabs were taken from 348 surgical patients by Colbeck. The results indicated that self-infection by carriers of staphylococcus was sixteen times greater than that of noncarriers.[122]

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[118]James B. Grogan and others, "A Study of Nose and Throat Carriers of Staphylococci in a General Community," Journal of the Mississippi State Medical Association, 2:137, 140, April, 1961.

[119]Ruth B. Knudsin and others, "Ecology of Staphylococcal Disease," Journal of the American Medical Association, 185:159-162, July 20, 1963.

[120]Dowling, op. cit., p. 134.

[121]Rountree, op. cit., p. 4.

[122]Colbeck, op. cit., p. 472.

Of 125 elective surgical patients, thirty-four percent had coagulase positive Staphylococcus aureus in their nares. Of this thirty-four percent, forty-three percent experienced complications while only twenty-six percent of those with negative nasal cultures developed complications. To further break down the complication figure, eighty-three percent were infected in the positive nasal culture group and forty percent infected in the negative nasal culture group.[123]

Hare and Cooks studied six staphylococcus aureus nasal carriers whose post operative wounds were not infected and who showed little contamination on their bodies. They concluded that nasal organisms contribute little toward the self-infection of a patient or his environment.[124]

When a high nasal carrier rate exists, Wells felt that many minor skin infections and occasional very serious or fatal infections should be expected.[125] Walter felt that in approximately half of the infective cases, nasal cultures will reveal the causative organism.[126]

Treatment of Carriers

There is no known method to prevent hospital personnel from becoming carriers of staphylococci.[127] Schreck advocated that all

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[123]Haskell J. Weinstein, "The Relation Between the Nasal-Staphylococcal-Carrier State and the Incidence of Postoperative Complications," New England Journal of Medicine, 260:1307, June 25, 1959.

[124]Hare, op. cit., p. 344.

[125]Wells, op. cit., p. 1221.

[126]Carl W. Walter, "Isolation Technic for Containment or Exclusion of Bacteria," Hospital Topics, 42:59, January, 1964.

[127]Adams, loc. cit.

infected persons be removed from duty.[128] To remove carriers without active lesions would be unreasonable due to their frequent occurrence.[129]

To prevent personnel from becoming carriers, Farringer recommended that masks and gloves be worn while changing bed linens.[130]

The personal hygiene of the patient is a factor in infection control. Daily baths should be given using a bacteriostatic skin detergent. Frequent shampoos dispose "the environment of bacteria retained on the hair long after antibiotics may have disinfected the living tissues of the patient."[131]

## III. BREAK IN ASEPSIS

Control of infections is not peculiar to our times. The book of Leviticus outlines a plan of control for isolation of the leper and gives other measures for the prevention of disease.[132] Until the time of Semmelweiss and Lister there was little concept of asepsis.[133] In the ensuing years hospital personnel were drilled in aseptic and antiseptic technic. Then came the antibiotics in the early forties. Since this time there has been a "gradual decline in strict adherance to

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[128]Kenneth M. Schreck, "Hospital Acquired Staphylococcal Infections," Current Medical Digest, 26:80, May, 1959.

[129]"Controlling the Hospital Staphylococcus," British Medical Journal, 2:361, August 5, 1961.

[130]Farringer, loc. cit.

[131]Walter, loc. cit.

[132]James Grant, "Isolation in the Control of Infection," Public Health, 73:210, March, 1959.

[133]Balcom, loc. cit.

aseptic techniques."[134] Protection from staphylococcal infections is not found solely in antibiotics.[135] Numerous authorities in this field are urging a return to the basic principles of asepsis.[136]

"No disease producing organism yet found has developed a resistence to good housekeeping, cleanliness and sanitation."[137]

The enforcement of aseptic principles lies with the professional nurse.[138] Gardner and associates recommended the appointment of a person whose duty, among others, would be to check on the performance of ward techniques to see if the wards are conforming to acceptable standards.[139]

Frequent handwashing is advocated by nearly everyone familiar with infection control. Walter[140] has added another step in this process. He suggested spraying the hands with an alcoholic germicide using a foot-operated dispenser.

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[134]Ibid.; and Gerald P. Turner, "Control of Infection in Hospitals," Canadian Hospital, 37:41, June, 1960.

[135]W. A. Altemeier, "Prevention and Control of Infections in Hospitals," Hospitals, 37:66, May 16, 1963.

[136]"Pseudomonas Threatens to Become Major Infection Hazard in Hospitals," Modern Hospital, 97:74, December, 1961; Fred Allison, "Practical Points in Management of Staphylococcal Disease," Journal of the Mississippi State Medical Association, 1:589, November, 1960; I. Ashley-Carter, "Barrier Nursing Is It Possible?" Nursing Times, 58:152, February 2, 1962; Nina D. Gage, John Fitch Landon, and Helen T. Sider, Communicable Diseases Philadelphia: F. A. Davis Co., 1959, p. 12; and Margaret E. Grigsby and Milton J. Fuertes, "The Prevention and Control of Hospital Infections," Journal of the National Medical Association, 54:480, July, 1962.

[137]McLean, op. cit., p. 81.

[138]Balcom, op. cit., p. 139.

[139]A. M. N. Gardner and others, "The Infection Control Sister," Lancet, 2:710-711, October 6, 1962.

[140]Walter, op. cit., p. 58.

At the Battersea College of Technology a study was done using two groups of six persons. Both groups pressed their finger tips on nutrient agar before and after washing, but without drying them. The result showed that the average colonies for the unwashed group was fifty-one and the washed group was 244. The group then dried their hands on sterile towels and innoculated the nutrient plate. This resulted in an average growth of forty-eight colonies. Six then rinsed their hands in one percent solution of sodium hypochlorite which resulted in an average growth of eighty-nine. The remaining six rinsed their hands in five percent solution of cetyl trimethyl. Five of the six showed no growth while one had eighty colonies.[141]

## IV. ISOLATION CART

In outlining an infection control program, Dr. Ian Maclean Smith recommended the use of a portable isolation cabinet which would contain gowns, masks, stethoscope and sphygmamanometer, etc. Housekeeping was responsible for its maintenance.[142]

In St. Louis, Missouri, the Alexiam Brothers Hospital has an isolation cart similar to those tested in this study. The cart is stationed in the hallway and is considered clean. Supplies that the nurse may need while giving care constitute the contents of it.[143]

A picture of an unenclosed cart was shown in an article on infection control in the September, 1959, issue of Modern Hospital. The only

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[141]Jeffrey L. Wood, "Handwashing," Nursing Times, 57:803, June 23, 1961.

[142]"Physician Outlines Infection Control Plan," Modern Hospital, 94:76, January, 1960.

[143]Brother Valentine, "I Would Like to Know...More About Isolation Technique and the Isolation Cart," Modern Hospital, 95:93-94, January, 1963.

comment made about the cart was that it contained gowns, masks, caps, supplies, and step-on disposal cans.[144]

## V. STAPHYLOCOCCUS

Because staphylococcus is undoubtedly the most serious problem in hospital infections,[145] this section of the review of literature covers only this organism. However, it should not be surmized that staphylococcus is the only guilty organism. Candida albicans, Escherichia coli, Aerobacter aerogenes, Pseudomonas aeruginosa, Proteus vulgaris and Bacillus alcaligenes are causing an increasing number of infections in post operative wounds as well as in the urinary tract.[146]

### History

Egyptian mummies dating back to 3000 B.C. have been shown to have had osteomyelitis which is caused by staphylococcus.[147] But it wasn't until 1880 that the organism was definitely associated with disease.[148] Thus staphylococcus was "one of the first human pathogens to be recognized

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[144]"Infection Control Leaves a Lump on the Budget: Here Is What It Costs to Operate the Program," Modern Hospital, 93:64-65, September, 1959.

[145]J. C. Colbeck, "Control of Infections in Hospitals," Hospitals, 37:59, January 16, 1963.

[146]W. A. Altemeier, "Surgeons Diagnose the Problem of Infections," Modern Hospital, 92:72, March, 1959; Manuel H. Fertman and Mildred B. Fertman, "Hospital Infections and Their Control: Pitfalls in the Interpretation of Statistical Data," Journal of the American Geriatric Society, 9:730, September, 1961; and Frank Gohr, "Hospital Sanitation, Part IV," Hospital Management, 91:44, June, 1961.

[147]Wells, op. cit., p. 1219.

[148]E. G. D. Murray, "About Staphylococcus," Canadian Nurse, 55:788, September, 1959.

and cultivated."[149] Between 1885 and 1887 researchers infected themselves and recovered the organism thus proving the pathogenicity of staphylococcus. Lister wrote in 1891 that Staphylococcus pyogenes aureus "seems to be the most frequent cause of suppuration in man."[150]

## Characteristics

There are two species of staphylococci with which this study is concerned--Staphylococcus aureus and Staphylococcus epidermidis (albus). Staphylococcus aureus is pathogenic, usually forms a golden-yellow pigment, ferments mannitol, coagulates plasma and is sensitive to a series of specific bacteriophages. Staphylococcus epidermidis is feebly pathogenic or non-pathogenic, forms porcelain-white or indifferently colored colonies, does not ferment mannitol, forms no coagulase, and is normally present on the skin and hair, and in water and dust.[151] There is no immunity acquired from staphylococcal infections.[152]

Rogers has commented that staphylococci can behave differently on different areas within one hospital. "The types of patients and types of procedures utilized in their care may play a major role in determining the nature and magnitude of the staphylococcal problem."[153] Susceptibility

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[149] Rene Dubos, "Staphylococci and Infection Immunity," Journal of the American Medical Association, 184:1038, June 29, 1963.

[150] Murray, loc. cit.

[151] Robert S. Breed, E. G. D. Murray, and Nathan R. Smith, Bergey's Manual of Determinative Bacteriology, 7th ed., Baltimore: Williams and Wilkins Company, 1957, pp. 464-465; and Roger Y. Stanier, Michael Doudoroff, and Edward A. Adelberg, The Microbial World, 2nd ed., Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963, p. 681.

[152] Cluff, op. cit., p. 66; and Wells, op. cit., p. 1222.

[153] Colbeck, op. cit., p. 842.

of tissues to staphylococcal infections vary. For example, the kidney is a frequent site for such infection.[154]

To provide an environment free from Staphylococcus aureus coagulase negative is virtually impossible. In fact, Turner states "there are a tremendous number of sources within our hospitals which can create bacterial infections."[155]

Staphylococcus aureus coagulase positive is likewise very prevalent in the environment and in the noses of carriers; however, hospital epidemics are much more likely to be caused by some strains of the organism than others.[156]

The ability of certain strains of staphylococcus to produce coagulase, an enzyme that clots plasma, denotes it potential pathogenicity.[157]

Virulence

In 1959 Schreck wrote that there was no good way to test the virulence of staphylococcus.[158] The following year Colbeck demonstrated abscesses developed in rabbits from threads which had been innoculated with staphylococci, dried, and kept at room temperature for one, two, six, seven and fourteen days. Even though the viable counts on the

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[154]Cluff, op. cit., p. 68.

[155]Turner, op. cit., p. 42.

[156]John C. Colbeck, "Environmental Aspects of Staphylococcal Infections Acquired in Hospitals," American Journal of Public Health, 50:468, April, 1960.

[157]Andre J. Nahmias and Theodore C. Eickhoff, "Staphylococcal Infections in Hospitals," New England Journal of Medicine, 265:76, July 13, 1961.

[158]Kenneth M. Schreck, "Medical Aspects in the Control of Hospital Acquired Staphylococcal Infections," American Journal of the Medical Sciences, 237:155, February, 1959.

threads fell moderately with succeeding days, he concluded that "surviving bacteria do not appear to lose their virulence."[159]

McDade and Hall studied the survival rate on two strains of Staphylococcus aureus--one strain being type 80/81. Environmental conditions were simulated in the laboratory. They found that pathogenicity remained after several days to one week and therefore recommended that "contaminated surfaces within hospitals may constitute reservoirs of pathogenic staphylococci."[160]

In a later experiment, McDade and Hall studied the effects of different temperatures and relative humidities on Staphylococcus aureus. Their conclusion was that "relatively small numbers of staphylococci innoculated onto sutures have been shown to remain viable and pathogenic for mice after exposure to ambient conditions for one week."[161]

Data presented by Hinton, Maltman and Orr suggested that staphylococci lose their pathogenicity with time, which therefore decreases the infective potential. In their testing, mice were given intramuscular and intravenous infections to test the virulence of Staphylococcus pyogenes. The infective potential is greatest upon release of the organism into the environment and subsequently declines.[162]

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[159]Colbeck, op. cit., p. 471.

[160]McDade, op. cit., p. 366.

[161]Joseph J. McDade and Lawrence B. Hall, "An Experimental Method to Measure the Influence of Environmental Factors of the Viability and the Pathogenicity of Staphylococcus Aureus," American Journal of Hygiene, 77:107, January, 1963.

[162]Hinton, loc. cit.

Not all strains of staphylococcus are equally dangerous. Also, some carriers seem more apt to infect the environment than others.[163] Illustrative of this is the example of a nurse who was a nasal carrier of type 52A. She was employed in a nursery that was not having any trouble with infections until a new nurse came. The new nurse had a face abscess caused by type 52A and soon after the infants became infected.[164]

Bacteriophage Typing

Once patients have acquired a staphylococcal infection, bacteriophage typing is useful in determining which strain he has.[165] During epidemics phage typing is very useful in tracing the source.[166]

To merely know that Staphylococcus aureus coagulase positive is the offender is not sufficient under epidemic conditions.[167] However, noting the organism gives an index to the extent of the infection in the hospital.[168]

Bacteriophage typing involves many technical difficulties and therefore the National Conference sponsored by the United States Public

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[163]"Controlling the Hospital Staphylococcus," British Medical Journal, 2:361, August 4, 1961.

[164]Schreck, op. cit., p. 154.

[165]Kenneth M. Schreck and Emily Hopps, "Observations on the Epidemiology of Staphylococcal Infections," American Journal of the Medical Sciences, 240:172, August, 1960.

[166]Kenneth M. Schreck, "Medical Aspects in the Control of Hospital Acquired Staphylococcal Infections," American Journal of the Medical Sciences, 237:153, February, 1959.

[167]Kenneth M. Schreck, "Hospital Acquired Staphylococcal Infections," Current Medical Digest, 26:79, May, 1959.

[168]Kenneth M. Schreck, "Medical Aspects in the Control of Hospital Acquired Staphylococcal Infections," American Journal of the Medical Sciences, 237:151, February, 1959.

Health Service and the National Research Council recommended that individual hospitals not undertake it; rather, it was suggested that they be served from a regional typing center. Thus, when faced with an epidemic, hospitals could take advantage of such services.[169]

The type of staphylococcus which is of most concern at present is type 80/81. It is often referred to as the "hospital strain."[170] It does not necessarily follow then that the presence of this strain causes infection, for this is untrue. It may be found in the noses and on the skin of infants and adults with no subsequent infective process. Once acquired by an individual, this strain proves to be more persistent than other strains. It is readily transmitted.[171]

Type 80/81 is not the only type causing hospital epidemics. Williams observed that several other phage types of staphylococci are troublemakers.[172]

There seems to be no solution in the near future for the problems caused by this organism--staphylococcus. Epidemic strains are infiltrating the community which will, in turn, reseed the hospitals.[173]

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[169] Ibid., p. 152.

[170] Ibid., p. 157; David E. Rogers, "Staphylococcal Disease on General Medical Services," American Journal of Nursing, 59:842, June, 1959; and Bashe, op. cit., p. 1811.

[171] Kenneth M. Schreck and Emily Hopps, "Observations on the Epidemiology of Staphylococcal Infections," American Journal of the Medical Sciences, 240:183, August, 1960.

[172] R. E. O. Williams, "Epidemic Staphylococci," Lancet, 1:194, January 24, 1959.

[173] Kenneth M. Schreck, "Medical Aspects in the Control of Hospital Acquired Staphylococcal Infections," American Journal of the Medical Sciences, 237:157, February, 1959.

## VI. SUMMARY

In an effort to curtail the ever increasing numbers of staphylococcal infections in hospitals, studies have been done on almost every aspect of the hospital environment to find the most likely reservoir. From blankets to telephones, to carrier states, researchers have tried to find these reservoirs and place them in their proper perspective. The best method at present for combatting such organisms is asepsis. These principles are fundamental in overcoming such infections.

The organism itself is still very ambigious, making it difficult to identify certain specific characteristics. Even so, research continues to investigate whatever is uncertain and unknown, in the hope that someday the problem will either be eliminated or controlled.

# CHAPTER III

## METHODOLOGY, ANALYSIS, AND INTERPRETATION

### I. METHOD OF GATHERING DATA

In order to find out if isolation carts play a role in cross infection, it was necessary to adopt some research tools and techniques which are presented in this chapter.

The study was conducted for three months. This three month period extended from December 12, 1963 to March 11, 1964. Two carefully instructed people were involved in collecting the data.

Permission was obtained through interview and letter* from the acting Director of Nursing Service of the selected hospital to conduct the study. It was requested that the nursing service personnel not be informed concerning the nature of the study as this might influence findings.

The descriptive survey was the method of study. It is defined by Hillway as describing "a condition or to learn the status of something and, whenever possible, to draw valid general conclusions from the facts discovered."[174]

Selection of Carts

All patients isolated for at least forty-eight hours or more during a three month period in one selected hospital were used in this

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*See Appendix.

[174]Tyrus Hillway, Introduction to Research, Boston: Houghton Mifflin Company, 1956, p. 175.

study except pediatric cases and instances in which it was necessary to use a make-shift cart. Pediatric cases were not used because isolation carts were not used on that unit. Make-shift carts were not used because they were not enclosed, therefore not having door pulls.

Obtaining Data

Cultures were taken twice on each isolation cart. The first was taken before the cart left Central Service serving as a control. The second was taken after the cart had been in use for approximately forty-eight hours, give or take two hours. Reasons for choosing this set number of hours were twofold. Robertson cultured the mattress, bed table, bath, wash basin, lavatory seat and blanket of a freshly cleaned room and found all but the lavatory seat negative for staphylococci. Two patients with open staphylococcal lesions were then admitted to the room. After the first day all but two cultures on these articles showed gross contamination with staphylococci. After the second day all cultures revealed heavy contamination. He concluded that a patient contaminates all that he touches and "much that is well beyond his reach."[175] Such a situation affords ample opportunity for the nurse to contaminate herself, perhaps unawares, and transmit this to the cart. This contamination, if it would be spread, would most likely be so within forty-eight hours after use. Secondly, on reviewing the number of isolation carts used during a previous three month period, at least a fourth of them were used for only two days. It was felt that this number constituted a sufficient proportion of the total number of carts.

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[175]Rocke H. Robertson, J. C. Colbeck and W. H. Sutherland, "Some Aspects of Hospital Infection," American Journal of Surgery, 92:235, August, 1956.

Door pulls were selected as the site to obtain specimens because it seemed to be the most logical place to be contaminated, if it were contaminated. Figure 1 on the following page shows a picture of the isolation cart used in the selected hospital.

Index cards were used to keep a record of the data. The patient's name, hospital number, room number, diagnosis, reason for isolation, date and time of first and second culture, laboratory result of first and second culture, and appearance of isolation cart at time of second culture were recorded.

Ruby Dybdahl, Chief Technologist of the Bacteriology Department of the selected hospital developed the specimen gathering technique used in this study. Sterile swabs were dampened in a trypticase soy broth solution and swabbed over the entire area of both door pulls on the isolation carts. The swabs were then replaced in the broth solution and stirred around so that the bacteria would become suspended in it. Following this the mouth of the culture tube was passed through a flame to insure sterility of the procedure and the tube cap replaced.

Laboratory Procedure

Specimens were innoculated on blood agar plates and in thioglycolate broth. These were incubated at 37.5° Centigrade for seventy-two hours. Plates were examined daily for any bacterial growth. If there was any growth in the broth, this was restreaked on a new blood agar plate. Smears were made on colonies on all plates that showed any growth. The pigment and hemolysis of the organisms were noted. These smears were stained by the gram stain method and examined under the microscope.

In most instances it would be expected that the stain smears, when examined, would show up as gram positive micrococci. In order to

FIGURE 1

PHOTOGRAPH OF ISOLATION CART, SHOWING DOOR PULLS,
AS USED IN SELECTED HOSPITAL

classify the micrococci, the colonies were streaked on mannitol salt agar. A coagulase test was run on those organisms that fermented the mannitel.

A pilot study was not done because of the standard nature of the tool and laboratory procedure.

## II. FINDINGS

During the three month period from December 12, 1963, to March 11, 1964, there were a total of twenty-two isolation carts requisitioned by nursing units. Four of the twenty-two isolation carts were not in use by nursing units for forty-eight hours and therefore were unacceptable for this study. Two of the twenty-two isolation carts were not studied--one because a Central Service employee failed to follow instructions and the other because it was impossible for the writer to obtain a specimen from the cart. The total number of isolation carts which were used in this study was sixteen.

Figure 2 shows the number of isolation carts requisitioned during the three month period of the study.

### Control Cultures

Thirteen of the sixteen control cultures on the isolation carts were negative for bacterial growth. Staphylococcus epidermidis in a small amount was found on the remaining three cultures. This organism is nonpathogenic and possibly came from the hands of Central Service employees while cleaning the cart.

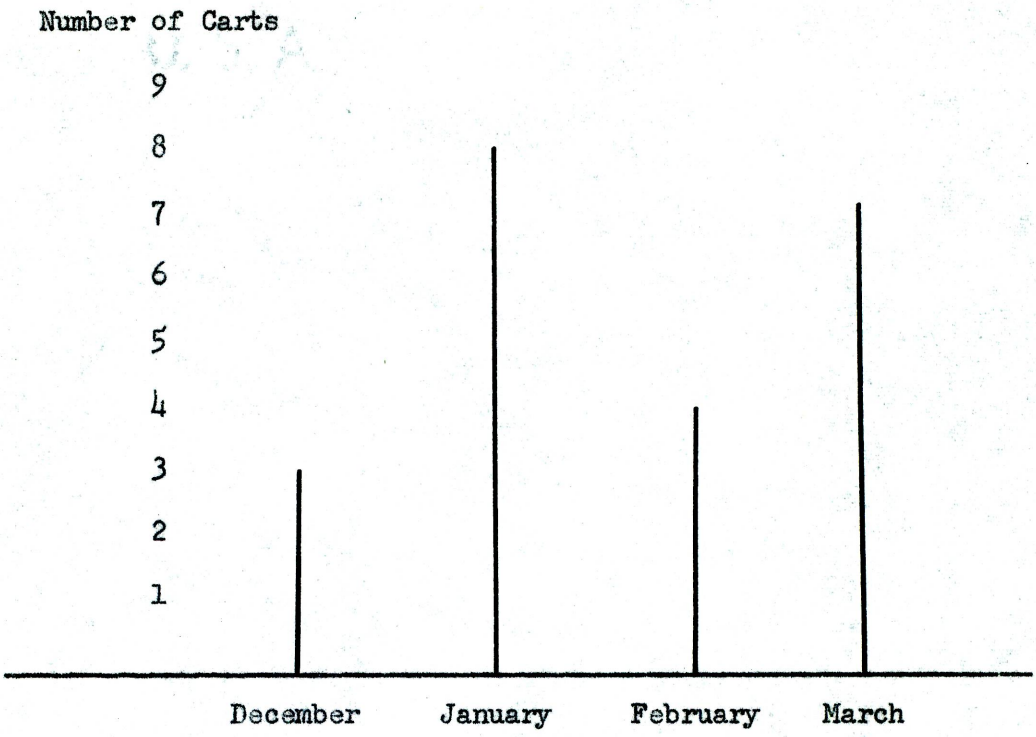


FIGURE 2

NUMBER OF ISOLATION CARTS REQUISITIONED
DURING THE THREE MONTH PERIOD FROM
DECEMBER 12, 1963 TO MARCH 11, 1964

Forty-eight Hour Cultures

The forty-eight hour cultures taken in an effort to find out if the isolation cart was a factor in cross infection were all negative for pathogenic organisms. Six of the sixteen cultures were negative for bacterial growth; eight of the sixteen cultures showed growths of Staphylococcus epidermidis; and the remaining two cultures showed growths of Staphylococcus aureus coagulase negative. Both types of bacterial growths are nonpathogenic and harmless.

A comparison of the control cultures and the forty-eight hour cultures is shown in Table I.

TABLE I

RESULT OF CONTROL AND FORTY-EIGHT HOUR CULTURES TAKEN ON ISOLATION CARTS DURING A THREE MONTH PERIOD

| Organism | Control | Forty-Eight Hour |
|---|---|---|
| Negative | 13 | 6 |
| Staphylococcus epidermidis | 3 | 8 |
| Staphylococcus aureus coagulase negative | 0 | 2 |

At the time of the forty-eight hour culture, the appearance of the isolation carts was noted. In all but three instances the doors of the isolation cart were found opened. On the top of the carts rested many items such as food trays, flowers, gowns, linen, pen, writing pads, etc. This was true of all isolation carts except one.

# III. ANALYSIS AND INTERPRETATION OF DATA

## Purpose for Requisitioning Isolation Carts

In only one instance was a patient isolated for his own protection and this was in the case of a patient with burns. The remaining fifteen patients were isolated because of some infection. These infections were caused primarily by Staphylococcus aureus coagulase positive although Escherichia coli and Pseudomonas aeruginosa were found.

## Bacterial Growth

Not once was any pathogenic organism found on the door pulls of the isolation carts. Only two different types of nonpathogenic organisms, Staphylococcus epidermidis and Staphylococcus aureus coagulase negative, were grown as specimens from the door pulls. These organisms could well have been from the nurses and others using the cart. This type of growth was expected and to pinpoint the source of such organisms would be meaningless.

Evidence showed that nurses did not transmit the causative infectious organisms from patients to door pulls, nor that the door pulls contained any other infectious organism.

Because many of the doors were found opened at the time of the second culture, it could be that the door pulls were not always used by nursing personnel. At one time the writer had opportunity to observe a nurse opening a door on the isolation cart. She did not use the door pull, rather placed the palm of her hand on the door surface and opened it. Further, because most of the doors on the carts were noticed to be opened at the time of the forty-eight hour culture, there may have been no need to use the door pulls.

Antibiotics

At the time isolation procedure was instituted, most of the patients were receiving antibiotics. Walter[176] stated that often the "offending bacteria disappear from both the air and the bedding within twenty-four hours following institution of an aggressive program of specific antibiotics." This may have affected the findings but it cannot be stated as positively doing so.

Statistical Analysis

Statistical analysis indicated an eighty percent probability of significance that there were organisms on the door pulls after forty-eight hours of use. Since these organisms were not pathogenic in nature, it could be that the organisms would be acquired just as readily had the carts remained in Central Service for this forty-eight hour time lapse.

## IV. SUMMARY

Permission was obtained from the acting Director of Nursing Service of the selected hospital to conduct this study. Door pulls on isolation carts were cultured twice in an effort to find out if they were a means of cross infection. The first culture was a control while the second was taken after forty-eight hours of use.

The descriptive survey served as the method of study. The technique of obtaining the specimen and the laboratory procedure used were described in detail.

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[176]Carl W. Walter, "Isolation Technic for Containment or Exclusion of Bacteria," Hospital Topics, 42:59, January, 1964.

Sixteen of a total of twenty-two isolation carts requisitioned by nursing units were studied over a three month period.

Of the control cultures thirteen were negative and three showed small amounts of Staphylococcus epidermidis. The forty-eight hour culture revealed negative bacterial growth on six, Staphylococcus epidermidis in small amounts on eight, and Staphylococcus aureus coagulase negative on two. All organisms were nonpathogenic and harmless.

# CHAPTER IV

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### I. SUMMARY

Since the advent of antibiotics about twenty-two years ago, hospital infections have steadily increased. Such hospital infections are not peculiar to any particular country or hospital, rather they are prevalent throughout the world. The new wonder drugs were viewed as cure-alls and as a result of this, standards of asepsis long held by medical and nursing ranks were lowered. With the lowering of aseptic standards came the inevitable increase in hospital acquired infections.

Nearly all authorities in the field strongly recommend isolation of infected patients accompanied by strict aseptic standards on the part of the nursing and medical staffs.

Much research has been conducted in an attempt to pinpoint modes of cross infection within the confines of the hospital. Research studies have been done on blankets, linen, pillows, and mattresses to find out what part they played in hospital infections. Floors, walls, and other surfaces have been researched. To this list can be added the air, dressing carts, laundry chutes, clothing, curtains and even telephones. Nearly all of these items have been shown to be contaminated at one time or another.

Carrier states in patients and hospital personnel have concerned many authorities. Anywhere from twenty to sixty percent of the hospital personnel are ambulatory carriers.

The organism which most commonly causes hospital infections is Staphylococcus aureus coagulase positive. However, Candida albicans, Escherichia coli, Aerobacter aerogenes, Pseudomonas aeruginosa, Proteus vulgaris, and Alcaligenes faecalis are also responsible and seem to be increasing in importance.

The purpose of this research study was ultimately aimed at developing a safer environment for the hospitalized patient. More specifically, its purpose was to identify the role isolation carts played in cross infection. Isolation carts in one hospital were selected for study. The carts are kept outside of the patient's room in the hall and are considered to be clean. It was the hypothesis of this study that these carts were actually contaminated after being in use for forty-eight hours.

To test the hypothesis, laboratory cultures were run on door pulls of all isolation carts used for at least forty-eight hours during a three month period from December 12, 1963 to March 11, 1964. Door pulls were selected as the site most likely to be contaminated, if the cart were contaminated. The control culture was taken before the cart was put into use by the nursing unit. Another culture was taken after forty-eight hours of use by the nursing unit. Assumptions and limitations were defined and a review of literature was done.

In gathering specimens from the door pulls, the following technique was used: sterile swabs were dampened in a trypticase soy broth solution and swabbed over the entire area of both door pulls on the isolation carts. The swabs were then replaced in the broth solution and stirred around so that the bacteria would become suspended in it.

Following this the mouth of the culture tube was passed through a flame to insure sterility of the procedure and the tube cap replaced. The specimens were then sent to the laboratory where they were innoculated on blood agar plates and in thioglycolate broth. These were incubated at 37.5° Centigrade for seventy-two hours. Plates were examined daily for any bacterial growth. Any growth seen was restreaked on new blood agar plates. Smears were made on colonies on all plates that showed any growth. The pigment and hemolysis of the organisms were noted. These smears were stained by the gram stain method and examined under the microscope. The gram positive micrococci were classified by streaking them on mannitol salt agar. A coagulase test was run on those organisms that fermented the mannitol.

Because of the standard nature of the tool and laboratory procedure, a pilot study was not done.

During the three month study period there was a total of twenty-two isolation carts requisitioned by nursing units. Of the twenty-two, only sixteen qualified for use in this study.

Thirteen of the sixteen control cultures on the isolation carts were negative for bacterial growth. On the other three cultures, Staphylococcus epidermidis in small amounts was found. This is a nonpathogenic organism and most likely came from the hands of whoever cleaned the cart.

Six of the sixteen forty-eight hour cultures were negative for bacterial growth. Eight showed growths of Staphylococcus epidermidis, and the remaining two showed growths of Staphylococcus aureus coagulase negative. Both organisms are nonpathogenic. Comparisons were made of the control and forty-eight hour cultures.

## II. CONCLUSIONS

The hypothesis for this study stated that a clean isolation cart was actually contaminated after forty-eight hours of use by nursing personnel. Laboratory cultures taken on the door pulls of the isolation carts after this time period revealed no pathogenic contamination, proving the hypothesis to be wrong. The organisms present on the door pulls could well have come from hospital personnel using the cart. Statistical analysis indicated an eighty percent probability of significance that there were organisms on the door pulls after forty-eight hours of use. However, because these were nonpathogenic organisms, there is the possibility that the organisms could be obtained just as readily had the carts remained in Central Service for this forty-eight hour time lapse.

On the basis of the contamination of the door pulls only, it can be safely said that in this one selected hospital there was no contamination.

## III. RECOMMENDATIONS

In reviewing literature, it was noticed that there was a difference in laboratory findings on fomites in the hospital environment under epidemic and nonepidemic conditions. Therefore, the following is suggested:

1. This same study be carried out under epidemic conditions rather than as it was--that is, under nonepidemic conditions.

Because a nurse was observed opening the isolation cart door with the palm of her hand placed on the surface of the door, it could be that the door pulls are not used as frequently as it was formerly thought. For this reason the following is recommended for further study:

2. That cultures be taken of approximately a one to two inch wide vertical strip running parallel to the door's edge. Such a study might reveal very different findings.

Very frequently the doors on the isolation carts were noticed to be opened at the time of the forty-eight hour culture. It was surmised that they were frequently left this way. Because of the heavy contamination found on the floor, much bacteria is stirred about when people walk. This contamination may eventually settle out inside the cart on the clean supplies. This brings up the possibility that:

3. Clean supplies contained in the isolation cart may actually be contaminated and should be studied, and

4. The shelves in the isolation cart may be contaminated and deserve consideration.

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APPENDIX

5451 Sepulveda, Apt. 20
Van Nuys, California
December 5, 1963

Miss Evelyn Domke, Director of Nursing Service
White Memorial Hospital
Los Angeles 33, California

Dear Miss Domke:

The purpose of this letter is to obtain permission to do a research study at the White Memorial Hospital. This is in fulfilling the requirements for my Master's Degree in medical-surgical nursing administration at Loma Linda University.

The study consists of obtaining cultures from the door handle on the isolation cart of the patient in isolation. Two cultures will be taken--one before the cart is sent to the unit and another after forty-eight hours of use. This will approximately extend over a three month period. The purpose of this is to find out if the cart is as uncontaminated as it is generally thought to be. Since it is necessary to conduct the study in as natural a setting as possible, I would appreciate it if the personnel were not informed as to the purpose of my research. Upon completion of the study I would be happy to furnish you with a summary of the study if you wish.

I would like to begin the study as soon as possible and would appreciate an early reply. Thank you for your consideration and I am looking forward to hearing from you.

Sincerely,

(Mrs.) Mary Alice Harper

LOMA LINDA UNIVERSITY

Graduate School

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# A STUDY OF ISOLATION CARTS IN A GENERAL HOSPITAL UNDER NONEPIDEMIC CONDITIONS

by

Mary Alice Harper

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An Abstract of a Thesis

in Partial Fulfillment of the Requirements

for the Degree Master of Science

in the Field of Nursing

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June, 1964

ABSTRACT

The purpose of the study was to find out if isolation carts were serving as a means of cross infection. Literature pertaining to sources of possible contamination on hospital units written in the past five years were reviewed.

Using the descriptive survey as the method of study, effort was made to find out if isolation carts were a means of cross infection on the hospital unit. Two laboratory cultures were obtained from both door pulls on all isolation carts used by nursing units. This was done over a three month period from December 12, 1963 to March 11, 1964. The first culture was taken before the cart was put into use by the nursing units and served as a control. The second culture was taken after the carts had been in use by nursing units for forty-eight hours.

For those patients isolated because of specific organisms, effort was made to grow these organisms. For patients isolated for their own protection, effort was made to grow pathogens which could be transmitted to the patient via the isolation cart.

To obtain specimens from door pulls, sterile swabs dampened in trypticase soy broth solution were swabbed over the entire area of both door pulls. The swabs were then replaced in the broth solution and stirred around so the bacteria would become suspended in it. The mouth of the culture tube was then passed through a flame to insure sterility of the procedure. Following this the specimens were sent to the clinical laboratory where they were innoculated on blood agar plates and in thioglycolate broth. These were incubated at 37.5° Centigrade for seventy-two

hours. Plates were examined daily for any bacterial growth. Any growth seen was restreaked on new blood agar plates. Smears were made on colonies on all plates that showed any growth. The pigment and hemolysis of the organisms were noted. These smears were stained by the gram stain method and examined under the microscope. The gram positive micrococci were classified by streaking them on mannitol salt agar. A coagulase test was run on those organisms that fermented the mannitol.

Sixteen isolation carts qualified for this study. Of the control cultures, thirteen were negative for bacterial growth. Three showed small amounts of Staphylococcus epidermidis. This is a nonpathogenic organism which probably came from the hands of whoever cleaned the cart.

Of the forty-eight hour cultures, six were negative for any bacterial growth. Eight showed growths of Staphylococcus epidermidis and the remaining two showed growths of Staphylococcus aureus coagulase negative. The latter organism is also nonpathogenic. Most likely these organisms came from those persons using the isolation cart.

These data indicated that door pulls did not harbor pathogenic organisms. Statistical analysis indicated an eighty percent probability of significance that there were organisms present on the door pulls after forty-eight hours of use. Because these were nonpathogenic organisms, it could be that these organisms could be acquired just as readily had the carts remained in Central Service for this forty-eight hour time lapse.

It was recommended that the study be carried out again under epidemic conditions; that a one to two inch wide vertical strip running parallel to the door's edge be cultured; and that articles inside the isolation cart be cultured.