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Incidence of Staphylococcus Aureus on Fomentation Covers

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INCIDENCE OF STAPHYLOCOCCUS AUREUS ON FOMENTATION COVERS

by

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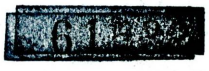

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Each person whose signature appears below certifies that he has read this thesis and that in his opinion it is adequate, in scope and quality, as a thesis for the degree of Master of Science.

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CHAPTER I

INTRODUCTION TO THE STUDY

Wherever the sick have been housed, cross-infection has occurred. During the last decade and a half the problem of hospital-acquired staphylococcal infection has grown into one of the major challenges confronting medicine. Because infection carries the potential threat to life, inconvenience, discomfort and expense, control of cross-infection is essential to good patient care.

This study was concerned with investigating one aspect of the hospital environment as a possible reservoir for Staphylococcus aureus.

I. NEED FOR STUDY

To study fully the problem of Staphylococcus aureus cross-infection, Blowers[1] felt that the discovery of inanimate reservoirs of pathogenic organisms in the hospital was one of the essential preliminaries.

One possible reservoir for Staphylococcus aureus in three selected private hospitals may be the covers used in giving the hydrotherapy treatments called fomentations. The fomentation covers were not sent at any specific time for laundering in Hospitals A and C and once weekly in Hospital B. The nurse using the fomentation covers might have placed them

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[1] Robert Blowers, "Control of Infection in Hospital Wards," Journal of Clinical Pathology, 14:21, January, 1961.

in the laundry chute if they appeared soiled; however, the covers usually had been used many times before they were laundered.

Fomentation treatments are often included in the nursing care for medical and surgical patients, so it seemed important that the material used in administering the treatments be free from pathogenic organisms. The researcher felt an investigation for evidence of Staphylococcus aureus on the fomentation covers, as a part of the environment, could add to the fund of knowledge regarding cross-infection in the hospital.

II. THE PROBLEM

Purpose of the Study

The purpose of the study was to culture fomentation covers for the incidence of Staphylococcus aureus in order to help maintain a safe environment for the patient.

Statement of the Problem

The problem of the study was to ascertain whether fomentation covers were carrying Staphylococcus aureus prior to being placed on the patient receiving a hydrotherapy treatment.

Hypothesis. The hypothesis for this study was that Staphylococcus aureus is present on fomentation covers.

Assumptions. The following assumptions were made for this study:

1. That the technique for collecting cultures from the covers was adequate.

2. That nursing and laboratory personnel or the researcher did not introduce Staphylococcus aureus onto the cultures.

3. That the laboratory procedures were valid for isolating and classifying Staphylococcus aureus.

Limitations. This study was limited in the following ways:

1. The 300 cultures were made from fomentation covers at three selected hospitals.

2. The cultures were obtained from fomentation covers on medical and surgical units only.

3. The cultures were collected during one month, from December 4, 1964 to January 3, 1965.

4. The only organism isolated and classified was Staphylococcus aureus.

5. The cultures were obtained during a period when no patient with staphylococcal infection was receiving fomentation treatments.

III. DEFINITION OF TERMS

Certain terms were explained to provide clearer interpretation and when used in this study denote the given meaning:

Staphylococcus aureus was the gram-positive coccus which grew on 7.5 per cent sodium chloride mannitol phenol red agar, usually formed yellow pigmented colonies, fermented mannitol, hemolysed sheep red blood cells and produced coagulase. These colonies were considered pathogenic.[2]

Salt mannitol agar[3] was the selective medium for the cultures made from the fomentation covers. The 7.5 per cent sodium chloride mannitol

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[2]Robert S. Breed, E. G. D. Murray and Nathan R. Smith, Bergy's Manual of Determinative Bacteriology, seventh edition, Baltimore: Williams and Wilkins Company, 1957, p. 465.

[3]Difco Manual of Dehydrated Culture Media and Reagents for Microbiological and Clinical Laboratory Procedures, ninth edition, Detroit: Difco Laboratories, 1953, p. 150.

phenol red agar, called salt mannitol agar in this study, contained the following materials added to one liter of distilled water:

Bacto-Beef Extract	1 gram
Proteose Peptone No. 3, Difco	10 grams
Sodium Chloride	75 grams
d-Mannitol, Difco	10 grams
Bacto-Agar	15 grams
Bacto-Phenol Red	0.025 grams

Fomentation treatments were hydrotherapy treatments ordered by physicians and administered by graduate nurses and nursing assistants. In preparing the fomentations the thick pads were heated with steam or hot water, wrapped in woolen blankets, and placed on top of one or two towels protecting the patient's skin. If the fomentation were placed over a surgical incision, in addition to the towels, a piece of plastic was used next to the dressing. The heat was conducted to the patient's skin as the vapor formed in the fomentation, passing through the meshes of the blanket pack and towels onto the skin where it condensed and the heat given off.[4] This topical application of heat increased circulation both locally and systemically.

Fomentation pads were made of three or four thicknesses of blanket (half wool and half cotton) sewed together and were about twelve by thirty inches in size. These pads were heated either by being passed through hot water and mechanically wrung out or by steam in a tank.

Fomentation covers were one thickness of 50 to 100 per cent wool blankets thirty by thirty-six inches square. These covers were folded in thirds around the heated pads for hydrotherapy treatments.

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[4]Fred B. Moor and C. W. Dail, Preclinical Physical Therapy, Loma Linda: College of Medical Evangelists, 1940, p. 38.

IV. METHOD OF STUDY

The descriptive survey was the method chosen for this study. Data were obtained by taking 300 bacteriological cultures from fomentation covers at three selected hospitals to ascertain the incidence of Staphylococcus aureus.

Following an interview and letter,* the Directors of Nursing at the three hospitals granted permission to obtain cultures from the fomentation covers on the medical and surgical units.

Literature was reviewed for several purposes: (1) to review current bacteriological knowledge regarding Staphylococcus aureus, (2) to review reports presenting adequate procedures for collecting and classifying the organism, (3) to elicit studies stating the incidence of hospital-acquired staphylococcal infection, and (4) to review studies showing the role of selected inanimate objects in hospital cross-infection.

A pilot study was conducted comparing two methods for collecting cultures from the fomentation covers. The triple-contact-plate method was chosen as the technique for obtaining the cultures which were processed in the Microbiology Department laboratory at Loma Linda University. The results of the data were analyzed, interpretations were made and recommendations suggested.

V. SUMMARY

The purpose of this descriptive survey was to ascertain the incidence of Staphylococcus aureus on fomentation covers used in three selected hospitals in order to help maintain a safe environment for the patient.

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*Appendix

Following a pilot study conducted to compare two methods for obtaining cultures from fomentation covers, the triple-contact-plate method was chosen to collect cultures which were processed in the bacteriology laboratory.

The review of literature is given in Chapter II. A complete description of the method used in this study and the collection of the data are included in Chapter III. The analysis and interpretation of the data are presented in Chapter IV. Summary of the study and recommendations are given in Chapter V.

CHAPTER II

REVIEW OF LITERATURE

Literature was selected on the subjects of classification of Staphylococcus aureus and hospital-acquired Staphylococcus aureus infection. The literature was reviewed for several purposes: (1) to review current bacteriological knowledge regarding the Staphylococcus aureus organism, (2) to review reports presenting adequate procedures for collecting and classifying the organism, (3) to elicit bacteriological knowledge regarding the Staphylococcus aureus infection, and (4) to review environmental studies showing the role of selected inanimate objects in hospital cross-infection.

I. CULTURING AND CLASSIFYING STAPHYLOCOCCUS AUREUS

To conduct this study it was necessary to obtain cultures from fomentation covers and to classify the staphylococci organism. Therefore, literature describing techniques for taking cultures from fabrics and stating laboratory classification of Staphylococcus aureus was reviewed.

Techniques for Taking Cultures From Fabrics

From Australia in 1960, Rubbo and Dixson described their method called the triple-contact-plate technique for obtaining Staphylococcus aureus cultures from fabrics.[1] The fabric was stretched over an aluminum

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[1]Sydney D. Rubbo and S. Dixson, "A Contact-Plate Technique for Determining Bacterial Contamination of Fabrics," Lancet, 2:395, August 20, 1960.

disk mounted to a wooden handle, and a petri disk containing medium was firmly pressed against the fabric at three different sites.

They compared their triple-contact-plate method with two other methods described as follows: (1) the sweep-plate technique, in which the edges of an open petri disk containing medium were brushed several times across the fabric and (2) a percussion-plate technique, in which the fabric was stretched and clamped 5 centimeters above an exposed medium disk in a confined space and then struck with a steel ball. From the results they concluded the triple-contact-plate method to be a simple and adequate method for studying surface contamination of fabrics.

In 1964 Yanis described an adaptation of the triple-contact-plate method. She substituted an Erlenmeyer flask for the aluminum disk and stretched the fabric over the flask, and firmly pressed a petri disk containing medium against the fabric. She felt this technique was an efficient and effective method for obtaining cultures from fabrics.[2]

Classifying Staphylococcus aureus

The study was concerned with Staphylococcus aureus, a micrococcus organism, which was gram-positive and appeared under microscopic view as spherical cells occurring singly, in pairs and in irregular clusters. The organism usually grew as yellow colonies, however, Bailey and Scott stated pigmentation was a variable characteristic as white or colorless colonies might occur.[3] According to Maitland and Martyn the organism was readily

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[2]Bertha Yanis, "The Role of the Environmental Bacteriology Laboratory," Hospital Management, 97:58, March, 1964.

[3]W. R. Bailey and E. G. Scott, Diagnostic Microbiology, Saint Louis: C. V. Mosby Company, 1962, p. 119.

cultured in media containing a salt concentration that inhibited most other morphologically similar bacteria. The ability to grow in salt concentrations allowed selective cultures to be taken from possibly contaminated sites.[4] Bergey's Manual of Determinative Bacteriology, listed the ability to grow in the presence of 10 per cent salt as a characteristic of pathogenic Staphylococcus aureus and Staphylococcus epidermidis, the latter being nonpathogenic white colonies which did not ferment mannitol and were coagulase negative.[5]

Chapman reported that the fermentation of mannitol was a characteristic of Staphylococcus aureus which served as a laboratory test. The property was noted when the phenol red in the agar culture medium turned yellow, indicating acid production.[6] This property was also listed by Breed.[7] However, Elek in his comprehensive review of literature on Staphylococcus aureus stated that certain bacteriologists had often used mannitol fermentation in the classification of staphylococci, but the property was considered of no value by other workers.[8]

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[4]H. B. Maitland and G. Martyn, "A Selective Medium for Isolating Staphylococcus Based on Differential Inhibiting Effect of Increased Concentrations of Sodium Chloride," Journal of Pathology and Bacteriology, 60:561, October, 1948.

[5]Robert S. Breed, E. G. D. Murray, and Nathan R. Smith, Bergey's Manual of Determinative Bacteriology, seventh edition, Baltimore: Williams and Wilkins Company, 1957, p. 465.

[6]George H. Chapman, "The Reliability of Bromthymol-Blue Lactose Agar and Bacto Phenol-Red Mannitol Agar for the Isolation of Pathogenic Staphylococci," Journal of Bacteriology, 48:556, November, 1944.

[7]Breed, Murray, and Smith, op. cit., p. 464.

[8]Stephen D. Elek, Staphylococcus Pyogenes and Its Relation to Disease, London: E. and S. Livingstone Limited, 1959, p. 12.

Nahmias and Eickhoff noted that Staphylococcus aureus hemolyzed red blood cells in most instances.[9] The well-defined clear zone hemolysis on blood agar had been an accepted reaction indicative of pathogenicity until it was shown that under certain circumstances nonhemolytic staphylococci were just as pathogenic as the hemolytic types. However, beta hemolysis was still a laboratory test used in classifying Staphylococcus aureus.[10]

Coagulase, an enzyme produced by certain pathogenic Staphylococcus aureus, manifested the ability to clot rabbit blood plasma. Blair reported in the Bulletin of the World Health Organization that the majority of investigators felt the coagulation of plasma by staphylococci was the most reliable laboratory test available at that time. The property of producing coagulase usually accompanied the property of producing infection.[11]

MacIntosh reviewed the difficulty in classifying the staphylococcal organism in which the results of tests may vary with colonies from the same culture. He concluded with the opinion that the coagulase test appeared to be fairly reliable.[12]

It became apparent after reviewing literature that methods for classifying Staphylococcus aureus were not agreed upon by all bacteriologists. The identification of Staphylococcus aureus as given by Blair[13] seemed to

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[9]Andre' J. Nahmias and T. C. Eickhoff, "Staphylococcal Infections in Hospitals," New England Journal of Medicine, 265:77, July 13, 1961.

[10]Breed, Murray, and Smith, op. cit., p. 465.

[11]John E. Blair, "Laboratory Diagnosis of Staphylococcal Infections," Bulletin of the World Health Organization, 18:299, 1958.

[12]O. C. MacIntosh, "Ubiquitous Staphylococcus Does Not Always Show Its True Colors," Canadian Medical Association Journal, 82:524, March 5, 1960.

[13]Blair, op. cit., p. 305.

be supported by Nahmias and Eickhoff[14] in their later review of literature. The identification of Staphylococcus aureus was based on gross appearance of the culture, microscopic identification of gram-positive cocci, the coagulase-positive test, typical pigmentation of colonies and hemolysis of blood agar. The pigmentation and hemolysis were two characteristics of Staphylococcus aureus not totally reliable for the organism was rather unstable showing pigmentation varying from white through pale yellow to gold and at times was nonhemolytic. Nahmias and Eickhoff suggested that staphylococci that were coagulase-positive and fermented mannitol were classified as Staphylococcus aureus. Staphylococci that were coagulase-negative and did not ferment mannitol were termed Staphylococcus epidermidis.[15]

While determining the various strains of Staphylococcus aureus was not a part of this study, bacteriophage typing of the organism was briefly explained. Staphylococci are susceptible to invasion by bacteriophages, an agent with characteristics of a virus, which "eats bacteria".[16] The bacteriophages grow not on ordinary culture media but in bacteria. The phages being specific for their hosts penetrate the susceptible staphylococcus cell and multiply inside the host until the host bacterium disintegrate. Because the bacteriophages are specific in their attack, certain phages are used to differentiate between various strains of Staphylococcus aureus. Bacteriophage typing is useful in epidemiologic studies to determine similar strains. The Staphylococcus aureus bacteriophage types 80/81/82 are frequently found causing hospital-acquired staphylococcal infection and are sometimes referred to

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[14]Nahmias and Eckhoff, loc. cit. [15]Ibid.

[16]Erwin Neter and D. R. Edgeworth, Medical Microbiology, Philadelphia: F. A. Davis Company, 1962, p. 347.

as the "hospital strains". However, these three strains are not the only strains causing hospital staphylococcal infection.

Emergence of Antibiotic Resistant Staphylococci

Barber reviewed the history of antibiotics used against Staphylococcus aureus infection. When penicillin was introduced in 1940 staphylococcal infection appeared to have been conquered. Early studies had shown that an occasional strain did develop resistance but it was not conceived that this would occur in the hospital. The penicillin-sensitive strains were killed off leaving the resistant strains to carry on the cross-infection within the hospital.[17]

The answer to resistant strains seemed to appear when the tetracyclines arrived in the 1950's because laboratory studies indicated that Staphylococcus aureus did not develop resistance to these drugs. However, Staphylococcus aureus did become resistant, and the cross-infection between patients soon led to the emergence of tetracycline-resistant strains. By 1952, Staphylococcus aureus presented strains with varying resistance to penicillin, tetracyclines and streptomycin.

Staphylococcus aureus appears to have an inherent property to produce penicillinase, an enzyme which destroys penicillin, causing the organism to be resistant. Resistance to other antibiotics may have appeared from exposure to the drug.

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[17]Mary Barber, "Hospital Infection Yesterday and Today," Journal of Clinical Pathology, 14:3, January, 1961.

Hinto and Orr reported that the rate of finding staphylococci resistant to a particular antibiotic has been directly related to the amount of antibiotic used.[18]

Presently methicillin, which is a penicillinase-resistant penicillin, is fairly effective against Staphylococcus aureus. Yet Barber demonstrated strains resistant to methicillin and suggested that a controlled antibiotic policy was necessary in order to prevent Staphylococcus aureus strains from developing against which there is no efficient antibiotic.[19]

After realizing that the hospital was a possible reservoir for multiple-resistant strains of Staphylococcus aureus, the newer antibiotics have been used with greater caution, thereby attempting by a controlled antibiotic policy to decrease the incidence of drug-resistant organisms.

The emergence of drug-resistant Staphylococcus aureus points up the importance of eliminating or controlling all possible hospital reservoirs of potentially pathogenic Staphylococcus aureus.

II. INCIDENCE OF HOSPITAL-ACQUIRED STAPHYLOCOCCUS AUREUS INFECTION

Although hospital-acquired staphylococcal infection has been a problem and was discussed by numerous authors, the magnitude of the problem was difficult to evaluate.

Finland felt that there had actually been an increase in the incidence and severity of staphylococcal infections. He presented points to support the claim as follows:

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[18] N. A. Hinto and J. H. Orr, "Studies on Incidence and Distribution of Antibiotic-Resistant Staphylococci," Journal of Laboratory and Clinical Medicine, 49:569, April, 1957.

[19] Mary Barber, "Methicillin-Resistant Staphylococci," Journal of Clinical Pathology, 14:393, July, 1961.

1. Reports, from many hospitals, of increasing numbers of infections following surgery.

2. Reports, from some hospitals, showing increase of staphylococcal pneumonia, bacteremia and endocarditis.

3. Reports of the increasing role of Staphylococcus aureus as a cause of death.

4. Reports of increased occurrence of antibiotic-resistant strains recovered from the community.[20]

Finland, Jones and Barnes reported a retrospective study at the Boston City Hospital during a twenty-two year period from 1935 to 1957. In 1957 there were nearly four times as many cases of staphylococcal bacteremia as in 1935 and more than twice as many in 1947. They noted nearly a five-fold increase in deaths due to Staphylococcus aureus from 1947 to 1957.[21]

On the other hand Rogers felt there was not an increase in the incidence of staphylococcal infection and reported a study from a New York Hospital showing that death due to staphylococcal infection occurred in ten patients between 1938 and 1940 and in seven patients between 1957 and 1958. The findings were based on 200 consecutive postmortem examinations. He noted a difference in the place where the infection was acquired. During 1938 to 1940 six patients acquired their infection inside the hospital, whereas, during 1957 to 1958 ten patients acquired their infection inside the hospital.[22]

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[20]Maxwell Finland, "Antibiotics for Staphylococcal Infections," Medical Clinics of North America, 42:1179-1181, September, 1958.

[21]Maxwell Finland, W. F. Jones, Jr., and Mildred W. Barnes, "Occurrence of Serious Bacterial Infections Since Introduction of Antibacterial Agents," Journal of the American Medical Association, 170:2191, 2193, August 29, 1959.

[22]Davis E. Rogers, "The Changing Pattern of Life-Threatening Microbial Disease," New England Journal of Medicine, 261:679, October 1, 1959.

Rogers previously reported that staphylococcal infection was a relatively stable contributor to death among medical patients. He noted that staphylococcal pneumonia had increased during the antibiotic era; however, those acquiring the disease were primarily elderly or ill with a predisposing disease.[23]

Information with a similar interpretation was reported by Barnes et al. in a study conducted at the Massachusetts General Hospital. From 1937 to 1957 there was no increase in staphylococcal infections following standardized surgical procedures of herniorrhaphies or abdominal hysterectomies. They felt the increased incidence of staphylococcal infection was a reflection of the older age group receiving surgery and the complexity of surgery being done.[24]

In a later study Barnes et al. reported the incidence of infection following subtotal gastrectomies: 1932 to 1940, 16 per cent; 1941 to 1953, 4.1 per cent; 1954 to 1958, 9.4 per cent; and 1959, 8.5 per cent. The apparent increased infection rate since 1953 was attributed to factors other than an absolute increase in hospital-acquired infections.[25]

Howe in 1954 reported a survey showing that the infection rate gradually increased over a five-year period in a step-wise manner so that in 1953 the incidence of infection had reached 4 per cent with Staphylococcus aureus

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[23]David E. Rogers, "Current Problem of Staphylococcal Infections," Annals of Internal Medicine, 45:762, November, 1956.

[24]Benjamin A. Barnes et al., "An Analysis of Factors Associated with Sepsis in Two Operative Procedures 1937-1957," New England Journal of Medicine, 261:1356, December 31, 1959.

[25]Benjamin A. Barnes et al., "Surgical Sepsis--Report on Subtotal Gastrectomies," Journal of the American Medical Association, 173:1075, July 9, 1960.

being responsible for 80.6 per cent of the infections. He felt that reliance on antibiotic therapy may have been reflected in this increased incidence.[26]

Finland and Jones reported a spot survey in 1956 of 1172 patients at the Boston City Hospital. Of the 181 patients manifesting a staphylococcal infection, 113 acquired the infection in the hospital.[27]

Farrer and MacLeod reported an attack rate for a twelve-month period as 12.8 infections per 10,000 patient-days of hospital care. Staphylococcal infection was hospital-acquired by 319 patients with 58 per cent of these patients experiencing a delay in discharge because of their infection. Forty-six of the patients admitted with staphylococcal infection had been recently hospitalized on an average of two months since discharge. An unknown portion of those patients could be classified as acquiring their infection in the hospital. During the year 10 per cent of the deaths occurring in the hospital were associated with Staphylococcus aureus, and the majority of these deaths were due to staphylococcal pneumonia or empyema.[28]

Minchew and Cluff in Baltimore compared their survey with Farrer and MacLeod in Pennsylvania stating that Baltimore had an overall infection rate of 7.6 per 1,000 patients (0.76 per cent) or 9.5 per 10,000 patient days. Similarly, Pennsylvania reported an overall infection rate of hospital-acquired staphylococcal disease of 13.6 per 1,000 patients (1.4 per cent),

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[26]Chester W. Howe, "Postoperative Wound Infections Due to Staphylococcus Aureus," New England Journal of Medicine, 251:413,415, September 9, 1954.

[27]Maxwell Finland and W. F. Jones, Jr., "Staphylococcal Infections Currently Encountered in a Large Municipal Hospital: Some Problems in Evaluating Antimicrobial Therapy in Such Infections," Annals of the New York Academy of Sciences, 65:192, 1956-1957.

[28]Sanford M. Farrer and Colin M. MacLeod, "Staphylococcal Infections in a General Hospital," American Journal of Hygiene, 72:44,56,57, July, 1960.

or 12.8 per 10,000 patient days. These studies were conducted during a non-epidemic period.[29]

Markham, Phil and Shoot reported from New Zealand the incidence of infection during a ninety-week nonepidemic period. Of the 1254 cases of infection studied, 508 were hospital-acquired. There was a decrease in apparent hospital-acquired staphylococcal infection following surgery with an increase in gram-negative bacilli infection. Staphylococcus aureus, phage types 80/81, accounted consistently for about a third of the staphylococcal infection. The average incidence of hospital-acquired infection among medical patients was 1.9 per cent; among surgical patients, 2.4 per cent, with Staphylococcus aureus responsible for the majority of infections.[30]

Interpretation of the preceding reports was difficult because: (1) surveillance practices varied, (2) most studies were concerned with only one hospital, and (3) many earlier studies were retrospective and may have lacked certain epidemiologic and laboratory information necessary for a complete picture of incidence trends. In the more recent literature reviewed better survey methods were advocated and a few surveys of numerous hospitals using specific criteria for reporting incidence of infection and laboratory work were reported.[31]

The British Public Health Laboratory Service prepared a standardized method using definite criteria to define sepsis in order to measure the incidence of infection after 3276 surgical operations in twenty-one hospitals.

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[29]Harvey Minchew and L. E. Cluff, "Studies of the Epidemiology of Staphylococcal Infection," Journal of Chronic Disease, 13:367, April, 1961.

[30]N. P. Markham, D. Phil (Oxon.), and H. C. Shott, "Sepsis in Hospital Patients Trends in the Epidemiology of Staphylococcal Sepsis," New Zealand Medical Journal, 62:526, November, 1963.

[31]Nahmias and Eickhoff, op. cit., p. 75.

They found the infection rate varied from 4.7 to 21.8 per cent with Staphylococcus aureus isolated most commonly from the wound.[32]

The Medical Audit Program of the American College of Surgeons and the Commission of Professional and Hospital Activities reported a survey of staphylococcal infection among 20,261 patients below fifteen years of age in nineteen hospitals. In 2.4 per cent of the patients staphylococcal infection was clinically diagnosed or suspected.[33]

The United States Veterans Administration reported a survey in six of their hospitals during an eighteen-month period from August 1957 through January 1959. A total of 29,817 patients were admitted, of whom 1093 had staphylococcal infection. Approximately half (511) of the 1093 patients with staphylococcal infection were considered as acquiring the infection within the hospital. Among the 1093 patients with staphylococcal infection, 151 patients died and in fifty-two cases death was attributed to hospital-acquired staphylococcal infection.[34]

Another facet which has emerged in this problem of hospital-acquired staphylococcal infection has been the spread of the organism from the hospital to the community by the discharged patient. When the "hospital strain" was introduced into the family from the hospital, Bashe, Miller and Wentworth

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[32]"Incidence of Surgical Wound Infection in England and Wales," Lancet, 2:663, September 24, 1960.

[33]Commission on Hospital Activities, Staphylococcal Infections in Pediatrics, Medical Audit Program Report No. 12. Ann Arbor: Commission on Hospital Activities, October, 1958, cited by Andre J. Nahmias and T. C. Eickhoff, "Staphylococcal Infections in Hospitals," New England Journal of Medicine, 265:76, July 13, 1961.

[34]"Evaluation of Hospital Infections with Analysis in Mortality and Morbidity," Surgery, Gynecology and Obstetrics, 110:157-163, February, 1960.

found there was about one chance in four that some other member of the family could become ill.[35]

III. ROLE OF SELECTED OBJECTS IN STAPHYLOCOCCUS AUREUS CROSS-INFECTION

Studies were reviewed concerning Staphylococcus aureus contamination of environmental objects similar in texture to the fomentation covers such as mattresses, pillow cases, blankets and sheets.

Virtually every inanimate object comprising the hospital environment was found to be contaminated with Staphylococcus aureus. However, Mortimer felt the epidemiologic significance of the environment was difficult to establish for the mere presence of the organism on objects should not be equated with infectiousness.[36]

In 1961 Howe et al. reporting a survey of seventy-three mattresses on a surgical unit during a three month nonepidemic period, found only two Staphylococcus aureus cultures. Among twenty-seven postoperative hospital patients with draining staphylococcal lesions only one patient's mattress was found to be contaminated by the organism. In this one case the organism cultured from both the mattress and the patient's lesion was Staphylococcus aureus with a bacteriophage pattern of 80/81/82. In the same study the plastic mattress covers were found contaminated by the organism in five of fifty-two cultures. Following surgery Staphylococcus aureus was a component of wound flora in four patients, but the organism was not cultured from the

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[35]W. J. Bashe, A. L. Miller and F. H. Wentworth, "Community Staphylococcal Infection Relationship to the Hospital Problem," American Journal of Public Health, 52:1815, November, 1962.

[36]Edward A. Mortimer, Jr., "Hospital Staphylococcal Infections Interruption of Transmission as a Means of Control," Medical Clinics of North America, 47:1250, September, 1963.

mattresses the day of surgery. The authors concluded that the mattresses were not an important reservoir of Staphylococcus aureus.[37]

Colbeck reported that patients in certain rooms appeared to have more boils and similar infections. The infections no longer occurred after the mattresses and blankets were disinfected. Mattresses may have been a reservoir for the organism passing through the sheets to the patient and vice versa.[38]

In another study reported by Colbeck, patients with suppurating lesions caused contamination of mattresses. When a stored group of twenty-eight mattresses were cultured, one-third retained pathogenic staphylococci despite being stored for "some months".[39]

Adams et al. reported that repeated random cultures from mattresses in constant use showed large numbers of bacteria.[40]

Few studies on pathogen-contaminated pillow cases were found. Kaye found a higher bacteria count on soiled pillow cases than on used wool blankets or sheets.[41] Walter stated there was a higher bacteria count on

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[37]Chester W. Howe et al., "Staphylococcal Contamination of Mattresses and Blankets on a Surgical Ward Under Nonepidemic Conditions," New England Journal of Medicine, 264:630, March 30, 1961.

[38]John C. Colbeck, "Environmental Aspects of Staphylococcal Infections Acquired in Hospitals I. The Hospital Environment--Its Place in the Hospital Staphylococcus Infections Problem," American Journal of Public Health, 50:469, 472, April, 1960.

[39]John C. Colbeck, "Studies in Hospital Infections," Canadian Services Medical Journal, 12:570, July-August, 1956.

[40]Ralph Adams et al., "Control of Infections Within Hospitals," Journal of American Medical Association, 169:1559, April 4, 1959.

[41]S. Kaye, "The Use of Ethylene Oxide for the Sterilization of Hospital Equipment," Journal of Laboratory and Clinical Medicine, 35:826, May, 1950.

pillow cases than on the head end of the top sheet.[42]

From his review of literature, Haas concluded that since "a considerable percentage" of patients became nasal carriers the patient's pillow would eventually become contaminated. The contaminated pillow may expel pathogens whenever the patient moves his head or the nurse fluffs the pillow.[43]

Blankets have been incriminated as important reservoirs of Staphylococcus aureus and responsible for hospital cross-infection. In 1915 after surveying blanket contamination before and after laundering, Blowers and Wallace felt that blankets were responsible for the cross-infection of patients with drug-resistant Staphylococcus aureus and that blankets should be washed or sterilized before use by each new patient.[44] On the other hand, Cowling reporting in 1962 was unable to show a lower incidence of acquired infection when each new surgical patient used a sterilized blanket.[45]

Blowers et al. in 1955 showed that blankets and sheets of infected patients were contaminated by large numbers of Staphylococcus aureus.[46]

In the report by Howe et al. previously referred to, the authors also studied the role blankets played in cross-infection. A total of 234 cultures were taken from sixty-two clean blankets placed on the unit for current use.

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[42]Carl W. Walter, "Environmental Sepsis," Modern Hospital, 91:75, December, 1958.

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

[44]Robert Blowers and K. R. Wallace, "Sterilization of Blankets with Cetyl Trimethylamine Bromide," Lancet, 1:1251, June 18, 1955.

[45]D. C. Cowling, "Comment on a Surgical Wound Survey at the Royal Melbourne Hospital (With a Note on the Introduction of Boiled Woolen Blankets)," Medical Journal of Australia, 1:926, June 16, 1962.

[46]Robert Blowers et al., "Control of Wound Infection in a Thoracic Surgery Unit," Lancet, 2:787, October 15, 1955.

By the end of eight weeks 80 per cent of the blankets were contaminated with Staphylococcus aureus. The degree of contamination was not heavy, showing only one to ten colonies per sweep plate. No significant correlation was made between the types of Staphylococcus aureus carried by patients with no infection and their blankets. No case of staphylococcal infection could be attributed to blankets. However, the Staphylococcus aureus strains most frequently cultured from blankets and unit personnel were bacteriphage types 80/81.[47]

In 1961 Hare and Cook found blankets used by six patients who were staphylococcal carriers to have few Staphylococcus aureus organisms on them.[48]

Referring again to Colbeck's report, the author compared Staphylococcus aureus counts on hospital blankets with blankets in trains and hotels and found the hospital blankets to have a higher bacteria count.[49]

Using a nonpathogenic marker organism in a hospital unit, Rubbo, Stratford and Dixson reported in 1962 a study comparing the bacteria count of various textiles. Cotton sheets were found to have little capacity to "absorb" air-borne organisms; however, the sheets had the heaviest surface count. The degree of surface contamination was important in aerial dispersion. Blankets when shaken yielded less than 5 per cent of their total bacteria content, while cotton sheets shaken dispersed up to 30 per cent of their bacterial load. A contaminated blanket covered with a spread dispersed more organisms than two uncovered blankets with twice the inoculum. Fewer

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[47] Howe et al., op. cit., p. 632.

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

[49] John C. Colbeck, "Environmental Aspects of Staphylococcal Infections Acquired in Hospitals I. The Hospital Environment--Its Place in the Hospital Staphylococcus Infections Problem," American Journal of Public Health, 50:469, April, 1960.

organisms were dispersed when the spread and blanket were fixed together with safety pins. The amount of organism dispersal seemed related to the amount of friction occurring between the surfaces of the spread and blanket.[50]

In 1960, Rubbo reported research concerning the degree of organism transfer from a textile to the hand. He stated, "In general the transfer efficiency is determined by two factors, (1) the heaviness of the surface contamination, and (2) the amount of moisture on the skin surface."[51] Woolen blankets and cotton sheets were exposed in the same ward for three days. The surface contamination was greatest for the cotton textiles. The cotton sheets, spreads and pillow cases "can play a very significant role in contact infection and that blankets, by comparison, are relatively unimportant."[52] The surface contamination of a textile was more important than its total bacterial count, also contact transmission depended partly on the degree of surface contamination and moisture on the skin. "We can definitely state that it is a break of aseptic discipline to handle textiles with hands which are moist either from natural or artificial causes."[53]

Cowling suggested the increased incidence of sepsis in the summer months may be attributed to the humidity and moist skin.[54]

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[50]Sydney D. Rubbo and B. C. Stratford, "Spread of a Marker Organism in a Hospital Ward," British Medical Journal, 2:287, August 4, 1962.

[51]R. E. O. Williams and R. A. Shooter (eds.) Infections in Hospitals Epidemiology and Control, Oxford: Blackwell Scientific Publications, 1963, p. 237.

[52]Ibid.

[53]Ibid., p. 239.

[54]Cowling, op. cit., p. 926.

IV. SUMMARY

Several culturing techniques for fabrics have been used by researchers and the triple-contact-plate method appeared to be an effective method for studying surface bacteria contamination of fabrics.

Staphylococcus aureus is a pathogenic organism as evidenced by the clinical infections caused. When classifying Staphylococcus aureus different cultures may react in varying ways to the laboratory tests. In general the Staphylococcus aureus characteristics agreed upon by bacteriologists were the pigmentation of the colonies growing on culture media, mannitol fermentation, clear zone hemolysis of blood agar, and the coagulation of blood plasma.

The incidence of staphylococcal hospital-acquired infection was found to vary from hospital to hospital. Comparison of the numerous surveys showing the incidence of staphylococcal infection was difficult due to the varying surveillance methods used for classifying staphylococcal infection and the lack of uniformity in reporting incidences of infection. There was an indication that staphylococcal hospital-acquired infection has shown a slight decline, while infection due to the gram-negative bacilli has increased. However, the possibility for a patient to acquire a staphylococcal infection was still present and measures should be taken to prevent cross-infection.

The role played by objects within the patient's environment in cross-infection was controversial. The viewpoint was held by some authors that the inanimate objects such as mattresses, blankets and sheets were reservoirs for staphylococci from which the patient directly acquired organisms causing infection. However, not all authors ascribed to the importance played by the environment, feeling the evidence from studies showed that patients infrequently acquired their infection from the environment. There was growing

interest in the amount of organism dispersal resulting from friction between the surfaces of bed linen and the contact transmission of organisms depending partly on the degree of surface contamination and moisture on the skin.

CHAPTER III

THE METHOD

In this chapter the method used to conduct the study is presented. The pilot study with the results, the technique used to collect the cultures, the laboratory process used for classifying the data and tabulation of the data are discussed.

A review of literature was made for several purposes: (1) to review current bacteriological knowledge regarding Staphylococcus aureus, (2) review reports presenting adequate procedures for collecting and classifying organism, (3) to elicit studies stating the incidence of hospital-acquired staphylococcal infection, and (4) to review studies showing the role of selected inanimate objects in hospital cross-infection.

The problem of the study was to ascertain whether fomentation covers were carrying Staphylococcus aureus prior to being placed on the patient receiving a hydrotherapy treatment. The purpose of the study was to culture the fomentation covers for the incidence of Staphylococcus aureus in order to help maintain a safe environment for the patient. The descriptive survey was chosen as the method for obtaining this information.

Following an interview and letter,* the Directors of Nursing Service at the selected hospitals granted permission to obtain cultures from the fomentation covers on the medical and surgical units. The nursing personnel were told the study was to ascertain whether there were organisms on the covers, and the researcher would periodically be obtaining cultures from the

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*Appendix

covers. During a one month period one-hundred cultures were made from the fomentation covers at each of the three hospitals.

Cultures were obtained from the researcher to ascertain whether she was a staphylococcal carrier. The cultures showed that she carried on her hands gram-positive staphylococci which formed yellow colonies, fermented mannitol, were nonhemolytic, and coagulase negative. As a precaution while collecting cultures for this study, clean plastic gloves, mask and gown were worn by the researcher.

I. CONDUCTING THE PILOT STUDY

A pilot study was conducted in one hospital to compare two methods for collecting organisms from fomentation covers.

A procedure described by Rubbo and Dixson,[1] called the triple-contact-plate technique, with the adaptation of Yanis,[2] was used to take cultures from the fomentation covers. The cover was stretched over the bottom of a clean Erlenmeyer flask and a petri dish containing salt mannitol agar was firmly pressed against the cover at three different sites. After each triple-contact-plate culture was made from the cover, the petri dish was labeled with date and source, and was incubated. This will be referred to as Method A.

Method B involved basting a patch in the center of twenty fomentation covers. These patches were 7.7 centimeters square (3.1 inches), with approximately the same area as a nine centimeter petri dish and were cut from a

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[1]Sydney D. Rubbo and S. Dixson, "A Contact-Plate Technique for Determining Bacterial Contamination of Fabrics," Lancet, 2:395, August 20, 1960.

[2]Bertha Yanis, "The Role of the Environmental Bacteriology Laboratory," Hospital Management, 97:58, March, 1964.

fomentation cover. After the cover had been in use, the basted patch was removed by cutting the thread and using a clean tongue depresser the patch was carefully transferred to an empty sterile petri dish, labeled and dated. In the laboratory the patch was transferred with flamed forceps into a sterile blender jar containing 10 milliliters of sterile water then whirled for a few seconds. One to two milliliters of the water were pipetted onto a petri dish containing salt mannitol agar, and the petri dish was labeled with date and source and was incubated. This was Method B.

A triple-contact-plate culture was also made from each cover after removing the patch.

A total of twenty patches were basted on the fomentation covers on three units: six on medical and seven on each of the surgical units. Ten patches were removed after two days use and seven patches were removed after four days use. The other three covers with patches were not located so were not included in the data of the pilot study.

By using Method A and Method B two cultures were taken from each of the seventeen fomentation covers. Three gram-positive cocci cultures were obtained, two cultures were from the same fomentation cover. The third culture was obtained by using Method B. Since Method B, which yielded only one more gram-positive cocci, was more complicated and involved, Method B was not considered superior to Method A. Therefore, Method A was selected as an adequate technique for collecting cultures from the fomentation covers.

The seventeen cultures obtained by Method B were not included in tabulating the results of the study.

II. COLLECTING THE DATA

The triple-contact-plate technique (Method A described in the pilot study) was used to collect the data for this study. One-hundred cultures were obtained from each of the three hospitals, making a total of 300 triple-contact-plate cultures collected. Of these, 116 cultures were taken from four medical units and 184 from seven surgical units. At Hospital A, with no laundry routine for fomentation covers, the cultures were collected on the first, second, third, fifth, seventh, eighth and tenth day of a ten-day period. At Hospital B, with a weekly laundry routine for the covers, the cultures were obtained on three different occasions: first, second, and fifth day after the covers were laundered. At Hospital C, with no laundry routine for the covers, all the cultures were obtained on the same day.

At Hospitals A and B the cultures were taken after the covers were folded around the heated pads ready for the hydrotherapy treatment. At Hospital C the cultures were taken from the fomentation covers before they were folded around the heated pads.

No patient with a staphylococcal infection received fomentation treatments during the survey period. This information was obtained at Hospital A by checking for fomentation treatments on the charts of those patients having a laboratory report of Staphylococcus aureus. At Hospitals B and C the information was obtained when collecting the cultures by observing for patients in isolation and inquiring of the head nurse.

Laboratory Process

All of the cultures were processed in the Microbiology Department laboratory at Loma Linda University.

The petri dishes used to culture the fomentation covers contained 7.5 per cent sodium chloride mannitol phenol red agar, called salt mannitol agar

in this study. This was a selective medium for isolating the staphylococci and was prepared by the following formula:[3]

Bacto-Beef Extract	1 gram
Proteose Pepetone No. 3, Difco	10 grams
Sodium Chloride	75 grams
d-Mannitol, Difco	10 grams
Bacto-agar	15 grams
Bacto-Phenol Red	0.025 grams

To rehydrate the medium 1000 milliliters of cold distilled water were added to the 111 grams of salt mannitol agar, stirred until well mixed and heated to dissolve the medium. The medium was poured into bottles and sterilized in the autoclave for fifteen minutes at fifteen pounds pressure. The medium was either cooled and poured into sterile petri dishes to solidify or was stored for later use. Until used the petri dishes containing the salt mannitol agar were refrigerated upsdie down to prevent condensation of moisture on the medium.

The beef extract and peptone in the medium were the nutrients for the organism. The salt mannitol agar was made selective by adding a high percentage of salt, which inhibited the growth of most organisms yet did not interfere with the growth of staphylococci. The mannitol was a glucose which the staphylococci organism fermented into an acid. The phenol red in the medium indicated this reaction by turning the medium from red to yellow. The agar which solidified at 37 degrees centigrade gave a solid medium on which staphylococci could grow and cultures from fomentation covers could be made.

After making the cultures from the fomentation covers, the petri dishes were taken to the laboratory and incubated at 37.5 degree centigrade.

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[3] Difco Manual of Dehydrated Culture Media and Reagents for Microbiological and Clinical Laboratory Procedures, ninth edition, Detroit: Difco Laboratories, 1953, p. 150.

The dishes were inspected without opening after twenty-four hours, then daily for three succeeding days.

A gram stain was made of the colonies growing on the selective media. Those found not to be cocci were discarded.

Pigmentation of the gram-positive cocci was noted by gross examination under artificial light. The pigmentation varied from pale to deep yellow. To aid in differentiating between pale yellow and white colonies a sterile wire loop was pulled across the medium to collect a mass of organisms and the pigmentation was noted.

Mannitol fermentation was readily identified by observing the bright yellow zone surrounding the organisms growing on the salt mannitol agar.

The gram-positive cocci were streaked onto sheep blood agar plates, and incubated for twenty-four hours. The hemolysis around individual colonies was noted when the petri dish was held up to artificial light. If single colonies were not present, another blood agar plate was streaked, incubated for twenty-four hours and the hemolysis around the individual colonies was noted.

Two coagulase tests were made on each gram-positive cocci culture. In a clean test tube one-half milliliter diluted citrated rabbit plasma 1:2 with sterile Todd Hewitt broth was inoculated heavily with a twenty-four hour culture of the organism and placed in a water bath at 37.5 degrees centigrade. Coagulation in one to four hours was interpreted as positive. The second coagulation test was conducted using commercial lyophilized human plasma (Diagnostic Plasma Warner-Chilcott). This Diagnostic Plasma was prepared from pooled human plasma standardized to contain optimal concentrations of clotting factors. In a sterile test tube with cotton plug, three-fourth milliliter diluted Diagnostic Plasma 1:3 with sterile

Todd Hewitt broth was inoculated heavily with a twenty-four hour culture of the organism and placed in a water bath at 37.5 degrees centigrade. Coagulation in one to three hours was interpreted as positive.

From each gram-positive staphylococci culture a nutrient agar slant culture was made and refrigerated for later reference if necessary. An index card was used on which to record identifying information and laboratory findings for each culture on which gram-positive cocci grew.

Classification of the Staphylococci

At the conclusion of the laboratory work thirty-eight cultures were found to be staphylococci organisms and were classified as Staphylococcus aureus or Staphylococcus epidermidis. The characteristics noted for the Staphylococcus epidermidis were (1) white colonies, (2) no mannitol fermentation, (3) no hemolysis, and (4) no coagulation of plasma. The four characteristics noted for the Staphylococcus aureus organisms were (1) colony pigmentation varying from pale to deep yellow or gold, (2) mannitol fermentation as evidenced by the phenol-red indicator turning yellow, (3) clear zone hemolysis around individual colonies in blood agar and (4) coagulation of plasma.

Use of the Data

Following the classification of Staphylococcus aureus the data were tabulated. Depending upon the single or multiple characteristics shown in the laboratory these specimens were further catagorized as "definite," "possible" or "questionable" Staphylococcus aureus. The incidence of Staphylococcus aureus collected from the medical and surgical units was tabulated. Interpretations were made from these data. These are presented in Chapter IV.

III. SUMMARY

The fomentation covers used in three selected hospitals were cultured for the incidence of Staphylococcus aureus as a means in ascertaining possible reservoirs for cross-infection. The descriptive survey served as the method for the study.

The Directors of Nursing at each of the three selected hospitals granted permission to collect cultures from the fomentation covers.

Following a pilot study comparing two methods for obtaining bacteriological cultures from the fomentation covers, the triple-contact-plate method was selected to collect the cultures. One-hundred cultures were obtained from each of the three hospitals making a total of 300 triple-contact-plate cultures collected. The method for obtaining the cultures and the classifying laboratory procedures were described in detail.

CHAPTER IV

PRESENTATION AND INTERPRETATION OF THE DATA

The purpose of this chapter is to present data gleaned during analysis of the 300 triple-contact-plate cultures made from the fomentation covers used at three selected hospitals.

I. CLASSIFICATION OF ORGANISMS

A total of thirty-eight, or 13 per cent of the 300 cultures, yielded gram-positive staphylococci. Among the thirty-eight gram-positive staphylococci cultures, twelve, or 4 per cent of the 300 cultures, were classified as Staphylococcus epidermidis and twenty-six, or 9 per cent of the 300 cultures, were classified as Staphylococcus aureus according to their single or multiple characteristics.

Cultures Classified as Staphylococcus Epidermidis

The twelve cultures that grew as white colonies on the salt mannitol agar, did not ferment mannitol, were nonhemolytic and coagulase-negative. Bergey's Manual of Determinative Bacteriology considered organisms having these characteristics as Staphylococcus epidermidis, therefore, these twelve cultures were classified as Staphylococcus epidermidis from the evidence demonstrated in the laboratory.[1] These findings were not alarming since Staphylococcus epidermidis is usually considered a nonpahtogenic inhabitant on the skin and mucous membranes.

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[1]Robert S. Breed, E. G. D. Murray and Nathan R. Smith, Bergey's Manual of Determinative Bacteriology, seventh edition, Baltimore: Williams and Wilkins Company, 1957, p. 466.

Cultures Classified as Staphylococcus Aureus

Twenty-six, or 9 per cent of the 300 cultures were classified as Staphylococcus aureus according to their single or multiple characteristics. To classify these twenty-six staphylococci cultures the single or multiple characteristics displayed by the organisms were compared with those listed in Bergey's Manual of Determinative Bacteriology.[2] The characteristics noted were: (1) yellow colonies growing on salt mannitol agar, (2) wide yellow zones indicating mannitol fermentation, (3) well defined beta hemolysis around individual colonies on sheep blood agar, and (4) coagulase-positive.

Of these twenty-six cultures, seven cultures were found at Hospital A, seven cultures at Hospital B and twelve cultures at Hospital C. There were thirteen cultures from the medical units and thirteen cultures from the surgical units as shown in Table I.

Of the twenty-six gram-positive cultures, two, or 0.66 per cent of the 300 cultures, were unquestionably pathogenic Staphylococcus aureus and were positive for all four characteristics.

Of the twenty-six cultures, twenty-four cultures were not positive for all four of the classifying characteristics. The varying characteristics were not surprising as bacteriologists have encountered difficulty in classifying Staphylococcus aureus. Elek,[3] a professor of Bacteriology at the University of London, in his 539 page monograph about Staphylococcus Pyogenes wrote of Staphylococcus aureus stating:

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[2]Ibid., p. 465.

[3]Stephen D. Elek, Staphylococcus Pyogenes and Its Relation to Disease, London: E. and S. Livingstone Limited, 1959, p. 16.

> Almost all its typical characteristics are subject to frequent variation, coagulase, haemolysins, carbohydrate fermentation, colony form, and pigment production all vary so frequently that no one of the characteristics can be relied on absolutely for taxonomic purposes, and multiple characters have to be taken to define Staphylococcus pyogenes for practical purposes.

Of the twenty-four cultures in question, there were four, or 1 per cent of the 300 cultures that were pigmented, fermented mannitol, and were beta hemolytic, but were coagulase-negative. These four cultures were classified as "definite" Staphylococcus aureus despite being coagulase-negative. It seemed reasonable to make this classification even though bacteriologists appear generally to agree that there is a correlation between being coagulase-positive and being pathogenic, as Williams[4] has stated:

> Coagulase-negative staphylococci are usually harmless, although there are a few exceptions to this generalization; they may cause urinary infections and have been seen as the organism responsible for endocarditis after operations on the heart.

Of the twenty-four cultures, seventeen cultures, or 6 per cent of the 300 cultures, met only two characteristics. These organisms were classified by their two typical characteristics of pigmentation and mannitol fermentation as "possible" Staphylococcus aureus.

There were three cultures, or 1 per cent, that were pigmented but did not ferment mannitol, were nonhemolytic and coagulase-negative. These organisms were classified as "questionable" Staphylococcus aureus from only one characteristic. These data are displayed in Table II.

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[4] R. E. O. Williams et al., Hospital Infection Causes and Prevention, Chicago: Year Book Publishers, 1960, p. 24.

TABLE I

PATHOGENICITY OF FOMENTATION CULTURES
FOR STAPHYLOCOCCUS AUREUS
AT THREE HOSPITALS

	Medical Unit				Surgical Unit			
Hospitals	A	B	C	Total	A	B	C	Total
Pathogenic								
Definite	2	1	2	5	1	0	0	1
Possible	3	0	4	7	1	4	5	10
Questionable	0	0	1	1	0	2	0	2
Totals	5	1	7	13	2	6	5	13

TABLE II

STAPHYLOCOCCUS AUREUS ISOLATED FROM 300 FOMENTATION CULTURES AT THREE HOSPITALS

Characteristic	Hospital A Number	Hospital B Number	Hospital C Number	Total	Per cent
Staphylococcus aureus "definite"					
Coagulase-positive					
Hemolytic					
Fermented	2	0	0	2	0.66
Pigmented					
Hemolytic					
Mannitol fermented	1	1	2	4	1
Pigmented					
Staphylococcus aureus "possible"					
Mannitol fermented					
Pigmented	4	4	9	17	6
Staphylococcus aureus "questionable"					
Pigmented only	0	2	1	3	1
Totals	7	7	12	26	8.66

II. STAPHYLOCOCCUS AUREUS OBTAINED AT EACH HOSPITAL

Of the 300 cultures made from fomentation covers at the three hospitals, twenty-six cultures were classified as "definite", "possible", or "questionable" Staphylococcus aureus. At Hospital A, which had no laundry routine for the fomentation covers, seven of the twenty-six cultures were obtained. These cultures were taken after the covers were folded around the heated pads ready for the hydrotherapy treatment. The cultures were collected on the first, second, third, fifth, seventh, eighth and tenth day of a ten-day period.

At Hospital A there were three "definite" and four "possible" Staphylococcus aureus cultures found. During the ten-day collecting period the three "definite" cultures were obtained on the first two days, one "possible" culture was taken on the seventh day, two "possible" cultures were taken on the eighth day and one "possible" culture was taken on the tenth day. The medical unit received a supply of clean fomentation covers on the fifth day of the collecting period and thereafter no "definite" Staphylococcus aureus cultures were found. No "questionable" cultures were found.

At Hospital B, which had a weekly laundry routine for the fomentation covers, seven of the twenty-six positive cultures were obtained. The cultures were obtained on three different occasions; on the first, second and fifth day after the covers were laundered.

At Hospital B, the one "definite" Staphylococcus aureus was obtained on the day after the cover was laundered, four "possible" cultures were taken on the second and fifth day after the covers were laundered and two "questionable" cultures were made on the third day. As might be expected, more covers were found contaminated on the second and fifth days than on the first day.

At Hospital C, with no laundry routine for the fomentation covers, twelve cultures were obtained. All of the cultures were made on the same day and were taken from the fomentation covers before they were folded around the heated pads.

Two cultures were classified as "definite" Staphylococcus aureus, nine cultures were classified as "possible" Staphylococcus aureus, and one culture was classified as "questionable" Staphylococcus aureus. These data are shown on Table II.

There appeared nearly a uniform number of cultures considered "definite" Staphylococcus aureus among the three hospitals, with Hospital A having three, Hospital B having one, and Hospital C having two. Of the cultures considered "possible" Staphylococcus aureus there was an equal number at Hospitals A and B of four each, whereas, Hospital C showed a higher incidence of nine. The cultures considered "questionable" Staphylococcus aureus were from only two hospitals, Hospital B with two and Hospital C with one.

The laundry routines might have influenced the slight variation in the number of "definite" Staphylococcus aureus cultures obtained from the covers. The two hospitals, where the fomentation covers were not routinely laundered, presented the highest and second highest number of "definite" Staphylococcus aureus cultures. While the hospital where the covers were laundered weekly had the lowest number of "definite" Staphylococcus aureus organisms. There were fewer fomentation covers found contaminated with "definite" Staphylococcus aureus when the covers were laundered weekly, than when there was no routine laundry schedule.

The covers folded in thirds around the heated pads prepared for the fomentation treatments and in contact with the heat and moisture showed more contamination from "definite" Staphylococcus aureus than those cultured before they were folded around the heated pad.

III. SUMMARY

A total of 300 triple-contact-plate cultures were collected from fomentation covers used in three selected hospitals. There were thirty-eight, or 13 per cent of the 300 cultures, that were gram-positive staphylococci. Of these thirty-eight, twelve, or 4 per cent of the 300 cultures were classified as Staphylococcus epidermidis, which is a reasonable finding since the organism is a normal inhabitant on the skin and mucous membranes. Of the thirty-eight cultures, the remaining twenty-six, or 9 per cent of the 300 cultures, were classified according to the single or multiple characteristics they presented. Of the twenty-six, there were six cultures considered "definite" Staphylococcus aureus, seventeen cultures were considered "possible" Staphylococcus aureus, and three cultures were considered "questionable" Staphylococcus aureus.

There were fewer fomentation covers found contaminated with "definite" Staphylococcus aureus when the covers were laundered weekly, than when there was no routine laundry schedule.

Staphylococcus aureus organisms were not destroyed by the covers being in contact with the heated pad when prepared for a hydrotherapy treatment.

Two per cent of the fomentation covers were found to be contaminated with pathogenic Staphylococcus aureus.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY AND CONCLUSIONS

Infection carries a potential threat to life, inconvenience, discomfort and expense, therefore, the control of cross-infection in the hospital is essential to good patient care. The problem of hospital-acquired staphylococcal infection has become a challenge to those responsible for patient care and discovering the inanimate reservoirs of the Staphylococcus aureus organism may be an essential preliminary in the control of cross-infection.

The problem of the study was to ascertain whether fomentation covers were carrying Staphylococcus aureus prior to being placed on the patient receiving a hydrotherapy treatment. The purpose of the study was to culture fomentation covers for the incidence of Staphylococcus aureus in order to help maintain a safe environment for the patient.

From a review of literature on the subject of the Staphylococcus aureus organism and from studies of hospital-acquired staphylococcal infection it appeared that: (1) researchers had used various techniques for making cultures from fabrics, (2) Staphylococcus aureus cultures may react in varying ways to the laboratory tests making classification somewhat difficult, (3) the problem of hospital-acquired staphylococcal cross-infection was present, (4) the role played by the environment in hospital-acquired infection was controversial, and (5) the amount of contact transmission of organisms depends partly on the degree of surface contamination and moisture on the skin.

The descriptive survey method was the method chosen for this study. Permission was granted at each of the three selected hospitals to collect cultures from fomentation covers on the medical and surgical units.

A pilot study was conducted at one hospital to compare two methods for collecting cultures from the fomentation covers. The triple-contact-plate method was chosen as the technique for obtaining the cultures. One-hundred cultures were obtained from each of the three hospitals, making a total of 300 triple-contact-plate cultures collected. The cultures were processed in the Microbiology Department at Loma Linda University.

The cultures were incubated and were inspected for colony growth after twenty-four hours, then daily for three days. A gram stain was made of the colonies growing on the salt mannitol agar, and those found not to be cocci were discarded. The pigmentation of the cocci colonies varied from pale to deep yellow. The mannitol fermentation was readily identified by the bright yellow zone surrounding the organisms growing on the salt mannitol agar. The gram-positive cocci were streaked onto sheep blood agar plates, incubated for twenty-four hours and the hemolysis around individual colonies was noted. On each gram-positive cocci culture two coagulase tests were made, one using diluted citrated rabbit plasma and the other using a diluted commercial lyophilized human plasma.

The characteristics noted for the Staphylococcus aureus organisms were: (1) colony pigmentation varying from pale to deep yellow or gold, (2) mannitol fermentation as evidenced by the phenol red indicator turning yellow, (3) clear zone hemolysis around individual colonies on blood agar, and (4) coagulation of plasma.

Depending upon the single or multiple characteristics shown in the laboratory these cultures were further organized as "definite" (three or

four characteristics), "possible" (two characteristics) or "questionable" (one characteristic) Staphylococcus aureus.

Summary of Findings

A total of 300 triple-contact-plate cultures were collected from fomentation covers used at three selected hospitals. There were thirty-eight, or 9 per cent of the 300 cultures, classified as gram-positive staphylococci cultures. Of these thirty-eight, twelve, or 4 per cent of all the cultures, were classified as Staphylococcus epidermidis, not an alarming finding since this organism is a normal inhabitant on the skin and mucous membranes.

Of the thirty-eight gram-positive staphylococci cultures, the remaining twenty-six, or 9 per cent of the 300 cultures, were classified according to the single or multiple characteristics they presented. There were six, or 2 per cent of the 300 cultures, that were considered "definite" Staphylococcus aureus, seventeen, or 6 per cent of all the cultures, were considered "possible" Staphylococcus aureus and three, or 1 per cent, were considered "questionable" Staphylococcus aureus.

Of these twenty-six cultures, at Hospital A there were three "definite" Staphylococcus aureus cultures, and four "possible" Staphylococcus aureus cultures. At Hospital B there were one "definite" Staphylococcus aureus culture, four "possible" and two "questionable" Staphylococcus aureus cultures. At Hospital C there were two "definite" Staphylococcus aureus, nine "possible" and one "questionable" Staphylococcus aureus cultures.

The six cultures classified as "definite" Staphylococcus aureus were considered potential pathogenic organisms.

Of the six "definite" Staphylococcus aureus cultures, five were obtained from the two hospitals not having a weekly laundry routine for the

fomentation covers, whereas, the remaining culture was from the hospital having a weekly laundry schedule.

In two hospitals the cultures were taken from the fomentation covers folded around the heated pads and in the third hospital from the covers before being placed around the heated pads. The covers in contact with the heated pads showed more contamination than those covers cultured before being placed around the heated pads.

Conclusions

The fomentation covers were found to be contaminated with *Staphylococcus aureus*. The percentage of covers contaminated with "definite" *Staphylococcus aureus* was 2 per cent. There was a low percentage of covers found contaminated at each of the three hospitals. The fomentation covers appear to be a potential but not a major reservoir of *Staphylococcus aureus*.

When there were no patients with staphylococcal infections receiving hydrotherapy treatments, 2 per cent of the fomentation covers were found contaminated with *Staphylococcus aureus*.

There were fewer fomentation covers found contaminated with *Staphylococcus aureus* at the hospital having the weekly laundry schedule, thus it appeared to be a safer procedure to launder the covers weekly than to have no laundry schedule.

The covers folded around the heated pads were contaminated showing that the heat and moisture of the pad were not sufficient to destroy the *Staphylococcus aureus* organism. The physical environment of the cover was not hostile to the *Staphylococcus aureus* organism.

The hypothesis stated for this study was that *Staphylococcus aureus* is present on fomentation covers. To test the hypothesis 300 cultures were obtained from fomentation covers at three selected hospitals. The cultures were processed in a microbiology laboratory. Two per cent of the fomentation

covers were found to be contaminated with Staphylococcus aureus thus proving the hypothesis of the study.

II. RECOMMENDATIONS

As a result of this study these recommendations were made.

1. That fomentation covers used in hydrotherapy treatments for patients with staphylococcal infection should not be returned to the unit supply until after the covers have been laundered.

2. That fomentation covers should be laundered at least once a week.

3. That inservice education for nursing personnel emphasize good hand washing as a step in preventing cross-infection while administering fomentation treatments.

Recommendations for Further Studies

1. That a similar survey be conducted over a longer period of time and during a period when patients with staphylococcal infection are on the hospital units.

2. That a survey be conducted to ascertain the quantitative Staphylococcus aureus contamination of the fomentation covers.

3. That a survey be conducted to ascertain whether the coagulase-negative Staphylococcus aureus found on fomentation covers show pathogenicity.

4. That a survey be conducted to ascertain whether Staphylococcus aureus from contaminated fomentation covers and from infected patients are the same bacteriophage type.

5. That a study be conducted to develop a procedure in caring for the fomentation covers that would eliminate Staphylococcus aureus.

6. That a study be conducted to ascertain the effectiveness of hydrotherapy treatments when plastic is placed next to the surgical dressing.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Bailey, W. R. and E. G. Scott. Diagnostic Microbiology. St. Louis: The C. V. Mosby Company, 1962. 327 pp.

Breed, Robert S., E. G. D. Murray, and Nathan R. Smith. Bergey's Manual of Determinative Bacteriology. Seventh edition. Baltimore: Williams and Wilkins Company, 1957. 1094 pp.

Difco Manual of Dehydrated Culture Media and Reagents for Microbiological and Clinical Laboratory Procedures. Ninth edition. Detroit: Difco Laboratories, 1953. 150 pp.

Elek, Stephen D. Staphylococcus Pyogenes and Its Relation to Disease. London: E. S. Livingstone Limited, 1959. 767 pp.

Moor, Fred B. and Clarence W. Dail. Preclinical Physical Therapy. Loma Linda: College of Medical Evangelists, 1940. 231 pp.

Neter, Erwin and D. R. Edgeworth. Medical Microbiology. Philadelphia: F. A. Davis Company, 1962. 545 pp.

Williams, R. E. O. and R. A. Shooter (eds.). Infections in Hospitals Epidemiology and Control. Oxford: Blackwell Scientific Publications, 1963. 355 pp.

Williams, R. E. O., et al. Hospital Infection Causes and Prevention. Chicago: Year Book Publishers, 1960. 307 pp.

B. PERIODICALS

Adams, Ralph, et al. "Control of Infections Within Hospitals," Journal of American Medical Association, 169:1557-1567, April 4, 1959.

Barber, Mary. "Hospital Infection Yesterday and Today," Journal of Clinical Pathology, 14:2-10, January, 1961.

_____. "Methicillin-Resistant Staphylococci," Journal of Clinical Pathology, 14:385-393, July, 1961.

Barnes, Benjamin A., et al. "An Analysis of Factors Associated with Sepsis in Two Operative Procedures 1937-1957," New England Journal of Medicine, 261:1351-1357, December 31, 1959.

_____. "Surgical Sepsis--Report of Subtotal Gastrectomies," Journal of the American Medical Association, 173:1068-1075, July 9, 1960.

Bashe, W. J., A. L. Miller, and F. H. Wentworth. "Community Staphylococcal Infection Relationship to the Hospital Problem," American Journal of Public Health, 52:1810-1817, November, 1962.

Blair, John E. "Laboratory Diagnosis of Staphylococcal Infections," Bulletin of the World Health Organization, 18:291-307, 1958.

Blowers, Robert. "Control of Infection in Hospital Wards," Journal of Clinical Pathology, 14:18-25, January, 1961.

_____, and K. R. Wallace. "Sterilization of Blankets with Cetyl Trimethylamine Bromide," Lancet, 1:1250-1251, June 18, 1955.

_____, et al. "Control of Wound Infection in a Thoracic Surgery Unit," Lancet, 2:786-794, October 15, 1955.

Chapman, George H. "The Reliability of Bromthymol-Blue Lactose Agar and Bacto Phenol-Red Mannitol Agar for the Isolation of Pathogenic Staphylococci," Journal of Bacteriology, 48:555-557, November, 1944.

Colbeck, John C. "Environmental Aspects of Staphylococcal Infections Acquired in Hospitals I. The Hospital Environment--Its Place in the Hospital Staphylococcus Infections Problem," American Journal of Public Health, 50:468-472, April, 1960.

_____. "Studies in Hospital Infections," Canadian Services Medical Journal, 12:563-580, July-August, 1956.

Commission on Hospital Activities. Staphylococcal Infections in Pediatrics. Medical Audit Program Report No. 12. Ann Arbor: Commission on Hospital Activities, October, 1958, cited by Andre J. Nahmias and T. C. Eickhoff. "Staphylococcal Infections in Hospitals," New England Journal of Medicine, 265:77-81, July 13, 1961.

Cowling, D. C. "Comment on a Surgical Wound Survey at the Royal Melbourne Hospital (With a Note on the Introduction of Boiled Woollen Blankets)," Medical Journal of Australia, 1:923-927, June 16, 1962.

"Evaluation of Hospital Infections with Analysis in Mortality and Morbidity," Surgery, Gynecology and Obstetrics, 110:157-163, February, 1960.

Farrer, Sanford M. and Colin M. MacLeod. "Staphylococcal Infections in a General Hospital," American Journal of Hygiene, 72:38-58, July, 1960.

Finland, Maxwell. "Antibiotics for Staphylococcal Infections," Medical Clinics of North America, 42:1179-1194, September, 1958.

_____, and W. F. Jones, Jr. "Staphylococcal Infections Currently Encountered in a Large Municipal Hospital: Some Problems in Evaluating Antimicrobial Therapy in Such Infections," Annals of the New York Academy of Sciences, 65:191-205, 1956-1957.

_____, W. F. Jones, Jr., and Mildred W. Barnes. "Occurrences of Serious Bacterial Infections Since Introduction of Antibacterial Agents," Journal of the American Medical Association, 170:2188-2197, August 29, 1959.

Haas, Wolfgang. "Patients and Pillows Infect Each Other," Modern Hospital, 94:152-160, June, 1960.

Hare, Ronald and E. M. Cook. "Self-Contamination of Patients with Staphylococcal Infections," British Medical Journal, 2:333-336, August 5, 1961.

Hinton, N. A. and J. H. Orr. "Studies on the Incidence and Distribution of Antibiotic-Resistant Staphylococci," Journal of Laboratory and Clinical Medicine, 49:566-572, April, 1957.

Howe, Chester W. "Postoperative Wound Infections Due to Staphylococcus Aureus," New England Journal of Medicine, 257:411-417, September 9, 1954.

_____, et al. "Staphylococcal Contamination of Mattresses and Blankets on a Surgical Ward Under Nonepidemic Conditions," New England Journal of Medicine, 264:625-632, March 30, 1961.

"Incidence of Surgical Wound Infection in England and Wales," Lancet, 2:659-663, September 24, 1960.

Kaye, S. "The Use of Ethylene Oxide for the Sterilization of Hospital Equipment," Journal of Laboratory and Clinical Medicine, 35:823-828, May, 1950.

MacIntosh, O. C. "Ubiquitous Staphylococcus Does Not Always Show Its True Colors," Canadian Medical Association Journal, 82:522-524, March 5, 1960.

Maitland, H. B. and G. Martyn. "A Selective Medium for Isolating Staphylococcus Based on Differential Inhibiting Effect of Increased Concentrations of Sodium Chloride," Journal of Pathology and Bacteriology, 60:553-561, October, 1948.

Markham, N. P., D. Phil (Oxon.), and H. C. Shott. "Sepsis in Hospital Patients Trends in the Epidemiology of Staphylococcal Sepsis," New Zealand Medical Journal, 62:521-527, November, 1963.

Minchew, Harvey and L. E. Cluff. "Studies of the Epidemiology of Staphylococcal Infection," Journal of Chronic Disease, 13:354-373, April, 1961.

Mortimer, Edward A. Jr. "Hospital Staphylococcal Infections Interruption of Transmission as a Means of Control," Medical Clinics of North America, 47:1247-1256, September, 1963.

Nahmias, Andre J. and T. C. Eickhoff. "Staphylococcal Infections in Hospitals," New England Journal of Medicine, 265:74-81, July 13, 1961.

Rogers, David E. "Current Problem of Staphylococcal Infections," Annals of Internal Medicine, 45:748-781, November, 1956.

_____. "The Changing Pattern of Life-Threatening Microbial Disease," New England Journal of Medicine, 261:677-683, October 1, 1959.

Rubbo, Sydney D. and S. Dixson. "A Contact-Plate Technique for Determining Bacterial Contamination of Fabrics," Lancet, 2:394-397, August 20, 1960.

_____, and B. C. Stratford. "Spread of a Marker Organism in a Hospital Ward," British Medical Journal, 2:282-287, August 4, 1962.

Walter, Carol W. "Environmental Sepsis," Modern Hospital, 91:69-78, December, 1958.

Yanis, Bertha. "The Role of the Environmental Bacteriology Laboratory," Hospital Management, 97:56-60, March, 1964.

APPENDIX

25156 Barton Road
Loma Linda, California
December 1, 1964

Mrs. Helen B. Austin, R.N.
Director of Nursing Service
Loma Linda University Hospital
Loma Linda, California

Dear Mrs. Austin:

In partial fulfillment of the requirements for the Master of Science Degree in Nursing I am interested in doing a study of one aspect of the patient's environment as a possible source of cross-infection. To conduct the study I am requesting your permission to collect biological specimens from the fomentation covers at Loma Linda University Hospital.

The purpose of the study is to ascertain whether Staphylococcus aureus is present on fomentation covers. The study will include obtaining cultures for evidence of Staphylococcus aureus from the fomentation covers on medical 200 and surgical 100A and 100B.

I would also like to request that the personnel not be informed as to the purpose of the study.

At the conclusion of the study I shall be happy to furnish you with a summary of the results.

Thank you for your kind attention.

Sincerely,

(Mrs.) Yvonne McDaniel

25156 Barton Road
Loma Linda, California
December 16, 1964

Miss Sylvia Sturdevant, R.N.
Director of Nursing Service
White Memorial Hospital
Los Angeles 33, California

Dear Miss Sturdevant:

In partial fulfillment of the requirements for the Master of Science Degree in Nursing I am interested in doing a study of one aspect of the patient's environment as a possible source of cross-infection. To conduct the study I am requesting your permission to collect biological cultures from the fomentation covers at the White Memorial Hospital.

The purpose of the study is to ascertain whether Staphylococcus aureus is present on fomentation covers. The study will include obtaining cultures for evidence of Staphylococcus aureus from the fomentation covers on the medical and surgical units.

I would also like to request that the personnel not be informed as to the purpose of the study.

At the conclusion of the study I shall be happy to furnish you with a summary of the results.

Thank you for your kind attention.

Sincerely,

(Mrs.) Yvonne McDaniel

25156 Barton Road
Loma Linda, California
December 1, 1964

Miss Ellen L. Gibson, R.N.,
Director of Nursing Service
Glendale Sanitarium and Hospital
Glendale, California 91209

Dear Miss Gibson:

In partial fulfillment of the requirements for the Master of Science Degree in Nursing I am interested in doing a study of one aspect of the patient's environment as a possible source of cross-infection. To conduct the study I am requesting your permission to collect biological specimens from the fomentation covers at Glendale Sanitarium and Hospital.

The purpose of the study is to ascertain whether Staphylococcus aureus is present on fomentation covers. The study will include obtaining cultures for evidence of Staphylococcus aureus from the fomentation covers on the medical and surgical units.

I would also like to request that the personnel not be informed as to the purpose of the study.

At the conclusion of the study I shall be happy to furnish you with a summary of the results.

Thank you for your kind attention.

Sincerely,

(Mrs.) Yvonne McDaniel

LOMA LINDA UNIVERSITY

Graduate School

INCIDENCE OF STAPHYLOCOCCUS AUREUS ON FOMENTATION COVERS

by

Yvonne Badgley McDaniel

An Abstract of a Thesis

in Partial Fulfillment of the Requirements

for the Degree Master of Science

in the Field of Nursing

June 1965

ABSTRACT

This study was to ascertain whether fomentation covers were contaminated with Staphylococcus aureus prior to being placed on a patient receiving a hydrotherapy treatment.

From a review of literature on the subject of the Staphylococcus aureus organism and from studies of hospital-acquired staphylococcal infection it appeared that: (1) researchers had used various techniques for making cultures from fabrics, (2) the Staphylococcus aureus cultures may react in varying ways to the laboratory tests making the classification somewhat difficult, (3) the problem of hospital-acquired staphylococcal cross-infection was present, (4) the role played by the environment in hospital-acquired infection was controversial, and (5) the amount of contact transmission of organisms depends partly on the degree of surface contamination and moisture on the skin.

The descriptive survey was the method used in this study. Following a pilot study conducted to compare two methods for obtaining cultures from fomentation covers, the triple-contact-plate method was chosen to collect cultures at three selected hospitals.

In the microbiology laboratory the classifying characteristics noted for the gram-positive cocci cultures were: (1) pigmentation varying from pale to deep yellow or gold, (2) mannitol fermentation, (3) clear zone hemolysis around individual colonies growing on sheep blood agar, and (4) coagulation of plasma.

When tabulated the data revealed out of the 300 cultures from the fomentation covers, thirty-eight were gram-positive staphylococci. Of these thirty-eight cultures, twelve, or 4 per cent of 300 cultures, were classified

as Staphylococcus epidermidis. The remaining twenty-six cultures, or 9 per cent of all the cultures, were classified according to their single or multiple characteristics as six "definite" (three and four characteristics), seventeen "possible" (two characteristics) and three "questionable" (one characteristic) Staphylococcus aureus. The six cultures classified as "definite" Staphylococcus aureus were considered as potential pathogenic organisms.

There were fewer fomentation covers found contaminated with "definite" Staphylococcus aureus at the hospital having the weekly laundry schedule, therefore it appeared to be a safer procedure to launder the covers weekly than to have no laundry schedule.

The covers folded around the heated pads were contaminated showing that the heat and moisture of the pads were not sufficient to destroy the Staphylococcus aureus organism.

Two per cent of the fomentation covers were found to be contaminated with Staphyloccus aureus. The fomentation covers appear to be a potential but not a major reservoir of Staphylococcus aureus.

Based on the findings of the study it was suggested that: the fomentation covers used in giving hydrotherapy treatments to patients with staphylococcal infection be laundered before being returned to the unit, all covers be laundered at least once a week; and that inservice education programs at the three hospitals emphasize the value of careful hand washing while giving hydrotherapy treatments.