# EFFECTIVENESS OF AN EDUCATION PROGRAM FOR NOSOCOMIAL INFECTION CONTROL IN RADIOLOGY

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A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF SCIENCE

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

TEXAS WOMAN'S UNIVERSITY

INSTITUTE OF HEALTH SCIENCE

SCHOOL OF HEALTH CARE SERVICES

HEALTH SCIENCES INSTRUCTION PROGRAM

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DENTON, TEXAS

MAY 1981

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ACKNOWLEDGEMENTS

I would like to thank the participants of my project for their cooperation in this research; the thesis committee for their persistent efforts, especially Dr. Barbara Cramer; and my family and friends for their strong support and encouragement.

# CHAPTER I

## INTRODUCTION

Infectious diseases will always be present in the hospital. It is essential, therefore, to prevent their spread from patient to patient, from patient to personnel, and from personnel to areas outside the hospital.

> From the moment patients are moved from bed into a departmental wheelchair or stretcher-carrier, these patients are exposed directly to bacterial contaminants from: the fomitic arm rests of wheelchairs, the contaminated stretcher mattresses on stretcher-carriers, the air-borne droplets expelled by other patients in the waiting room, the microbes abounding on x-ray tables, and similarly chest boards and chin rests. Following the x-ray study, patients return to their rooms in wheelchairs or on carriers for further exchange of bacterial contaminants on these fomites with those of previous patients and to leave a microbial legacy for subsequent patients.[1]

However harsh this statement may seem, in general it is true. In most, if not all hospitals, the diagnostic radiology department is the single area in the hospital where patients from every service are brought physically together, including medical and surgical patients, presurgical and post-operative patients. From this possible central source,

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[1] William G. Terry & J. W. McLaren, Planning a Diagnostic Radiology Department (London: W. B. Saunders, 1973), p. 78.

organisms are brought back to the various services on the hands and other parts of patients for possible further transmission to other parts of the same patients, or to other patients, personnel, and fomites.

The goal of intervention by an in-service educational program on nosocomial infection control in radiology is to replace indifference and carelessness with a new awareness of the role the department of diagnostic radiology plays in the universal problem of hospital-acquired infections. This may reduce the chance that the patient will experience complications of his original health problem that caused hospitalization, or acquire a new health problem, or die.

## Statement of the Problem

The problem of this study was the development of an in-service education program and the determination of its effectiveness toward the control of nosocomial infections in a radiology department.

## Purpose of the Study

The purpose of this study was to determine if an increase in knowledge about nosocomial infections and their control would change behavior.

## Research Questions

The two research questions were:

1. Will knowledge of nosocomial infections, their cause, and their control be increased?

2. Will an in-service hospital education program on nosocomial infection control influence personnel behavior in a manner which will reduce the bacterial counts on selected fomites in a radiology department?

## Need for the Study

Radiologic Technologists in this geographic area have stated that infection control in the radiology department is a definite problem and an in-service education program would be helpful. To determine the need for this study, bacteriological environmental samplings were done at a selected 175-bed county hospital. On June 19, 1978 bacteriologic samples showed, by the subjective decision of laboratory personnel, several unacceptable counts. A follow-up bacteriologic sampling was done on July 5, 1979, finding a marginal improvement in the microbial counts.[2] These data established indication that an instructional program may be a means of intervention. There is a need for in-service education programs designed to inform personnel that a problem exists

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[2]Copies of these environmental samplings may be found in Appendix.

and to provide means for its possible alteration.

## Definition of Terms

For the purpose of this study the following definitions were used:

A nosocomial infection is a disease of microbial or viral aetiology contracted which would not have occurred had the patient not been hospitalized, or "an infection acquired in a hospital."[3]

Behavior is the "manner in which one behaves; . . . the actions or reactions of persons . . . under specified circumstances."[4]

Knowledge is defined as "familiarity, awareness, or understanding gained through experience or study."[5]

The Radiologic Technologist is one who is primarily concerned with demonstration of portions of the human body on an x-ray film or fluoroscopic screen for diagnostic use by the radiologist.[6]

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[3]Clayton L. Thomas, ed. Taber's Cyclopedic Medical Dictionary. Philadelphia: F.A. Davis Company, 1977.

[4]William Morris, ed. The American Heritage Dictionary of the English Language. (Boston: Houghton Mifflin Co.), 1976.

[5]Ibid.

[6]American Registry of Radiologic Technologists. Directory of Radiologic Technologists. (ARRT: December, 1978), p. 5.

The Darkroom Assistant is a person who is utilized to provide the necessary technical expertise in maintenance of the darkroom of the radiology department and the processing of exposed x-ray film.[7]

The Transporter is a person utilized to transport patients between their hospital rooms and the x-ray department.[8]

## Limitations

The limitations of this study were:

1. The same pretests and posttests were utilized and validity or reliability indexes were not established
2. Only one hospital was used in this study

## Assumptions

The assumptions were made that:

1. The in-service education students answered the pretests and posttests to the best of their ability
2. There can be a reliance on laboratory findings performed by others
3. All radiology personnel have reviewed the radiology procedure manual

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[7]Robert L. Patrick, An Introduction to Health Care Careers. (Houston: D. Armstrong Co., Inc., 1978), 207.

[8]Ibid. p. 181.

# CHAPTER II

## REVIEW OF RELATED LITERATURE

### Radiology Department as a Source

In 1960 the National Research Council of Canada published a two-volume bibliography of the world's literature on hospital cross infection including 1959. No citations were found relating to cross infections in radiology departments. Moreover, the same absence is conspicuous in a number of excellent published symposia on incidence and prevention of infection. The occurrence of infections in hospitals is still considered to be a sensitive public matter and carries implications of blame in respect to the occurrence of these infections.

In the formidable literature that has accumulated on nosocomial infections during the past 20 years, the role of radiology departments in modern hospitals in producing cross infection has been largely overlooked. In the latest study on national nosocomial infection control, the highest nosocomial infection rate was found to be in the Municipal or County Hospital. Nosocomial infection rates were found to be highest in two of the services, medicine and surgery. Both services constantly provide the patient load for the

radiology department.[9] National studies indicate that between 5 percent and 8 percent of all patients admitted to hospitals develop nosocomial infections.[10] Eighty percent of all patients admitted to the hospital are brought to the radiology department for x-ray studies at least once.[11]

The Department of Radiology is the one place in a hospital where routinely and daily the admixture of patients is complete. Patients are brought to the department from throughout the hospital on the department's own wheelchairs and stretchers. These patients all come together, are congregated together in a waiting room, physically share the same fomites such as chairs, sofas, magazines, x-ray tables, x-ray chest boards, the chin rest above the chest board, etcetera. It seems inconceivable, but few hospital personnel ever think of the radiology department and its fomites as means of cross infection. Once it is "brought to mind", the possibilities are frightening enough to encourage positive action.[12]

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[9]Center for Disease Control, National Nosocomial Study Report (HEW: 1978), p. 2.

[10]A.T. Wallace, "The Cost of Nosocomial Infection," Newsletter, Volume II A.P.I.C. 1974.

[11]Terry, Planning a Diagnostic Radiology Department, p. 76.

[12]Ibid.

Hospital personnel and students exposed to initially unsuspected active cases of tuberculosis were in a 15-month study to define the risk of their acquiring infection. Data indicate that personnel who have prolonged inpatient exposure are most likely to develop infection. The findings in table 1 show emergency room nurses and x-ray technologists as the groups with the highest frequency of multiple patient exposures.[13]

Table 1

Relative Hazard of Multiple Exposures to Initially Unsuspected Tuberculosis by Occupational Category

| Occupations | Percent of Total Occupational Category with More Than Two Exposures |
|---|---|
| X-ray technologists | 38.2 |
| Licensed practical nurses | 12.7 |
| Registered nurses | 9.2 |
| Attendants | 5.1 |
| Medical students | 4.8 |
| Physicians | 4.5 |
| Student nurses | 1.2 |

Source: Craven, Wenzel, & Atuk, "Minimizing Tuberculosis Risk to Hospital Personnel and Students Exposed to Unsuspected Disease," Annals of Internal Medicine 82 (1975): 631, table 4.

The Joint Commission for Accreditation of Hospitals now requires infection control plans for every hospital

[13]Craven, Wenzel, & Atuk, "Minimizing Tuberculosis Risk to Hospital Personnel and Students Exposed to Unsuspected Disease," Annals of Internal Medicine 82 (1975): 631.

department. The need for this type of policy arises from the alarming statistics of "in-house" spreading of various types of infections in the hospital setting. According to the policy, both radiographic and fluoroscopic equipment should be decontaminated including the following: radiographic tube housings and cables, radiographic tubes, radiographic chest units, radiographic head units, portable radiographic units and other accessories that come into patient contact (e.g. stretchers). All patient contact surfaces should be decontaminated.[14] Guidelines for Infection Control in Radiology from the Center for Disease Control are available for use by radiology departments of hospitals as well as by the infection control nurse.

## Potential Pathogens and Modes of Transmission

The etiologic agents of most nosocomial infections are bacteria, 70 percent of which are gram-negative aerobic rods such as Escherichia Coli, Pseudomonas aeruginosa and Klebsiella pneumoniae. Listed in table 2 are common pathogens and their modes of spread. Pathogens expected to have the highest rate of incidence in the radiology department are: Escherichia Coli, Staphylococcus Aureus, Streptococcus

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[14]Joel Ehrenpreis and Theodore Sorandes, "Keeping the Bugs Out of Radiology: a Need for Infection Control," Radiologic Technology Volume 49, No. 2 (1977): 160.

Table 2

Pathogens and Their Modes of Spread

| Pathogen | Modes of Spread |
|---|---|
| Staphylococcus Aureus | Contaminated objects<br>Hands of personnel<br>Airborne<br>Self |
| Group A Streptococcus | Direct contact<br>Airborn droplet<br>Hands |
| Group B Streptococcus | Maternal genital tract |
| Enterococcus | Self<br>Hands of personnel |
| E. Coli, Klebsiella, Enterobacter | Self<br>Hands of personnel<br>Food<br>Contaminated materials |
| Proteus, Salmonella, Providence, Serratia, Citrobacter | Hands of personnel<br>Contaminated materials<br>Self<br>Food |
| Pseudomonas | Environmental<br>Hands of personnel<br>Contaminated materials<br>Food<br>Self |
| Hepatitis B | Droplet<br>Direct contact<br>Contaminated materials |
| Herpes | Direct contact<br>Self<br>Airborne<br>Droplet |

SOURCE: John Matsen, "Pathogens, their Sources and Control," Hospitals, J.A.H.A. 48 (December, 1974): 73, table 2.

Group D, Proteus, and Pseudomonas. The primary mode of transmission is from patient to patient or from health professional to patient by close contact rather than by airborne route.[15]

## Environmental Cultures

Infection control committees require bacterial culture records as evidence of a hospital's efforts to maintain a high standard of cleanliness.[16] Bacterial culturing has been found to be an effective method to determine the efficacy of sterilization and disinfection techniques, and can be used to identify problem areas and as a fulcrum for change or improvement of technique. Culturing should be conducted routinely in areas where pathogens are most likely to be found. It is an essential tool when used in conducting epidemiological investigations and may also be used for educational purposes.[17]

## In-service Education Programs

The first factor contributing to the high rate of

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[15]John Matsen, "Pathogens, their Sources and Control," Hospitals, J.A.H.A. 48 (December, 1974): 73.

[16]Charles Letouneau and James Hicks, "Administrative Aspects of Infection Control," Hospital Management 102 (September, 1966): 43.

[17]Arthur Mabbett and Mary Flynn, "Infection Control: A Self Evaluation," Hospital Topics (November, 1975): 29.

cross infections is the failure to educate personnel successfully. In-service education is a valuable and effective means of spreading information regarding control and prevention of nosocomial infections.[18]

Participants of educational programs must understand that pathogenic microorganisms exist and are frequently prominent in the department. They must develop a better understanding of bacteria and the diseases bacteria can cause, and know that inanimate articles or fomites, which have been contaminated, are likely sources of infection.[19]

It has been determined that an important aspect of any comprehensive infection control program include the development of an educational program. Educational programs are considered an important feature in the control of infection and should be instituted to increase awareness of hospital infection and ways of prevention.[20]

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[18]Janice Babcock, "Some Practical Problems and Troubleshooting," Hospitals, J.A.H.A. 50 (March, 1976): 134.

[19]Donald Gibala, "Training Supportive Personnel on the Environmental Aspects of Infection Control," Hospital Topics (September, 1976): 1.

[20]"Infection Controlled," Lancet (May 5, 1973): 981.

# CHAPTER III

## METHODOLOGY

### Population

A one-group pretest-posttest design was used for this study. The Radiology Department of a 175-bed general hospital was selected for convenience. All employed radiology personnel at this hospital included 7 radiologic technologists, 1 darkroom technician, and 1 transporter.

### Procedures Relating to Cultures

Bacterial cultures of potential fomites were randomly cultured under normal conditions during the working day. Radiology personnel were not aware of the time or day cultures were taken. The specified areas cultured were selected randomly by blind draw. The areas of concern and potential fomites within the Radiology Department used in this study are shown on table 3.

All cultures were plated using Replicate Organism Detection and Sampling Plates (Rodak). The Rodak plate technique is simple, standardized, and has been used to develop standards for surface contamination. The principle of the procedure is as follows: Small plastic plates are completely filled with an agar medium. The plate is pressed against a surface resulting in impaction of particles in the agar surface. The plate is incubated for 48

Table 3

Cultured Areas of Concern in Radiology

| | |
|---|---|
| R/F* room 1 | Top of x-ray table<br>Floor beside table<br>X-ray tube handle |
| R/F room 2 | Bottom of x-ray table<br>Foot stand on table |
| R/F room 3 | Side of x-ray table<br>Center of chest board<br>Chin rest on chest board |
| Specials room 4 | Top of x-ray table<br>Floor beside table |
| Mammographic room 5 | Bottom of x-ray tube<br>X-ray tube handle |
| Intradepartmental fomites | "Prep" table<br>Cassettes (4)<br>Hands of x-ray technologists (2) |
| Intrahospital fomites | Portable tube head<br>Portable cassette bin<br>Portable wheels<br>Portable bar handle<br>Portable cassettes (2)<br>Wheelchair armrests (2)<br>Center of stretcher |

*Radiographic/Fluoroscopic

hours at which time all bacterial colonies are counted. Results are expressed in total colonies per plate. Under certain circumstances, enumeration of pathogenic organisms such as staphylococci may be made separately.

A committee of the American Public Health Association recommended that, using the Rodak Plate technique, anything over 100 colonies per Rodak plate indicates a need for more frequent maintenance in "dirty areas" (e.g. floors). In "clean areas" (e.g. surgery), 0-25 colonies per Rodak plate was established as acceptable and over 25 colonies per plate as unacceptable for contaminants.[21]

On April 16, 1979 the specified areas (see table 3) in the Radiology Department were cultured. The results of this culture were included as part of an educational program that was presented to all radiology personnel the following week. Post-educational program cultures of the same specified areas were taken on May 14 and May 29, at two and four weeks following the program.

Procedures Relating to Educational Program

The instructional unit consisted of an investigator-developed slide/lecture program on Nosocomial Infection

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[21]Raymond Bartlett, James Hammond and Virginia Wickersham, Hospital Associated Infections (Chicago: American Society of Clinical Pathologists, 1971), p. 86.

Control in Radiology. The program had a length of one hour with a pretest and posttest (see appendix). The program was given at 11:00 a.m. and 4:00 p.m. on the same day so that all personnel would be able to attend.

## Analyses of Data

The statistical method used for comparison of precultures and postcultures was a Chi square correlation with .1 level of significance and 21 degrees of freedom. The pretests and posttests were collected, graded, and computer calculated using point biserial correlation, a t test of significance at the .1 level, and 8 degrees of freedom.

# CHAPTER IV

## FINDINGS

Results of the bacterial cultures from x-ray equipment and other fomites are listed in table 4. Pre-in-service cultures revealed ten sources of unacceptable counts due to either number of counts or pathogens found. Post-in-service cultures at two weeks and four weeks revealed five and six unacceptable areas respectively.

The pathogens found were Staphlococcus Aureus and Enterobacter Agglomerans. Staphlococcus Aureus was found on the pre-cultures in room 1, top of the x-ray table. At two weeks post-educational program, no organisms were found and at four weeks post-educational program only 2 Bacilli were found. The Enterobacter was found on the chin rest of a chestboard in room 3. Pathogens were absent from this area's two and four week post-educational cultures. Two other areas of interest were the hands of x-ray technologists and departmental cassettes. Pre-educational program cultures and post-educational cultures at four weeks of both areas revealed Staphlococcus Aureus providing an unacceptable count.

Staphlococcus Epidermis, Mold, and Bacillus are considered contaminants and only become significant with unacceptable counts in "clean areas." The "clean areas" suggested by the laboratory environmental sampling forms are items such as tables, equipment, hands, surgery floors,

Table 4

Microbial Isolates from the Radiology Department

| Site Cultured | Organisms Recovered Pre-In-Service | Count | Organisms Recovered Two Weeks Post-In-Service | Count | Organisms Recovered Four Weeks Post-In-Service | Count |
|---|---|---|---|---|---|---|
| X-ray tube handle (Room 1) | Staph. Epi. | 2 | ----- | 0 | Bacillus, Staph. Epi. | 49 |
| Top of X-ray table (Room 1) | Staph. Aureus, Staph. Epi., Bacillus | 10 | ----- | 0 | Bacillus | 2 |
| Floor beside table (Room 1) | Staph. Epi., Bacillus | 74 | Staph. Aureus, Staph. Epi., Bacillus | 52 | Bacillus, Staph. Epi. | 50 |
| X-ray tube bottom (Room 2) | Bacillus, Staph. Epi. | 7 | ----- | 0 | ----- | 0 |
| Foot Stand (Room 2) | Staph. Epi., Bacillus | 83 | Bacillus, Staph. Epi. | 100 | Bacillus, Staph. Epi. | 100 |
| Side of X-ray table (Room 3) | Staph. Epi. | 3 | Bacillus, Staph. Epi. | 3 | Bacillus | 2 |
| Center of Chest Board (Room 3) | Staph. Epi., Mold | 2 | ----- | 0 | Staph. Epi. | 9 |
| Chestboard Chin Rest (Room 3) | Enterobacter, Staph. Epi. | 18 | Staph. Epi. | 3 | Bacillus, Staph. Epi. | 20 |
| Top of X-ray table (Room 4) | Staph. Aureus Staph. Epi., Bacillus | 26 | Staph. Epi., Bacillus | 34 | Bacillus | 22 |
| Floor beside table (Room 4) | Staph. Epi, Mold Bacillus | 20 | Bacillus | 55 | Bacillus | 26 |
| X-ray tube bottom (Room 5) | Staph. Epi., Mold Bacillus | 16 | Staph. Epi. | 1 | Bacillus | 1 |
| X-ray tube handle (Room 5) | Bacillus, Staph. Epi. | 14 | Staph. Epi. | 5 | Bacillus | 4 |
| Prep table | Bacillus, Mold, Staph. Epi. | 70 | Bacillus, Staph. Epi. | 13 | Bacillus, Staph. Epi. | 5 |
| Hands of X-ray Tech. | Bacillus, Staph. Epi., Staph. Aureus | 77 | Staph. Epi., Bacillus | 100 | Staph. Epi., Bacillus, Staph. Aureus | 100 |

Table 4 - Continued

| Site Cultured | Organisms Recovered Pre-In-Service | Count | Organisms Recovered Two Weeks Post-In-Service | Count | Organisms Recovered Four Weeks Post-In-Service | Count |
|---|---|---|---|---|---|---|
| Dept. Cassettes | Staph. Aureus, Mold, Staph. Epi., Bacillus | 49 | Staph. Epi. | 5 | Bacillus, Staph. Epi. Staph. Aureus | 100 |
| Wheelchair armrests | Staph. Epi., Mold Bacillus | 65 | Staph. Epi., Bacillus | 46 | Staph. Epi., Bacillus | 41 |
| Stretcher | Staph. Epi. | 18 | Staph. Epi. | 7 | Bacillus, Mold | 8 |
| Portable tube head | Staph. Epi., Bacillus | 34 | Staph. Epi. | 3 | Staph. Epi., Bacillus | 11 |
| Port. Cassette bin | Bacillus, Mold Staph. Epi. | 28 | Staph. Epi. | 26 | Staph. Epi., Bacillus | 17 |
| Port. wheels | Bacillus, Mold | 40 | Bacillus, Staph. Epi | 13 | Bacillus | 56 |
| Port. bar handle | Bacillus | 11 | Staph. Epi. | 9 | Staph. Epi., Bacillus | 38 |
| Port. Cassettes | Staph. Epi., Bacillus, Staph. Aureus | 79 | ----- | 0 | Bacillus | 8 |

Note: the underlined organisms are considered to be pathogens, microorganisms capable of producing disease

etcetera. Statistical analysis by Chi square correlation and 21 degrees of freedom was found to be significant at .1 level at two weeks and non-significant at four weeks.

Results of the grades from the pretests and post-tests were analyzed by a statistical t test with 8 degrees of freedom and were found to be significant at .1 level (see table 5). The range for the pretest and posttest scores was 60-76 and 64-100 respectively. The mode for both tests was 76. Five students (56 percent) increased their score, two students (22 percent) kept the same score and two students (22 percent) decreased their score. A probability or significance at the .1 level suggests that the differences obtained as a function of chance was only 10 percent.

Table 5

Correlated t Test Data

| Pretest | Posttest | Difference |
|---|---|---|
| 68 | 70 | 2 |
| 60 | 88 | 28 |
| 76 | 82 | 6 |
| 76 | 70 | -6 |
| 76 | 76 | 0 |
| 60 | 100 | 40 |
| 76 | 76 | 0 |
| 68 | 94 | 26 |
| 76 | 64 | -12 |

Mean Difference = 9.33
With a variance of 312.000 and a standard deviation of 5.8878

t Test value for 8 degrees of freedom = 1.5852

# CHAPTER V

## SUMMARY, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

### Summary

The purpose of this study was to determine the effectiveness of an in-service education program on Nosocomial Infection Control in the Radiology Department. The need for this study was demonstrated by the number of unacceptable microbial counts and type of organisms found on bacteriological environmental samplings on June 19, 1978 and July 5, 1979. The suggested mode for the improvement of behavior to reduce the number of microbial counts and pathogens was an investigator-developed slide/lecture in-service education program. Bacterial cultures were taken before and after the program to assess its effectiveness. The personnel involved were all radiologic technologists, darkroom technicians, and transporters employed in the Radiology Department of a 175-bed general hospital.

A culture sample of specified areas in the Radiology Department were collected and analyzed by laboratory personnel on April 16, 1979. The results of these cultures were included as part of the in-service education program presented the following week. Culture samplings were then collected at two and four weeks following the program. A

Chi square test of the overall data at two weeks with 21 degrees of freedom suggested a 90 percent probability that the training caused a difference in the behavior to reduce microbial counts and pathogens in the Radiology Department. However, the findings at four weeks proved non-significant.

A pretest and posttest were used as a measure of knowledge for the in-service education program on Nosocomial Infection Control. Results from a correlated t test from both sets of scores with 8 degrees of freedom indicate a 90 percent probability the differences obtained were a result of the training program. Knowledge of nosocomial infections, their cause, and their control was increased.

## Discussion

Anything done to a patient in the hospital or radiology department involves a potential hazard if it alters the patient's basic defense mechanisms, if it penetrates a patient's protective barriers, or if it unnecessarily places a patient in contact with a potentially infective agent. Infectious diseases will always be present and the radiology department has presented itself as a possible central source for transmission of organisms that can cause disease; therefore, a certain degree of awareness and control is necessary in order for radiology personnel to proceed appropriately to prevent nosocomial infections whenever possible and in order

to correct problems that may exist within the department.

The effectiveness of an in-service education program to control nosocomial infection in radiology was suggested by the reduction of microbial counts and pathogens. The increase in knowledge of nosocomial infections, their cause and their control was demonstrated by the pretest and posttest statistical analysis t test. The t test allows the comparison of the two means on the tests to determine the probability that the difference between the means is a real difference rather than a chance difference. A confidence of 90 percent or .1 level of significance was considered sufficient.[22]

The effectiveness of the in-service education program was also demonstrated by the improvement of behavior to reduce microbial counts and pathogens suggested by the results of bacterial samplings done before and after the program, statistically analyzed by the Chi square test. Areas that showed little or no reduction in counts were the hands of radiologic technologists, cassettes and wheelchair armrests. The pathogens, disease-producing organisms, found in the study were Staphylococcus Aureus, the prime or major offender in the area of hospital infections, and Enterobacter

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[22]William H. Beyer, Standard Mathematical Tables, 25th ed. (New York: CRC Press, Inc., 1978), 536.

Agglomerans, a ubiquitous intestinal organism. Of interest was the marked decrease in the number of these pathogens on the two and four week cultures.

Pointing to the areas of little or no improvement, one of the most subtle of hospital fomites is identified as the cassette. If a patient is too sick to come to the department for x-rays, the portable cassette is available to reach out into the operating room, nursery, intensive care, and every room in the hospital. The hands of a portable x-ray technologist certainly cannot be overlooked. As a group with a very high frequency of multiple patient contact, x-ray technologists handle patient after patient with hands constantly being exposed to fomites which must be presumed to be bacterially contaminated. Another area considered is the wheelchair armrest, because of patient's hands, which can transfer organisms to other parts of the body such as nares, lips, oral cavity and possibly to an incision site or dressing. The implication is that time is not taken to wash the hands, clean the cassettes, or "wipe down" the wheelchairs. This behavior does not comply with the policy of the radiology department.

The Chi square correlation between the pre-in-service and post-in-service cultures at two weeks indicates the frequencies obtained are different from the frequencies

expected based on chance variation alone. Again a confidence of 90 percent or .1 level of significance was considered sufficient.[23]

The Chi square correlation between the pre-in-service and post-in-service cultures at four weeks indicates no significance may be due to the forgetting curve. Ebbinghaus's curve of forgetting is primarily a function of interference from materials or habits learned previously.[24] Therefore, forgetting may be a result of the interference or competition of "old" and "new" responses or habits. The correlation at four weeks may implicate that the "old" habits had replaced the "new".

## Conclusions

It is concluded that:

1. The Radiology Department and its personnel are definitely sources for transmission of infection

2. With the inclusion of an in-service education program on the subject, microbial counts will decrease, possibly reducing nosocomial infections

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[23]Ibid.

[24]Norman J. Slamecka, ed., Human Learning and Memory (New York: Oxford University Press, 1967), p. 10.

## Recommendations

It is recommended by this study that:

1. An in-service education program on infection control in the Radiology Department be instituted and periodically given

2. Bacterial sampling reports of the Radiology Department should be sent to that department for review as a reinforcement of behavior

3. This study should be repeated using more than one hospital to involve a larger population

4. The reliability and validity of the pretest and posttest should be determined for the in-service program

# APPENDIX

Date of Survey: 6-19-78 Type: Pre-clean Post-clean (Random)
Location: X-Ray Time of Collection: 1:50 pm

| Culture site | Count | Accept. | Unaccept. | Organisms & Comments |
|---|---|---|---|---|
| Rm #2 Table | TNTC | | X | 15 Bacillus<br>>100 Staph. Epi. |
| Dressing room | TNTC | | X | TNTC Bacillus<br>50 Staph. Epi. |
| Fluoroscopy table | 8 | | X | 5 Staph. Epi.<br>2 Bacillus 1 GNR |
| Dressing table | 26 | | X | 7 Staph. Epi.<br>2 Bacillus 17 GNR |
| Stretcher | 6 | X | | 6 Staph. Epi. |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

EVALUATION:
"Dirty Areas" such as floors, walls, footstools, wheels, etc.

1. Contaminants
   0-100 acceptable
   >100 unacceptable
2. Pathogens
   0-10 acceptable
   >10 unacceptable

"Clean Areas" such as tables, equipment, hands, surgery floor, etc.

1. Contaminants
   0-25 acceptable
   >25 unacceptable
2. Pathogens
   >0 Unacceptable

Suggestions:

Collected by: _____ Date: 6-19-78

_____

Identified by: _____ Date: 6-20-78

Date of Survey: 7-5-78 Type: Pre-clean (Post-clean) Random
Location: X-ray & other areas Time of Collection: 1:20 pm

| Culture site | Count | ACCEPT. | UNACCEPT. | Organisms & Comments |
|---|---|---|---|---|
| ER - Rm 2 Stretcher rail | 12 | | X | 8 Staph. Epi. 2 Bacillus 1 GNR |
| ER - shower | TNTC | | X | TNTC - GNR (E. Coli) |
| ER - eye tray | TNTC | | X | TNTC Staph. Epi. TNTC Bacillus, few GNR |
| X-ray Dressing table | 7 | X | | 3 Staph. Epi. 4 Bacillus |
| X-ray - Rm 4 Table | 17 | | X | 15 Staph. Epi. 1 Bacillus 1 GNR |
| Pharmacy Counter | 0 | X | | |
| Resp. Table Table | 21 | X | | 11 Staph. Epi. 10 Bacillus |
| Central Supply Dishwasher | 5 | X | | 4 Staph. Epi. 1 Bacillus |
| Central Supply Work table | 3 | X | | 3 Staph. Epi. |

EVALUATION:
"Dirty Areas" such as floors, walls, footstools, wheels, etc.
1. Contaminants
   0-100 acceptable
   >100 unacceptable
2. Pathogens
   0-10 acceptable
   >10 unacceptable

"Clean Areas" such as tables, equipment, hands, surgery floor, etc.
1. Contaminants
   0-25 acceptable
   >25 unacceptable
2. Pathogens
   >0 unacceptable

Suggestions:

Collected by: _____ Date: 7-5-78

_____

Identified by: _____ Date: 7-6-78

# NOSOCOMIAL INFECTION CONTROL IN RADIOLOGY

Major Goals: To increase knowledge of nosocomial infection control

To change behavior to control cross-infections in the Radiology Department

Objectives: Upon completion of the one-hour education program, the student will:

1. Define nosocomial infection
2. Recall methods of infection control
3. Differentiate types of bacteria and select the nosocomial infection each might cause
4. Identify different aspects of the disease process
5. Identify current policies on infection control in the Radiology Department

Outline:

I. Infection
   - A. Nosocomial Infections
   - B. Basic Components of Infection
   - C. Types of Infections One Might Acquire (most common according to the American Hospital Association)
   - D. Various Modes of Disease Transfer
   - E. Patient Susceptibility
   - F. Examples of Microorganisms

II. Bacterial Culture Studies
   - A. Rodac Plate Procedure

Outline

B. Cultures
   1. June, 1978
   2. July, 1978
   3. August, 1979

C. Significance of Cultures
   1. Significance in terms of:
      a. time
      b. cost
      c. inconvenience to patient
      d. inconvenience to hospital
   2. Infections microorganisms may cause

III. Review of Current Policies and Procedures for Nosocomial Infection Control

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# NOSOCOMIAL INFECTION CONTROL IN RADIOLOGY

(Pretest and Posttest)

Directions: Circle the letter before the best answer.

1. Diseases of microbial or viral etiology contracted by a patient which would not have occurred had the patient not been hospitalized is the definition for:

   a. nosocomial infections
   b. hospital-acquired infections
   c. contagious infections
   d. a & b
   e. b & c

2. From the list below, which is NOT a way of transmitting infection?

   a. contact
   b. transfer
   c. air-borne
   d. vector-borne

3. No known infected cases are done in which of the following radiographic rooms:

   a. room 1
   b. room 2
   c. room 3
   d. mammographic room

4. Patients most susceptible to infection are:

   a. fibrocystic disease patients
   b. transplantation patients
   c. diabetic patients
   d. geriatric patients
   e. all of the above

5. A microorganism is ALWAYS considered a:

   a. pathogen
   b. non-pathogen
   c. bacteria
   d. microscopic germ

Pretest and Posttest

6. The portable x-ray unit SHOULD:

   a. always be used on isolation cases
   b. be wiped down daily with a germicide
   c. be wiped down daily with an antiseptic
   d. never be used on isolation cases

7. Departmental notification of the category of patient isolation involved should be done by:

   a. your supervisor
   b. personnel from the floor
   c. the Radiologist
   d. the Infection Control Nurse

8. An example of a gram-negative rod is:

   a. Staph. Aureus
   b. E. Coli
   c. Bacillus
   d. Streptococcus

9. E. Coli can be classified with:

   a. pneumonia organisms
   b. blue group organisms
   c. intestinal tract organisms
   d. pimple organisms
   e. scarlet fever organisms

10. Pathogenic organisms are:

   a. capable of producing disease
   b. harmless to the body tissues
   c. capable of producing an allergic reaction
   d. non-living organisms

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