A COMPARISON OF TWO METHODS OF SURVEILLANCE OF WOUND INFECTIONS ON A GENERAL SURGERY WARD

by

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CHAPTER I

INTRODUCTION

Statement of the Problem

Despite antimicrobial therapy, infection is still a problem in hospitals. It is estimated that five per cent of all patients entering hospitals in the United States will contract a hospital-acquired infection. (5) When antimicrobial drugs were introduced, it was felt that infection was no longer a threat to patients. Contrarily, many microbes developed antibiotic resistant strains, and there was an increase in infections caused by gram negative bacilli and fungi. (5, 16) During the period when antibiotics were gaining widespread usage, less stress was placed on aseptic technique and isolation procedures. (1) The result of these circumstances was that infection has not been eradicated, but remains a prominent problem which must be managed by recognition of its extent, scientific investigation of means to control it, and intelligent use of these means.

There are other factors which currently affect the occurrence of infection. One is that the hospital population includes an increased number of infants, elderly people, and chronically ill people who are more likely to develop infection. Another is that diagnostic and therapeutic procedures are providing new routes of admission for infectious agents. The following are examples of these diagnostic and therapeutic procedures: arteriography, cholangiography, cystoscopy,

urinary and intravenous catheterizations, blood transfusions, inhalation therapy treatments, and radical surgeries. A third factor is that some therapeutic procedures decrease the host's resistance to infection. For example, cancer chemotherapy and immunosuppressant drugs alter the host's defense mechanisms. (18)

Infection is destructive, expensive, and sometimes has far-reaching consequences. Infection causes much illness, increases existing sickness, or occasionally leads to death. It can cause the failure of operative procedures, delay their therapeutic effects, or create the necessity for further procedures. It may increase the patient's hospital stay a week or more longer than it would have been without infection. (9) This extension of hospital care increases the patient's hospital expenses, decreases his income, increases insurance payments, and decreases the capacity of the hospital to give care and treatment to others. Infection may become epidemic in the hospital ward, causing many patients to be affected by its destructiveness. It may be spread into the community by a patient who is discharged with an unrecognized infection. (8) It has been found that infection acquired in the hospital often is caused by antibiotic resistant organisms which make treatment and cure more difficult so infection is especially harmful in a community setting. (15) Thus the cost of ignoring or being indifferent to infection is high.

The first step toward control of hospital infection is to recognize that it is still dangerously prevalent. (7) No one denies that infection occurs, but too often its seriousness is ignored because knowledge of the frequency of its occurrence depends on

memory instead of scientifically maintained records. Estimates as to the amount of infection present in the hospital at any time are usually low and cannot be viewed as reliable indices. Objectively obtained infection incidence rates were frequently collected during an epidemic so they do not represent the endemic level of disease in that area and cannot be used for comparisons with other areas or as evaluation devices for the same area. To define accurately the incidence of infection in a hospital population, a continuous system of record keeping or case finding must be instituted.

Several investigators have studied the endemic incidence of nosocomial infections in their hospitals. In a search for nosocomial infections, Knudson studied the charts of 124 surgical patients who were discharged from a large medical school hospital. He found that 22.6 per cent (n=28) were infected of which 6.5 per cent were surgical wound infections. In addition, he showed that of 439 patients discharged from the same hospital in one year 8.9 per cent had a hospital-acquired infection, 1.4 per cent had a probably hospital-acquired infection, and 17.7 per cent had a non-hospital-acquired infection, or a total of 27.9 per cent of all discharged patients were infected. (14) The percentage of hospital-acquired infections in his study was twice as high as had been reported by others. The United States estimate is five per cent and Thoburn reported four per cent. (16, 17)

At Johns Hopkins Hospital, a large teaching center, Thoburn obtained data on the frequency and characteristics of various types of infections which occur in hospitals. For a six month period, private, semi-private, and ward patients on all services, except

psychiatry and dental surgery, were surveyed by a nurse epidemiologist. From an average of 2,500 admissions per month, a total of 592 patients developed nosocomial infections, or an incidence rate of four per cent. The urinary tract was the major source of infection, constituting 40 per cent of the total infections. Wounds were the second highest source of infection, representing 30 per cent of the total. Of 7,900 operations performed, 178 became infected, or an incidence of 2.3 per cent. (17)

To determine a protocol for surveillance in community hospitals, Eickhoff conducted a study of six hospitals which ranged in size from 176 to 507 beds. These hospitals, unassociated with medical schools, offered both medical and surgical services to the community. Four of the hospitals had intern and resident staffs. In five hospitals the surveillance activities were done by a nurse epidemiologist. The total number of discharges was 105,265 of which 1,460 developed nosocomial infections, or an incidence of 1.4 per cent. Since prevalence studies showed that the surveillance program was only 40 per cent effective, the adjusted nosocomial infection rate was 3.5 per cent. The range of infection rates per service was 0.3-2.9 per cent with the surgery service having the highest rate. The percentage of infections by classification as to source of infection showed that the urinary tract was the greatest with 36.4 per cent and surgical wounds were the second greatest with 25.3 per cent. (11)

Since some of the variables in the studies, such as method of surveillance, composition of patient population, type of hospital, and definition of infectious disease, may differ, exact comparison of

results may be difficult. However, despite this difficulty, the conclusions of the investigators seem to be the same. The consensus is that nosocomial infections are a grave problem.

The American Hospital Association is concerned with the problem of infection in hospitals. Its Committee on Infection Within Hospitals recommends that each hospital establish infection committees whose specific purpose is to investigate and deal with infection acquired in the hospital. The Association's reason for this committee is to reduce infection to the lowest possible minimum by making infection control the specific responsibility of a few. (2)

The Joint Commission of Accreditation of Hospitals has decided that one criterion for hospital accreditation should be that a hospital have a system for surveillance of hospital infections and a program for prevention and control of infection. (4) The consensus is that only as a specific body is set up to carry out these functions will there be adequate knowledge of the incidence of infection and thereby sufficient emphasis on controlling infection.

In searching for information regarding an adequate surveillance system it was found that several had been devised by various infection control committees. One system employed the nurse or physician as a recorder. He or she listed the names of infected patients in a book or on forms which were reviewed periodically by the infection control officer. (10) Another method was for the infection control officer to follow up bacteriology reports of pathogenic organisms. (7) As another means of surveillance, the infection control officer reviewed autopsy data or discharge summaries to determine in retrospect the

presence of infection. (4) A fourth method of surveillance was for the officer to make daily visits to the wards to examine the records of patients with elevated temperatures, those receiving antibiotics, or those with other significant signs or symptoms. (10)

There are desirable and undesirable aspects of each of these methods. A study by Cohen at Johns Hopkins Hospital compared the accuracy of locating staphylococcal infections by "report of infection" cards with ward visits by an infection control person who was following up positive bacteriology reports. All the medical and surgical patients discharged during a fourteen month period were included in the study, but no sample size was given in the report. The results indicated that the "report of infection" cards were unreliable and poorly represented the incidence of hospital-acquired infection. In fact, only 65 per cent of the infections were reported on the cards. While the cards underestimated the incidence of hospital-acquired infection, it was felt that bacteriology reports overestimated the incidence. Bacteriology reports identified patients who came into the hospital with an infection, those who became infected during hospitalization, and those who had microorganisms, but were not clinically infected. Since bacteriology reports were available only if someone took a culture of a possible infection and since cards alerted the committee to possible infections, it was felt that using more than one method of reporting infections would be advantageous. Cohen also investigated discharge summaries to determine the frequency with which infections were noted. After it was discovered that only one-third of the hospital-acquired infections were recorded on

discharge summaries, he concluded that this method was more inefficient than infection report cards. (7) Another investigator, Theburn, indicated that reporting infections on cards alone was unreliable, but was useful in combination with bacteriology reports. (17)

One means of surveillance which was begun in England and proved successful was to appoint a nurse as the infection control officer. (12) This form of surveillance was adopted in the United States and the new role was titled nurse epidemiologist. After ten years of having a nurse epidemiologist at Johns Hopkins Hospital, Theburn reported satisfaction with this method. (17)

The literature indicated that the role of a nurse epidemiologist was mainly infection case finding. In this capacity she followed up reporting forms, checked on positive bacteriology reports, made daily ward rounds, conferred with charge nurses, and reviewed patients' charts. From the information she collected, she made a record which she analysed and reviewed with the hospital epidemiologist. Every month she summarized the record as a statistical report for the infection control committee. She was not a diagnostician in reference to infections, but was a recorder acting under the authority of the infection control committee. (2, 3, 10, 11, 12, 13, 19)

Additional responsibilities which the nurse epidemiologist assumed had to do with controlling and preventing infection. She became a consultant and adviser on isolation techniques. She checked on the health of hospital personnel to detect the presence of a carrier of potential pathogens. She inspected the environment of the hospital, occasionally culturing areas, to assure and maintain sanitary conditions,

She assisted with inservice education programs that dealt with the prevention and control of infections. She assisted in epidemiological investigation of unusually increased infections. (3, 11, 12, 13, 19)

As has been indicated, the incidence of hospital infections is high. The surgical wound is one of the greatest sources of these infections as the literature has shown with incidence rates ranging from 7-30 per cent. A surveillance system is needed for continuous reporting of these infections so purposeful and effective preventive measures can be executed and evaluation of the measures can be made. Several surveillance systems have been devised, but most of them have been found to underreport the incidence of infection. For the seriousness of this problem there have been surprisingly few studies reporting on methods of surveillance.

Purpose of the Study

The purpose of this study was to examine two different methods of infection case finding in general surgery patients and to test two hypotheses:

1. There is no difference between the rate of reporting of nosocomial wound infections by the method of "report of infection" cards and the rate of reporting of nosocomial wound infections by the nurse epidemiologist's surveillance program.
2. There is no difference in the amount and kind of charting of infected conditions in patients' records before and after the nurse epidemiologist's management

of the surveillance program.

Limitations

1. This study was limited to the data obtained from 811 charts of patients over the age of fourteen admitted to the general surgery service of a university teaching hospital.
2. The selection of the charts was from two separate time periods: 521 charts were taken from the period of September 1, 1967, to August 31, 1968; 290 charts were taken from the period of June 1, 1970 to November 30, 1970.
3. No attempt was made to validate the observations of the investigator.
4. The results of this study apply only to the group of patients whose charts were involved.

Explanation of Terms

Terms used in this study include the following:

Attack rate: the number of cases of infection per the number of people at risk during a specified time, expressed as a percentage.

Endemic: the usual occurrence of a specific disease.

Epidemic: an increase of disease in an area over that amount which is normally expected.

Hospital-acquired infections (Nosocomial): these infections occurring in patients after admission to the hospital which were not

present or incubating at the time of admission, even if clinical evidence of infection does not appear until after discharge.

Incidence: the frequency of occurence of an infection over a specific period of time and for the specific population in which it occurs, usually expressed as a rate.

Infection: entry into the body of a pathogenic agent which multiplies and may produce injurious effects.

Prevalence: the frequency of an infection at a particular time and for the particular population involved.

Surveillance: a continuous look at the occurrence and spread of infectious disease to determine necessary prevention and control measures and to evaluate their effectiveness.

Wound infection: a wound which shows clinical signs of an infectious disease process, such as pain, heat, erythema, or purulent drainage, with or without a systemic reaction of pyrexia or leukocytosis, or which discharges fluid from which pathogenic organisms are cultured.

Research Design

Sources of Data

The primary sources of data were the 811 charts of general surgery patients admitted to a university teaching hospital.

The secondary sources of data were the related literature and studies pertaining to infectious diseases, their incidence, and their surveillance.

Procedure of the Study

The steps through which this study developed were as follows:

1. Literature and studies relevant to infectious diseases, their incidence and surveillance were reviewed.
2. The problem was defined.
3. The purpose and limitations of the study were determined.
4. The hypotheses were formulated.
5. The data collecting tool was designed. (Appendix A)
6. Oral permission was obtained from the nursing supervisor at the university teaching hospital to use any records necessary to identify the patients admitted to the general surgery service during the specific time intervals.
7. Oral permission was obtained from the supervisor of the hospital's medical records department to review the patients' charts.
8. Oral permission was obtained from the Chairman of the Department of Public Health and Preventive Medicine and the nurse epidemiologist to use their surveillance records for the time periods involved.
9. The charts were located and reviewed to determine the presence or absence of an infected wound.
10. The surveillance records were obtained and compared to the patients who had infected wounds.
11. The data obtained were tabulated and interpreted.
12. The findings were summarized, conclusions were drawn, and recommendations for further study were made.

Overview of the Study

This study is presented in four chapters. Chapter I consists of a statement of the problem, a review of related literature and pertinent studies, the purpose of the study and its limitations, explanation of terms, and the research design. Chapter II presents the methodology of the study. Chapter III describes the findings of the study and shows the analysis and intepprotation of the data. Chapter IV contains the summary of the study, the conclusions drawn, and the recommendations for further study.

CHAPTER II

METHODOLOGY

The major source of infections in hospitals is the urinary tract, but this study was limited to the second highest source which is surgical wounds. The reason for this selection was that there would more likely be clinical symptoms recorded in the chart if a surgical wound were infected, but not cultured or diagnosed, than for a urinary tract infection.

This was a retrospective record study of patients' charts. Charts of all patients admitted to the general surgery service in one selected hospital from September 1, 1967, to August 31, 1968, were examined. There were 545 charts and all but 24 were located, or 521 or 95.8 per cent of the charts were obtained. During this time the surveillance program consisted of report forms submitted by registered nurses or physicians. These report forms consisted of the date, ward, patient's name, type of infection, site of infection and place of acquisition, that is, whether it was hospital-acquired or not. All report forms were submitted to the infection control committee. (Appendix B)

In January, 1970, a registered nurse with a baccalaureate degree was hired as a nurse epidemiologist. Her primary function was surveillance of hospital infections. Each day she visited the laboratory, looked at all culture reports, and separated those with potentially pathogenic organisms. For example, Escherichia coli is a normal inhabitant of the intestinal tract, but if it was found in a

burn wound of a hand, it could be a transitory contaminant of the wound or culture, or it could be pathogenic. Other signs and symptoms exhibited by the patient would substantiate or repudiate the diagnosis. The nurse then checked the patients' charts to see if there was active infection.

For the study of the nurse epidemiologist's surveillance program, charts of all patients admitted to the general surgery service from June 1, 1970, to November 30, 1970, were reviewed. There were 308 charts, and all but 18 were located, or 94.2 per cent of the charts were located. The unlocated charts were either signed out of the medical records department by the Outpatient Clinic or physicians or had incorrect patient identification numbers so they could not be found. Accordingly, the data were collected from 290 charts.

The patients included in the study were adults admitted to the general surgery service of a university teaching hospital. Many of the patients had multiple diagnoses. Others had complicated and unusual illnesses. Many of the patients were in a debilitated condition when they entered the hospital, or their illnesses were so severe that they became debilitated during their stay. Any or all of these circumstances could have influenced the development of infection.

A form was developed to record the information about infection found in the patients' charts. (Appendix A) The first item on the form was the final discharge diagnosis. In the final discharge diagnosis, disease entities are classified by a code number from the International Classic Coding Book of Diseases. The code numbers are accompanied by an identifying name. The diagnosis was checked as to

whether it contained the code number and name for a wound infection.

The second item to be examined was the discharge summary to see if there was any report of a wound infection or any reference that might signify a wound infection, such as, debridement of a wound, surgical incision and drainage of a wound, spontaneous opening or draining of a wound, or pathogenic organisms in a wound.

The physicians' progress reports were inspected next. Statements of a wound infection or references suggestive of wound infection, such as opening, draining, irrigating, packing, or culturing a wound, or mention of a pathogenic organism cultured from a wound were noted. The nurses' notes were also examined for references to the condition of the wound; for instance, purulent drainage from it or erythema or tenderness around it, and for references to any treatment.

In the laboratory reports two elements were considered: the white blood cell count and culture reports. For the purposes of this study white cell counts above 10,000 indicated an infection. Cultured organisms were noted and evaluated as to the possibility of their being pathogenic in that situation. The temperature record was checked, and an oral temperature of 100 F. or higher indicated infection in this study.

Finally, the physicians' order sheets were looked at to find orders for cultures of the wound, for treatments to be performed on the wound, and/or for isolation techniques to be employed in caring for the wound or patient.

CHAPTER III

REPORT OF THE STUDY

Introduction

This study was made to examine two different methods of surveillance of surgical wound infections: 1) reporting by the hospital personnel using "report of infection" cards and 2) case finding performed by a nurse epidemiologist. The literature presented in Chapter I indicated that "report of infection" cards alone are unreliable indicators of the incidence of infection. A combination of the "report of infection" cards plus bacteriology reports to initiate surveillance of infections yields more accurate indices of infection. The nurse epidemiologist's role is to search for infections, using positive bacteriology reports and "report of infection" cards as suggestions. Thus the nurse epidemiologist's infection rates should be accurate. The study tested the hypotheses and followed the steps presented in Chapter I.

Description of Population

Charts of patients admitted to the general surgery service of a university teaching hospital were reviewed to identify the prevalence of wound infections. The patients, whose charts were reviewed, had been admitted during two different time periods. The two groups of patients will be described separately. During the first time period,

September 1, 1967 to August 31, 1968, 521 patients' charts were located. Of that number, 464 patients were not infected, 16 patients had non-hospital-acquired wound infections, and 43 patients developed nosocomial wound infections. One of the patients, who developed a nosocomial wound infection, had entered the hospital with a non-hospital-acquired wound infection which differed from the subsequent infection, so he was counted in both categories. Another patient in the nosocomial wound infection category developed two distinctly different nosocomial wound infections, so she was counted twice in that category. Thus the total population in the first group equaled 523.

The ages of the 523 patients ranged from 14 to 90 years with two patients' ages not located. The mean age was 61 with the largest number of patients in the 50 through 60 age groups. Of the remainder more patients were in the younger rather than older age groups. The data are shown on Table 1.

Table 1. Distribution of 523 Patients by Age Groups

Ages	Patients	
	N	%
10-19	42	8.1
20-29	64	12.3
30-39	34	6.5
40-49	74	14.2
50-59	156	29.9
60-69	106	20.4
70-79	38	7.3
80-89	6	1.1
90-99	1	.2
unlocated	2	--

Dividing the 523 patients according to the presence or absence of infection showed that the distribution of ages closely approximated that of the total study population. The age range of the non-infected patients was from 14 to 90 years with a mean age of 62 and a predominant number of ages in the 50 through 60 age group. The age range of the patients with non-hospital-acquired wound infections was from 17 to 88 years with a mean age of 60 and the most frequent number of ages in the 50 year group. The age range of the patients with nosocomial wound infections was from 16 to 82 years with a mean age of 58 and a predominant number of ages in the 50 year group. See Table 2.

Table 2. Distribution of 523 Patients by Age Groups According to the Presence or Absence of Wound Infection.

Ages	Not Infected	Non-Hospital-Acquired Wound Infection	Nosocomial Wound Infection
10-19	39	1	2
20-29	59	1	4
30-39	30	2	2
40-49	66	3	5
50-59	136	5	15
60-69	95	2	9
70-79	33	1	4
80-89	4	1	1
90-99	1	0	0
unlocated	1	0	1
Totals	464	16	43

Of the 43 patients with nosocomial wound infections the incidence of infection was higher in the older patients. See Table 3. This trend was consistent with the reports in the literature.

Table 3. Incidence of Forty-three Nosocomial Wound Infections by Age Groups.

Ages	Number of Patients	Number Infected	Infection Rate %
10-19	42	2	4.8
20-29	64	4	6.3
30-39	34	2	5.9
40-49	74	5	6.8
50-59	156	15	9.6
60-69	106	9	8.5
70-79	38	4	10.5
80-89	6	1	16.7
90-99	1	0	0.0
unlocated	2	1	--

In the first time period the population consisted of 287 males and 236 females, 54.9 per cent and 45.1 per cent respectively. This relatively equal division of males and females was evident also in the non-infected and nosocomial wound infection groups. There were approximately a third more males than females in the non-hospital acquired wound infection group. See Table 4.

Table 4. Distribution of 523 Patients by Sex According to the Presence or Absence of Wound Infection.

Sexes	Non-Infected		Non-Hospital-Acquired Wound Infection		Nosocomial Wound Infection	
	N	%	N	%	N	%
Males	257	55.3	10	62.5	20	46.5
Females	207	44.7	6	37.5	23	53.5
Totals	464	100	16	100	43	100

In the first time period 155 patients did not have surgery. Thus the population at risk for nosocomial wound infections was 368 patients. With 43 nosocomial wound infections, the incidence rate was 11.7 per cent. In a subsequent section the nosocomial wound infections will be discussed in detail.

The types of surgery which most frequently became infected were those involving the gastrointestinal tract. These infections could have been caused by accidental spillage of bacteria-laden bowel contents into the wound during the operation. Surgical procedures performed in areas which were potentially contaminated prior to the operation, such as those associated with gunshot wounds, also frequently became infected. Other wound infections occurred following complex and radical surgeries, such as, after hiatal herniorrhaphies, radical neck resections and radical mastectomies, which occurrences had been suggested in the literature. Other surgeries, such as incisional herniorrhaphies and endarterectomies, which were associated with a moderate amount of wound infection, could have become infected because of poor tissue strength or insufficient circulatory function.

A predominant number of those surgeries which were not infected were those which would less likely become contaminated during the procedure or were relatively minor operations. Refer to Table 5.

Table 5. Frequency of Nosocomial Wound Infection Following Operations Performed, September 1, 1967 to August 31, 1968 on 368 Patients.

Surgical Procedure	Number of Operations Performed	Number of Nosocomial Wound Infections	Infection Rate %
Gastrointestinal			
Cholecystectomy	39	2	5.1
Gastric surgery	22	2	9.1
Colectomy	18	6	33.3
Appendectomy	11	0	0.0
Exploratory laparotomy	13	3	23.1
Colostomy	6	3	50.0
Colostomy closure	6	2	33.3
Hemorrhoidectomy	6	0	0.0
Abdominal-perineal resection	5	0	0.0
Exploratory laparotomy associated with gunshot wounds	3	3	100.0
Fistulectomy	3	1	33.3
Pelvic exenteration	1	1	100.0
Miscellaneous	19	0	0.0
Vascular			
Endarterectomy	7	2	28.6
Vein stripping	6	0	0.0

Table 5. Continued

Surgical Procedure	Number of Operations Performed	Number of Nosocomial Wound Infections	Infection Rate %
Bypass grafting	5	0	0.0
Thrombectomy	3	1	33.3
Miscellaneous	24	0	0.0
Miscellaneous			
Biopsy or excision of miscellaneous lesions and masses	35	2	5.7
Inguinal herniorrhaphy	28	1	3.5
Breast biopsy	19	0	0.0
Radical and simple mastectomy	17	3	17.6
Thyroidectomy	12	0	0.0
Reconstructive surgery and skin graft	11	0	0.0
Amputation of extremity	8	1	12.5
Incisional and ventral herniorrhaphy	7	2	28.6
Hiatal and diaphragmatic herniorrhaphy	6	5	83.3
Radical neck resection	6	2	33.3
Adrenalectomy and oophorectomy	6	0	0.0

Table 5. Continued

Surgical Procedure	Number of Operations Performed	Number of Nosocomial Wound Infections	Infection Rate %
Splenectomy	5	0	0.0
Groin dissection	4	0	0.0
Excision of pilonidal cyst	4	0	0.0
Debridement	3	1	33.3
Totals	368	43	

The number of patients' charts obtained during the second time period, June 1, 1970 to November 30, 1970, was 290. The number of patients who were not infected equaled 259; the number who had entered the hospital with wound infections was 11; and the number who developed nosocomial wound infections was 20.

The range of ages of the 290 patients was from 15 to 86 years with ten patients' ages unlocated. Although approximately one half of the patients were in the 50 through 60 year age group, the mean age was 48 because most of the remaining patients were in the 20 through 40 year group. Refer to Table 6.

Table 6. Distribution of 290 Patients by Age Groups.

Ages	Patients	
	N	%
10-19	13	4.6
20-29	47	16.8
30-39	28	10.0
40-49	46	16.5
50-59	70	25.0
60-69	61	21.8
70-79	13	4.6
80-89	2	0.7
90-99	0	0.0
unlocated	10	--
Totals	290	100

The range and mean of the portion of patients who were not infected were similar to those of the total study population, 15 to 86 years and 49 years respectively, with the ten unlocated ages occurring in the non-infected category. For the non-hospital-acquired infected wound category, the range was 16 to 62 years and the mean was 38 years, which range indicated a younger group of patients than were in the non-infected category. The nosocomial wound infection category had ages ranging from 16 to 73 years and a mean of 47 years, which range and mean were similar to the non-infected category and the total study population distribution. See Table 7.

Table 7. Distribution of 290 Patients by Age Groups According to the Presence or Absence of Wound Infection.

Ages	Not Infected	Non-Hospital Acquired Wound Infection	Nosocomial Wound Infection
10-19	10	2	1
20-29	42	2	3
30-39	23	2	3
40-49	43	2	1
50-59	58	2	10
60-69	59	1	1
70-79	12	0	1
80-89	2	0	0
90-99	0	0	0
unlocated	10	0	0
Totals	259	11	20

In the nosocomial wound infection category for the second period the infection rate was highest in the 50 year age group with a second high rate in the 30 year group. Other moderately high rates occurred in the younger as well as older age groups indicating that for this population, age was not a predisposing factor in the acquisition of wound infection. See Table 8.

Table 8. Incidence of Twenty Nosocomial Wound Infections by Age Groups.

Ages	Number of Patients	Number Infected	Infection Rate %
10-19	13	1	7.7
20-29	47	3	6.4
30-39	28	3	10.7
40-49	46	1	2.2
50-59	70	10	14.3
60-69	61	1	1.6
70-79	13	1	7.7
80-89	2	0	0.0
90-99	0	0	0.0
unlocated	10	0	0.0

The population in the second time period consisted of 122 males and 168 females, 42.1 per cent and 57.9 per cent respectively. The same trend of a few more females than males was evident in the non-infected and non-hospital-acquired wound infection categories, but in the nosocomial wound infection category, the males predominated. The differences in distribution of sex were too small to conclude that sex was a determinant in the development of wound infections. The data are shown on Table 9.

Table 9. Distribution of 290 Patients by Sex According to the Presence or Absence of Wound Infection.

Sexes	Non-Infected		Non-Hospital-Acquired Wound Infection		Nosocomial Wound Infection	
	N	%	N	%	N	%
Males	105	40.5	5	45.5	12	60.0
Females	154	59.5	6	54.5	8	40.0
Totals	259	100	11	100	20	100

Of the 290 patients located in the second time period, 87 had not had surgery, leaving 203 patients at risk of developing nosocomial wound infections. Thus, with 20 nosocomial wound infections, the incidence rate was 9.9 per cent. These infections will be discussed in detail later in this report.

During the second period twelve of the twenty nosocomial wound infections occurred after surgeries of the gastrointestinal tract. Since most of those surgeries involved incisions through the colon, the wounds could have been contaminated with bowel contents during the procedure. Many of those twelve infections were associated with surgeries of the colon, which association is a common occurrence since the colon, when incised, can contaminate the wound with its contents full of the normal variety of bacterial flora. Two of the surgeries, an appendectomy following a rupture and a skin graft to a fissure in ano, probably became infected because of prior contamination of the areas with feculent material. Another surgery, a pedicle graft to an ulcerated area of the skin, might have become infected because of poor tissue healing following radiation to the area. Further

analysis of the reasons for surgical wounds to become infected was not within the scope of this study. Refer to Table 10.

Table 10. Frequency of Nosocomial Wound Infection Following Operations Performed, June 1, 1970 to November 30, 1970.on 203 Patients.

Surgical Procedure	Number of Operations Performed	Number of Nosocomial Wound Infections	Infection Rate %
Gastrointestinal			
Cholecystectomy	23	0	0
Gastric surgery	11	1	9.1
Colectomy	11	2	18.2
Colostomy	6	4	66.7
Appendectomy	4	2	50.0
Colostomy closure	4	0	0.0
Abdominal-perineal resection	4	2	50.0
Cholecystojejunostomy	3	1	33.3
Hemorrhoidectomy	2	0	0.0
Exploratory laparotomy	1	0	0.0
Vascular			
Bypass grafting	15	1	6.7
Endarterectomy	9	0	0.0
Vein stripping	2	0	0.0
Thrombectomy	1	0	0.0
Miscellaneous			
Breast biopsy	17	0	0.0

Table 10. Continued

Surgical Procedure	Number of Operations Performed	Number of Nosocomial Wound Infections	Infection Rate %
Biopsy or excision of miscellaneous lesions and masses	16	0	0.0
Inguinal herniorrhaphy	12	0	0.0
Reconstructive surgery and skin graft	9	3	33.3
Splenectomy	8	1	12.5
Thyroidectomy	8	0	0.0
Radical and simple mastectomy	5	0	0.0
Incisional and ventral herniorrhaphy	4	0	0.0
Amputation of extremity	4	2	50.0
Adrenalectomy and oophorectomy	4	0	0.0
Excision of pilonidal cyst	3	1	33.3
Radical neck resection	2	0	0.0
Debridement	2	0	0.0
Groin dissection	1	0	0.0
Miscellaneous	12	0	0.0
Totals	203	20	

Although the two time periods were different lengths, one year and six months, the data accumulated from the two showed various similarities. The ranges of ages for the total populations and the

nosocomial wound infection categories were alike. The most frequent ages were in the 50 through 60 year group and in the 50 year group for the nosocomial wound infections categories. A dissimilarity occurred in the mean ages 61 and 48 for the total populations and 58 and 47 for the infected populations, showing that the second population included more young people than the first. Both populations were evenly divided regarding the sexes. The nosocomial wound infection rates for the two periods were almost equal: 11.7 and 9.9. The types of surgeries performed during the two periods were about the same, and the nosocomial wound infections in both instances mainly followed gastrointestinal surgeries. Since the two populations were so alike, it was possible to compare them regarding the amount of wound infection reporting performed without adjustments having to be made for other factors.

Testing the Hypotheses

An established policy of the university teaching hospital was that nosocomial infections were to be reported to the chairman of the Infection Control Committee. From September 1, 1967 to August 31, 1968, the means of reporting was by "report of infection" cards sent by the hospital personnel to the chairman. From June 1, 1970 to November 30, 1970, nosocomial infections were located and records of them were compiled by a nurse epidemiologist.

The hypothesis was that there was no difference between the rate of reporting of nosocomial wound infections by the method of "report of infection" cards and the rate of reporting of nosocomial wound

infections by the nurse epidemiologist's surveillance program. To test the hypothesis, the number of nosocomial wound infections which occurred during these two times was determined by reviewing the charts of patients admitted to the general surgery ward. It was established that a wound had become infected by the physician's diagnosis and/or a positive culture recorded in the chart. Confirmation that the diagnosis and culture were indicative of infection was obtained from the patient's concomitant signs and symptoms. Then the "report of infection" cards and nurse epidemiologist's records were examined to discover which nosocomial wound infections were reported.

The use of "report of infection" cards to identify all the nosocomial wound infections was found to be 16.3 per cent efficient whereas reporting by the nurse epidemiologist was 75 per cent effective. Therefore, the hypothesis was rejected. Because the difference between the efficiency of the two programs was so significant, no statistical manipulation was necessary to demonstrate that the nurse epidemiologist's surveillance program was superior in detecting the presence of nosocomial wound infections. The effectiveness of the two methods is depicted by the data shown on Table 11.

Table 11. Efficiency of Two Methods of Surveillance of Nosocomial Wound Infections.

Method of Surveillance	Nosocomial Wound Infections Reported	Nosocomial Wound Infections Detected	Per Cent of Nosocomial Wound Infections Reported
"Report of Infection" cards	7	43	16.3
Nurse epidemiologist	15	20	75.0

As a test of the second hypothesis of no difference in the amount and kind of charting of infected conditions in patients' records before and after the nurse epidemiologist's surveillance program was instituted, the physicians' and nurses' notations in the charts regarding wound infections were counted. During the second period a wound infection was diagnosed by the physicians appreciably less number of times in the discharge diagnosis than during the first period. See Table 12.

Table 12. Presence or Absence of Wound Infection Diagnoses Recorded in Discharge Diagnoses.

	September 1, 1967- August 31, 1968		June 1, 1970- November 30, 1970	
	N	%	N	%
Diagnosis of infection	21	48.8	4	20.0
No diagnosis of infection	22	51.2	16	80.0
Totals	43	100	20	100

The number of implied or definite diagnoses of wound infections in the physicians' discharge summary statements was also less during the second interval, as shown on Table 13.

Table 13. Presence or Absence of Wound Infection Diagnoses Recorded in Discharge Summaries.

	September 1, 1967- August 31, 1968		June 1, 1970- November 30, 1970	
	N	%	N	%
Diagnosis of infection	17	39.5	3	15.0
Implied infection	5	11.6	5	25.0
No diagnosis of infection	11	25.6	8	40.0
No summary made	10	23.3	4	20.0
Totals	43	100	20	100

The diagnoses in the physicians' progress notes were less in the second period as well, as noted on Table 14.

Table 14. Presence or Absence of Wound Infection Diagnoses Recorded in Progress Notes.

	September 1, 1967-August 31, 1968		June 1, 1970-November 30, 1970	
	N	%	N	%
Diagnosis of infection	17	39.5	6	30.0
Implied infection	21	48.9	9	45.0
No diagnosis of infection	5	11.6	5	25.0
Totals	43	100	20	100

There was apparently no improvement in the amount and kind of charting performed by the physicians after the institution of the nurse epidemiologist's surveillance program. The assumption, therefore, might be that the nurse epidemiologist was ineffective in evoking increased awareness of wound infections. However, no definite conclusion can be made because there were uncontrolled variables, such as the amount of staff training and the rotation of physicians.

The number of notations by the nurses describing the patients' wounds and their care remained the same or was increased in five of the six factors examined. The inference might be made that the nurses became more cognizant of wound infections because of the nurse epidemiologist's interest, but again no specific conclusions should be formulated. Refer to Table 15.

Table 15. Nurses' Chart Notations of Conditions and Treatment of Wounds.

	September 1, 1967- August 31, 1968 n=43			June 1, 1970- November 30, 1970 n=20		
	Recorded	Not Recorded	% Recorded	Recorded	Not Recorded	% Recorded
Culture	16	27	37.2	11	9	55.0
Erythema	13	20	30.2	4	16	20.0
Foul odor	2	41	4.7	7	13	35.0
Purulence	30	13	69.8	20	0	100
Tenderness	2	41	4.7	2	18	10.0
Wound care	40	3	93.0	18	2	90.0

The patients' systemic responses to the infections provided supporting evidence of the presence of wound infections. Approximately three-fifths of the patients in both intervals demonstrated leukocytosis. See Table 16.

Table 16. Presence or Absence of Leukocytosis as a Result of Wound Infection.

	September 1, 1967- August 31, 1968		June 1, 1970- November 30, 1970	
	N	%	N	%
Greater than 10,000	26	60.5	13	65.0
Less than 10,000	17	39.5	7	35.0
Totals	43	100	20	100

During the two time periods about seven-tenths of the patients manifested pyrexia. See Table 17.

Table 17. Presence or Absence of Phyrexia as a Result of Wound Infection.

	September 1, 1967-August 31, 1968		June 1, 1970-November 30, 1970	
	N	%	N	%
Greater than 10,000	33	76.7	14	70.0
Less than 10,000	10	23.3	6	30.0
Totals	43	100	20	100

The majority of cultures taken from the patients' wounds were positive, showing the presence of pathogenic organisms. Refer to Table 18.

Table 18. Presence or Absence of Pathogenic Organisms in Wounds.

	September 1, 1967-August 31, 1968		June 1, 1970-November 30, 1970	
	N	%	N	%
Positive culture	37	86.0	19	95.0
Negative culture	4	9.3	0	0.0
Not cultured	2	4.7	1	5.0
Totals	43	100	20	100

Staphylococcus aureus and Escherichia coli were the principal pathogenic organisms isolated from the wounds. Many of the wound

cultures grew multiple organisms; thus it was impossible to determine which one of them caused the infection. Staphylococcus aureus was isolated singly from eight wounds in the first period and four wounds in the second period. Escherichia coli was the other single isolate, being present in four wounds during the first period and two wounds during the second. Gram negative organisms were as prevalent in the wounds as gram positive, which finding is consistent with the literature. See Table 19.

Table 19. Types of Organisms Isolated from Wound Cultures.

Organism	September 1, 1967-August 31, 1968		June 1, 1970-November 30, 1970	
	N	%	N	%
Gram positive				
Staphylococcus aureus	12	15.2	8	19.5
Streptococcus faecalis	8	10.1	1	2.4
Beta streptococcus	2	2.5	3	7.3
Clostridium perfringens	1	1.3	0	0.0
Gram negative				
Escherichia coli	20	25.3	12	29.4
Pseudomonas aeruginosa	7	8.8	8	19.5
Klebsiella	6	7.6	2	4.9
Proteus mirabilis	5	6.3	3	7.3
Aerobacter	4	5.1	2	4.9
Bacteroides	3	3.8	0	0.0
Serratia	2	2.5	0	0.0
Candida albicans	1	1.3	1	2.4
Proteus morganii	1	1.3	0	0.0

Table 19. Continued

Organism	September 1, 1967- August 31, 1968 N	%	June 1, 1970- November 30, 1970 N	%
Proteus rettgeri	1	1.3	0	0.0
Negative	4	5.1	0	0.0
No Culture	2	2.5	1	2.4
Totals	79	100	41	100

The physicians' directives for care of the patients, as recorded on the order sheets, indicated possible wound infections; the majority of charts contained orders for cleaning, irrigating or packing the wounds. Since only about half of the charts included orders for culturing the wounds, the adequacy of surveillance based on bacteriology reports alone seems doubtful. Only a small number of orders were written for isolating the infected patients, but it was not within the scope of this study to examine the utilization of isolation for infected patients. See Table 20.

Table 20. Physicians' Orders for Care of Infected Patients.

	September 1, 1967- August 31, 1968 n=43			June 1, 1970- November 30, 1970 n=20		
	Ordered	Not Ordered	% Ordered	Ordered	Not Ordered	% Ordered
Culture	25	18	58.1	11	9	55.0
Isolation	4	39	9.3	3	17	15.0
Wound care	38	5	88.4	18	2	90.0

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of the Study

The intent of this study was to compare two methods of surveillance of nosocomial wound infections: 1) "report of infection" cards submitted by the hospital personnel to the chairman of the Infection Control Committee and 2) detection of infections by a nurse epidemiologist utilizing the reports of wound culture growth. Another purpose was to assess the level of awareness of the hospital staff to a patient's wound infection by the notations regarding infection recorded in the patient's chart.

A review of the literature indicated that hospitals were assigning the major responsibility for infection surveillance to one individual. Rather than the physician filling that position, the trend is for a nurse, called a nurse epidemiologist, to be the surveillance officer. Very few studies were reported in the literature regarding the adequacy of the nurse epidemiologist's surveillance programs.

To study the effect of a program of one individual performing surveillance contrasted to responsibility divided among many, a retrospective review of patients' charts was undertaken. A data collection sheet was devised to implement the review. The supervisors of a university teaching hospital and medical records department

gave oral permission to search the patients' records to detect the presence or absence of nosocomial wound infections. Oral permission was also received from the Chairman of the Department of Public Health and Preventive Medicine to review the infection surveillance records to determine the number of wound infections reported.

Two time periods were chosen to represent the two methods of surveillance. During the first period, a year, 547 patients were admitted to the general surgery ward of the university teaching hospital, but only 521 patient charts were located for review. Two of those patients were counted twice because each had two infections during his hospitalization. The second period, six months, had 308 patients admitted to the general surgery service with 290 patient charts found.

The patients in the first period of time ranged in age from 14 to 90 with a mean age of 61. During the second time the patients' ages ranged from 15 to 86 with 48 the mean. Both periods had a predominant number of patients in the 50 through 60 years age group. The sexes of the patients were almost equally divided in both sections.

Physicians' and nurses' chart notations were examined for evidence of nosocomial wound infections. The patients' systemic signs were considered in order to detect patterns characteristic of responses to infection. Isolates from wound cultures were studied to assess their pathogenic properties. Decisions concerning the presence or absence of disease in every patient were then derived from the collection of data.

The number of nosocomial wound infections detected during the

first interval was 43, an incidence of 11.7 per cent since only 321 patients in the total population had surgery. In the second time period 20 infections were found, yielding an incidence of 9.9 per cent, 87 patients not having had surgery. The age range of the 43 patients was 16 to 82 with a mean of 58 years. The mean age of the 20 patients was 47 with a range of ages from 16 to 73. In the two groups the number of males approximately equalled the number of females. In both groups the surgeries that were most frequently followed by wound infections were gastrointestinal.

The nosocomial wound infections which were located were compared to the infection surveillance records collected during the two times. The number of "report of infection" cards sent to the infection committee chairman from September 1, 1967 to August 31, 1968 was seven, the rate at which the infections were reported thus being 16.3 per cent. Fifteen nosocomial wound infections were detected by the nurse epidemiologist from June 1, 1970 to November 30, 1970, making the percentage of infections located by this method 75 per cent. No statistical computation was necessary to acknowledge the greater efficiency of the nurse epidemiologist's surveillance program in locating nosocomial wound infections.

The physicians' and nurses' observations pertaining to the patients' wounds were contrasted between the two periods. Physicians tended to diagnose or imply that a wound was infected less often in the second time period than in the first. More nurses' notations concerning symptoms and treatment of wound infection were present in the charts of the second period than the first.

The presence of leukocytosis and pyrexia in the majority of patients in both instances supported the decision that a wound infection had occurred. The isolation of pathogenic organisms from most of the wounds also confirmed the presence of infection. Although most of the wounds contained multiple organisms, Staphylococcus aureus was isolated singly eight times in the first series and four times in the second. Gram negative bacteria were the causative organisms in the wound infections as often as gram positive bacteria.

Conclusions

The study indicated that further research into the efficiency of different methods of surveillance would be necessary and profitable in determining the preferable means of locating nosocomial wound infections. Although the study data only apply to these groups of patients, this study could be a pilot to other investigations.

The following conclusions may be derived from the findings of the study:

1. The data rejected the hypothesis of no difference between the rate of reporting of nosocomial wound infections by the method of "report of infection" cards and the rate of reporting of nosocomial wound infections by the nurse epidemiologist's surveillance program. The latter program identified more nosocomial wound infections.
2. Since many variables were not controlled, the data are inconclusive regarding the difference between

the amount and kind of charting of infected conditions in patients' records before and after the nurse epidemiologist's management of the surveillance program. However, the physicians tended to record less information about infections and the nurses more information during the second time period.

The findings of this study concerning reporting of infections were consistent with those of Lawrence S. Cohen in his study of the epidemiology of staphylococcal infection at Johns Hopkins Hospital from September, 1960 through October, 1961. (7)

Recommendations for Further Study

Recommendations for improvement of the present study are as follows:

1. Another study conducted in this manner should involve equal time intervals.
2. To assist in the identification of infection, thought should be given to the patient's sedimentation rate and white blood cell differential.
3. The influence of antibiotics and immunosuppressants on the patient's systemic signs should be taken into account in the identification of infection.
4. The patient's underlying pathology, including organic as well as other infectious diseases,

is a variable which should be considered in determining the presence of infection.

5. To test the change in awareness of the hospital personnel concerning infections after the advent of the nurse epidemiologist, the following would be necessary: 1) more information concerning her formal and informal staff teaching programs, 2) more specific measurements to indicate change, and 3) more control of the variable of rotation of physicians.

The following are recommendations for related studies:

1. Further investigation of surveillance methods could be done in the form of a prevalence study including all types of infections to examine the efficiency of one method of surveillance for a short, intensive time span.
2. A prospective study of surveillance methods including personal examination of the patients by the investigator would add another factor to the number of criteria used to determine the presence of infection.
3. A study of the frequency with which specific operative procedures become infected could be conducted.
4. A study could be performed regarding the rate at which gram positive and gram negative bacteria cause infectious disease.

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APPENDICES

APPENDIX A

Form Used in Locating Wound Infections

APPENDIX A

Form Used in Locating Wound Infections

1. Final discharge diagnosis

2. Physician's discharge summary

3. Physician's progress reports

4. Laboratory reports
   - A. White blood cell counts
   - B. Culture results

5. Nurses' notes

6. Temperature records

7. Physician's order sheets

APPENDIX B

"Report of Infection" Card for Hospital Personnel

APPENDIX B

"Report of Infection" Card for Hospital Personnel

INFECTION REPORT
TO MEDICAL DIRECTORS OFFICE

Date

Unit No.
Name

Birthdate

Room No., Clinic, or Dept.:

Type of Infection:

Developed in Hospital? Yes: No:

Site on the Body:

If No New Infections Check Here:

Signature of Person Submitting Report

APPENDIX C

Raw Data

APPENDIX C

Raw Data

	September 1, 1967- August 31, 1968	June 1, 1970- November 30, 1970
Number of Patients Admitted	547	308
Number of Charts Not Located	24	18
Number of Charts Located	521	290
Non-Infected Patients	464	259
Patients with Non-Hospital Acquired Wound Infections	16	11
Patients with Nosocomial Wound Infections	43	20
Age Ranges	14-90	15-86
Sexes: Males	287	122
Females	236	168
Patients Who Had Surgery	368	203
Patients Who Had Not Had Surgery	155	87
Infections Reported	7	15
Infections Detected	43	20
Final Discharge Diagnosis:		
Diagnosis of Infection	21	4
No Diagnosis of Infection	22	16
Physicians' Discharge Summary:		
Diagnosis of Infection	17	3
Implied Infection	5	5
No Diagnosis of Infection	11	8
No Summary Made	10	4
Physicians' Progress Reports:		
Diagnosis of Infection	17	6
Implied Infection	21	9
No Diagnosis of Infection	5	5
White Blood Cell Count:		
Greater Than 10,000	26	13
Less Than 10,000	17	7
Temperature Records:		
Greater Than 100 F. Orally	33	14
Less Than 100 F. Orally	10	6
Culture Results:		
Pathogenic Organisms	37	19
Non-Pathogenic or No Organisms	4	0
Not Cultured	2	1
Types of Organisms:		
Gram Positive	23	12
Gram Negative	56	29

Raw Data continued

	September 1, 1967- August 31, 1968		June 1, 1970- November 30, 1970	
Nurses' Notes	Recorded	Not Recorded	Recorded	Not Recorded
Culture	16	27	11	9
Erythema	13	30	4	16
Foul Odor	2	41	7	13
Purulence	30	13	20	0
Tenderness	2	41	2	18
Wound Care	40	3	18	2
Physicians' Order Sheets	Ordered	Not Ordered	Ordered	Not Ordered
Culture	25	18	11	9
Isolation	4	39	3	17
Wound Care	38	5	18	2

AN ABSTRACT OF THE THESIS OF

JOANNE M. JACKSON

For the MASTER OF SCIENCE in NURSING EDUCATION

Date of receiving this degree: June 9, 1972

Title: A COMPARISON OF TWO METHODS OF SURVEILLANCE OF WOUND INFECTIONS ON A GENERAL SURGERY WARD

Approved: [redacted]
(Associate Professor in Charge of Thesis)

In this study two methods of surveillance of nosocomial wound infections were compared: 1) "report of infection" cards prepared by hospital personnel and 2) detection of infection by a nurse epidemiologist through use of culture reports. The possibility of a change in the level of awareness of hospital personnel toward patients' wound infections after the institution of a nurse epidemiologist's surveillance program was also investigated.

From a study of literature it was learned that most hospitals do have one person responsible for infection reporting, usually a nurse epidemiologist, but that little research has been made into the efficiency of such programs.

The method of this study was to review patients' charts during two time periods, one before and the other after the establishment of the nurse epidemiologist's surveillance program. The patients' charts were examined for notations by physicians and nurses concerning

symptoms and treatment related to wound infections, for systemic signs indicative of infection, and for pathogenic organisms to confirm the presence of infection.

The number of nosocomial wound infections located from the patients' charts was compared to the number of "report of infection" cards filed during the first time period and to the number of wound infections detected by the nurse epidemiologist during the second interval. The "report of infection" cards method was found to be only 16.3 per cent effective during the period studied whereas the nurse epidemiologist's surveillance program of the selected period demonstrated 75 per cent efficiency. The study of the charts showed that the physicians tended to record a diagnosis of wound infections less often during the time period after the advent of the nurse epidemiologist whereas notations by nurses regarding symptoms and treatment of wound infections increased during this interval in comparison to the first.

Since more nosocomial wound infections were identified by the nurse epidemiologist's surveillance program, the hypothesis of this study, that there is no difference between the rate of reporting of nosocomial wound infections by the method of "report of infection" cards and the rate of reporting of nosocomial wound infections by the nurse epidemiologist's surveillance program, has been rejected.

Because of many uncontrolled variables, no conclusion can be made concerning the difference between the amount and kind of charting of infected conditions in patients' records before and after the institution of the nurse epidemiologist's surveillance program.

Recommendations for Further Study

Recommendations for improvement of the present study are as follows:

1. Another study conducted in this manner should involve equal time intervals.
2. To assist in the identification of infection, thought should be given to the patient's sedimentation rate and white blood cell differential.
3. The influence of antibiotics and immunosuppressants on the patient's systemic signs should be taken into account in the identification of infection.
4. The patient's underlying pathology is a variable which should be considered in determining the presence of infection.
5. To test the change in awareness of the hospital personnel to infections after the advent of the nurse epidemiologist, the following would be necessary: 1) more information concerning her formal and informal staff teaching programs, 2) more specific measurements to indicate change, and 3) more control of the variable of rotation of physicians.

The following are recommendations for related studies:

1. Further investigation of surveillance methods could be done in the form of a prevalence study including all types of infections to examine the efficiency of one

method of surveillance for a short, intensive time span.

2. A prospective study of surveillance methods including personal examination of the patients by the investigator would add another factor to the number of criteria used to determine the presence of infection.
3. A study of the frequency with which specific operative procedures become infected could be conducted.
4. A study could be performed regarding the rate at which gram positive and gram negative bacteria cause infectious disease.

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