NOSOCOMIAL INFECTIONS AND ANTIBIOTIC UTILIZATION IN LONG-TERM CARE FACILITIES: TRADITIONAL VERSUS PROTECTIVE CARE SETTINGS

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Nosocomial Infections and Antibiotic Utilization in Long-Term Care Facilities: Traditional versus Protective Care Settings

by

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Abstract

Retrospective surveillance for nosocomial infection and antibiotic utilization was conducted at three multi-skilled long-term care facilities in St. John's, Newfoundland. The average incidence of facility acquired infection, based on the units under study, was 9.1 infections per 1000 resident days. No significant differences in infection rates were found between the protective care units and the traditional ward units. The most common source of infection was respiratory tract infections (36.6%); eye, ear, nose and mouth infections (21.0%); and skin infections (19.2%). The four most common pathogens documented in culture results were *Escherichia coli* (31.3%), *Pseudomonas aeuroginosa* (17.6%), *Enterococcus faecalis* (9.8%), and *Klebsiella pneumoniae* (9.8%). The most common treatments prescribed for infection were Sodium Salamyd (16.4%), Amoxil (12.7%), and Septra (10.3%). Among all residents surveyed, over the two year period, 70.1% received at least one course of antibiotics. In addition, antibiotic resistance was noted in 49.3% of all pathogens identified in the study. This study concludes that both nosocomial infections and antibiotic resistant pathogens are increasing in the long-term care environment.

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Chapter 1:

Introduction

The long-term care requirements of Canada's elderly population continues to be discussed, revealing a diverse and complex picture for care providers. It is ever apparent that many Canadians will avail themselves of some type of long-term care, at some stage in elderly life. It is essential to recognize that long-term care services, delivered in an institutional setting, will pose an inherent risk for nosocomial infection. This risk can be attributed to both the physical condition of the resident and the institutional environment.

As we explore new models of institutional care, and debate the old ones, attention must be focussed on nosocomial infection and factors contributing to their transmission. The era of drug resistance poses significant additional challenges for long-term care facilities. Surveillance for infection and resistant pathogens must proceed with proper documentation in long-term care settings, complete with an assessment of antibiotic utilization.

The research documented herein examined the issue of nosocomial infection in long-term care. The underlying intention of this study was to document the rates of various infection groups which have been indicated to pose significant challenges to long-term care providers, at present and in the decade ahead. This study also explored several issues related to nosocomial infection, namely the use of antibiotics, the identification of resistant pathogens, and the use of

vaccinations. All issues are critically important to the long-term care environment. This research adopted a retrospective cohort methodology, performing surveillance in two different long-term care environments, the protective care unit and the traditional ward unit. This study utilized a multi-centre approach to studying infection rates in long-term care, a significant deviation in methodology from previously documented research. Investigations were conducted in three long-term care facilities that contained both active protective care units and traditional ward units.

The goal of this research was to identify if residents on protective care units had higher incidence rates of infection than residents in the traditional ward setting. Since most data on nosocomial infection are derived from the acute care setting, a long-term care perspective is required to identify the incidence of nosocomial infection in long-term care facilities. In addition, this study aimed to clarify the burden of infectious morbidity in long-term care residents. This was done in conjunction with an assessment of the use of antibiotics. The study also explored the issue of resistant organisms in long-term care settings using a systematic protocol for the identification of resistant pathogens and antibiotic susceptibility.

The protective care unit is a relatively new area for research in Canada and the US. Although the concept of protective care units is familiar in Western European countries, their integration into the long-term care setting in North America is somewhat of a novelty. The prevalence of infections and treatment modalities, in these segregated units, requires documentation. Even if segregated units are proven to improve the functioning of the resident, one must still document the risk of infection on these highly secured enclosed units. As researchers debate the functionality of protective care units, little information has been gathered in the area of disease surveillance on these relatively new units. Published research is minimal and ongoing studies are few. However, investigations of this nature are warranted, if we are to fully validate this adopted model of long-term care for a growing class of dementia sufferers. Governments and care providers have to be confident that protective care units pose no increased risk for infection than the traditional ward settings. They must also be assured that resistant pathogens are monitored to ensure that the formulation of intervention plans proceed in a timely and responsive manner. The monitoring of such organisms must be performed jointly with the tracking of antibiotic utilization.

It is imperative that researchers and care providers increase research in communicable disease surveillance in the long-term care environment. Such

research, documenting current infection rates and resistant pathogens, can impact on delivery of long-term care by providing a greater awareness of the issue to administrators and government agencies. In addition, research in this area can significantly influence the quality of life for residents living in these environments. If infection rates can be documented by the source of infection, it is highly reasonable to postulate that interventions can be designed to disrupt the mode of transmission for most of these infections. This could lead to a possible decrease in overall infectious morbidity of residents living in long-term care environments. Research in this area can also add to the limited published works in this field.

This study postulated that the protective care unit, being a highly secured and segregated unit, may be an environment conducive to increased spread of communicable diseases. The formulation of this hypothesis is grounded in two inferences. Firstly, the protective care unit has a greater degree of difficulty in isolating sick and highly infectious residents. Due to the limitation of space, the security features imposed by the environmental design and the wandering behaviour of the residents, isolation procedures are hard, if not impossible, to implement. In comparison, the traditional ward setting has increased flexibility in dealing with infectious residents. The inference suggested here is that the traditional unit can alleviate the risk in transmission to a much higher degree than

the protective care unit. Secondly, the population of the protective care unit is presumed to have more atypical behaviours than the traditional ward setting. The protective care unit has a resident profile of mostly dementia sufferers who have increased wandering behaviour and erratic socialization patterns. In many cases, even normal personal hygiene skills are lost with many forms of dementia. Therefore, the opportunity for increased transmission of infectious agents may exist. Due to these behaviours on protective care units, it is possible that greater interaction and contact between infected residents will lead to increased risk of transmission of infectious agents.

If it can be confirmed that infection rates are indeed higher on protective care units, then specially designed infection control programs may be necessary. If institutional care is going to endorse and implement the protective care unit model, provincially and nationally, then studies in this area have to ensure that residents are not at increased risk for infection and subsequent communicable disease. If studies in this area indicate a higher risk for nosocomial infection, then the protective care unit model will require re-examination and evaluation.

Chapter 2:

Literature Review

2.1 Elderly Population

2.1.1 Demography

In the past 75 years, Canada's elderly have experienced a significant amount of social and economical change (Hudson, 1995). Since the turn of the century, Canada's population has been aging at a continual rate (McEwan *et al.*,1991). According to Statistics Canada, Canada's elderly (aged 65+) represented 12.3% of the population in 1997 (Statistics Canada, 1997). It has been estimated that by the year 2001, this figure will rise to 14% (Lipps, 1988). McEwan *et al.* (1991) point out that the very young (aged 0-14) will actually decrease during this period.

Increasing most rapidly are the "old old", those 85 years and older, who are often frail and have children that are advanced in years themselves (Bentley *et al.*, 1992). Tables 2.1 and 2.2 outline the relative increases in population by age group in Canada and Newfoundland, respectively, for the survey period 1975-1993 (Statistics Canada, 1995). Both Newfoundland and Canada show substantial population increases in all elderly age groups. Of particular interest, the "old old" segment grew by 95.1% in Canada and 70.1% in Newfoundland from 1975-1993. By comparison, the general Canadian population increased by only 27% during this time period.

Table 2.1 Elderly population in Canada by age group, 1975 and 1993

Year	65-69	70-74	75-79	80-84	85 & Over	65 & Over
1975	701,943	525,040	354,444	218,129	161,084	1,960,640
1993	1,099,411	914,901	640,595	418,539	317,631	3,391,077
%Increase	56.6	74.3	80.7	91.9	95.1	73.0

Table 2.2 Elderly population in Newfoundland by age group, 1975 and 1993

Year	65-69	70-74	75-79	80-84	85 & Over	65 & Over
1975	12,977	9,471	6,468	3,951	2,638	35,505
1993	18,099	15,876	11,599	7,343	4,499	57,416
%Increase	39.5	67.6	79.3	85.9	70.5	61.7

In 1997, the elderly represented 10.9% of the population in Newfoundland and Labrador. (Statistics Canada, 1997). Despite a lower percentage of elderly people compared to the Canadian national average, Newfoundland and Labrador is aging moderately faster than most provinces in Canada. The province's annual elderly growth rate is 3.7% compared to the Canadian average of 3.5% (Statistics Canada, 1995). In the next decade, the elderly population in Newfoundland and Labrador is projected to increase at least as rapidly as the national average.

2.1.2 Health Status and Health Care Utilization

For most people, the prevalence and incidence of serious physical and psychological impairments increase with age (Zedlewski and McBride, 1992).

This is evident in elderly Canadians, since they consume the majority of health expenditures through ambulatory care visits, institutional resident-days, medical testing, and respite care (Statistics Canada, 1995). Caring for the elderly becomes an expensive and demanding exercise.

The physical care of the elderly consumes the majority of health expenditures (Hudson, 1995). In particular, the costs associated with mental health problems among Canada's seniors can be quite significant . The Canadian Medical Association (1987) stated that at any point in time, approximately 30% of elderly persons require mental health services. A large amount of resources are used in diagnosis, treatment, and care for seniors with dementia, depression, delirium, substance abuse, and anxiety (McEwan *et al.*, 1991). In McEwan's work on the mental health assessment of senior Canadians, it was found that approximately 16% of seniors suffer from some form of depression or dementia and about 9% are haunted by anxiety, adjustment disorders, psychosis, substance abuse, delirium and other less common, but disabling, psychiatric conditions. Hence, about 25% of seniors have some form of mental health problem. If these estimates are correct, then approximately 847,000 elderly Canadians had some form of a mental health problem in 1993. In Newfoundland, that would translate into approximately 14,000 elderly in need of mental health services.

2.2 Models Of Long-term Care

2.2.1 Traditional Ward Care versus Protective Care

For 40% of dementia sufferers, institutionalization is required at some point in the illness (Angus *et al.*, 1995). On institutionalization, the usual method of care is the use of protective care unit. These extensive segregated units are becoming more prominent in most long-term care facilities. In the US, protective care units, for residents with related dementias, have increased significantly since the early 1980's (Weiner *et al.*, 1989). The protective care unit many adaptive features including a special engineered design that attempts to meet the needs of the cognitively impaired. The protective care unit ensures a safe environment, allowing sufficient space and a wandering path in its environmental design. The criteria for admittance into such a unit are specific and rigid. The policies put forth by the Government of Newfoundland for admittance to a protective care unit are as follows:

> *The resident must be mobile, must suffer some degree of cognitive impairment, have the potential to wander and require some level of nursing care.*
>
> *(Policy & Procedures, Government of Newfoundland)*

In addition, an assessment from a multidisciplinary team is required before admittance.

The goals of the protective care unit program focus on normalization methods, especially in producing an environment that is conducive to the resident. The programs try to restore social roles and maintain dignity. Immediate pleasure and friendship creation are emphasized. Many of the program activities are flexible and varied. They are specially designed to address the social, physical, spiritual, and emotional needs of the resident.

Protective care units have attracted a significant body of research during the last decade. Studies conducted on the effectiveness of this model of elder care have initiated significant debate in the field of gerontology. While the debate over these issues still continues, little attention has been placed on the rates of infections among residents of these units. In fact, only one study has been published that specifically compared the rate of infection on protective care units to that of the traditional ward units (Perls *et al.*, 1995).

2.2.2 Critical Analysis of Protective Care Unit's

The proponents of institutionalization argue that segregated dementia units improve resident outcomes, and enhance family and staff satisfaction (Maas,

1988; Robins, 1986; Ronch, 1987). Some studies have concluded that residents of protective care units have improved cognition, emotional status, and social functioning (Benson *et al.*, 1987; Greene *et al.*, 1985). Others have noted improvement in performing activities of daily living (ADL's) and reduced apathy, anxiety, and lonesomeness (Cleary *et al.*, 1988; Benson *et al.*, 1987). Cleary *et al.* (1988) reported actual weight gain in protective care residents and an increase in family satisfaction. All of these studies have reported and concluded improvement in resident performance because of the protective care unit environment.

The latest research seems to contradict the findings of the previous studies. Opponents of institutionalization argue that protective care units are ineffective and unnecessarily costly (Wilson, 1989; Sloane, Matthew, & Weissert,1991). Coleman *et al.* (1990), in a comparative outcome study, found a trend of increased hospitalization in protective care unit residents. Holmes *et al.* (1990) reported no significant effects on cognitive status, mood, or selected functional status measures. This claim was further strengthened when Chafetz (1991) and Swanson *et al.* (1993, 1994) concluded the same findings. However, more socialization and fewer adverse behavioural reactions were found by Swanson *et al.* (1993, 1994).

2.3 Nosocomial Infection in Long-Term Care Facilities

2.3.1 Definitions

As the population continues to age, the demand for institutional care will ultimately increase. The mental health needs of the elderly who are cognitively and/or behaviourally impaired, will also increase based on the sheer volume of people aging. Thus, it is fair to assume that the protective care unit will continue to be the model of care to meet these mental health needs. With the anticipated increase in protective care usage, the documentation of nosocomial infection must be incorporated into the overall evaluation plan of these units.

In order to apply the systematic tracking of nosocomial infection to the long-term care setting, we should first consider the historical meaning of nosocomial infection. The term *nosocomial*, derived from the Greek *noses* meaning "disease" and *komeo* meaning "to care for", has been exclusively used in acute care settings. It has generally been used to label infections that develop within a hospital or post-hospitalization period. During the past decade, the term has slowly evolved to include long-term care facilities and extended care facilities.

Both the hospital and the long-term care facility share a number of similar qualities that predispose residents to nosocomial infections. In both

environments, residents with weakened immune systems are clustered together and exposed frequently to potential pathogens. The chain of infection must include three interlocking elements in order for the nosocomial infection to occur: the reservoir of microorganisms, a means of transmission, and a susceptible host. All elements exist in both the hospital and long-term care environment.

2.3.2 Historical Trends

The study of nosocomial infection has evolved over the past thirty years. The majority of this research has been based on hospital studies. From this extensive body of knowledge, it is known that hospital-associated infections develop in 5% to 10% of all hospital patients (Smith, 1994). Goldman *et al.* (1997) have broadened this range indicating that 5-15% of hospital patients develop a nosocomial infection, with about 2% dying from the resultant nosocomial infection. The consequences of nosocomial infection, in addition to mortality, are significant in terms of morbidity and health care cost. Increased morbidity and the drain on health care resources are reflected in the prolongation of hospital stays (Hughes, 1987). The correlation between a nosocomial infection and increased morbidity and mortality is apparent in the United States. Hospital-acquired infections are the 11th most common cause of death in the US (Goldman *et al.*,1997).

Table 2.3: Prevalence and incidence of nosocomial infection in long-term care facilities for studies released between 1980-1991

Author	Year	Nosocomial Infection Rate
Magnussen *et al.* (1980)	1980	18.2%
Garibaldi *et al.* (1981)	1981	16.2%
Gambert *et al.* (1982)	1982	15.9%
Nicolle *et al.* (1984)	1984	16.1%
Farber *et al.* (1984)	1984	20.1%
Standfast *et al.* (1984)	1984	32.7%
Setia *et al.* (1985)	1985	12.0%
Price *et al.* (1985)	1985	5.4%
Franson *et al.* (1986)	1986	12.5%
Scheckler *et al.* (1986)	1986	10.7%
Alvarez *et al.* (1988)	1988	6.6%
Jacobsen *et al.* (1990)	1990	22.0%
Steinmiller *et al.* (1991)	1991	9.8%
Magnaziner *et al.* (1991)	1991	4.4%

The prevalence and incidence of nosocomial infection in long-term care facilities are not so clear. Several studies were initiated to address this issue in the early 1980's. The study designs were variable and used different definitions of nosocomial infection. However, interesting results were generated. As Table 2.3 indicates, studies in this area have yielded nosocomial infection rates between 4.4% to 32.7%. There are indications, from the studies listed in Table

2.3, that nosocomial infection rates in long-term care maybe higher than those found in acute care.

2.3.3 Infections in Long-Term Care Facilities

Infection control practitioners in long-term care facilities are confronted with the potential risk of infection in their residents. This risk is attributable to various factors. Firstly, many residents have underlying diseases which predispose them to infection. Secondly, residents are clustered together in a closed environment, increasing the likelihood for communicable disease transmission. Perls *et al.* (1995) insist that the protective care unit is a unique example of this closed system and have higher rates of respiratory illness. The reason for the higher rates is somewhat ambiguous. Perls *et al.* (1995) hypothesize that the protective care environment, through its socialization strategies, increase interaction by encouraging resident participation in group activities. In addition, the claim is made that residents are cared for by employees who often have limited professional training. Perls *et al.* (1995) report that the level of educational attainment of staff and the rate of nosocomial infection are highly correlated.

Administrators and infection control professionals in long-term care facilities often have little information about the rates of endemic infection. There is high

variability from province to province on what guidelines should be used to prevent the transmission of infectious diseases in these environments. There is also significant deviation in surveillance systems for infection within the long-term care sector. Most administrators insist that the guidelines and systems for infection control are largely hospital-based, for patients in acute situations (McGeer *et al.*, 1991). In long-term care, residents are primarily elderly with high prevalence of chronic conditions housed in one facility.

In 1988, Health and Welfare Canada responded to these issues and produced infection control guidelines for long-term care facilities. In the same year, the US based agency, the Centre for Disease Control tailored its documents on nosocomial infection and surveillance to long-term care institutions. In 1995, Health Canada updated its document with current procedures and definitional criteria. Research studies in this area can now use standard definitions of nosocomial infection and assess surveillance much more rigorously. Cross comparison can also be achieved since generic terminology has been formulated. The reported calculations of nosocomial infection rates are given in Table 2.4 for major studies completed in nosocomial infection surveillance.

Table 2.4: Incidence of nosocomial infection in long-term care facilities for studies released between 1984-1996

Author	Year	Nosocomial Infection Rate/1000 Resident Days
Farber *et al.* (1984)	1984	6.7
Franson *et al.* (1986)	1986	4.6
Vlahov *et al.* (1987)	1987	3.6-3.8
Alvarez *et al.* (1988)	1988	3.9
Jacobson *et al.* (1990)	1990	2.6
Hoffman *et al.* (1990)	1990	4.6
Darnowski *et al.* (1991)	1991	1.8
Lee *et al.* (1992)	1992	5.2
Jackson *et al.* (1992)	1992	7.1
Perls *et al.* (1995)	1995	4.9-6.3
Mylotte (1996)	1996	3.0-5.0

Given the history of nosocomial infection and the subsequent derived guidelines for infection control, research in the area has been progressive. The major infection groups, specific to long-term care facilities, have been studied and examined in several studies. A brief discussion of these groups and reported incidence rates is included here.

(I) Urinary Tract Infections

The majority of studies conducted in long-term care disease surveillance have shown that urinary tract infections occur more often than any other type of

infection (Perls *et al.*, 1995; Jacobson *et al.*, 1990; Vlahov *et al.*, 1987). The underlying reason is the urinary catheter. The infection predominantly occurs from gram-negative bacteria, many of which are normal gastrointestinal flora (*E. coli*, *Proteus* species). Although endogenous bacteria account for the majority of cases, cross-infection is also a risk in long-term care facilities. The urinary tract is also a major site of antibiotic resistant infections (Smith, 1994). The incidence of this infection varies from 1.8 to 2.7 cases per 1000 resident days (Perls *et al.*, 1995).

(II) Skin Infections

The decubitus ulcer (pressure ulcer) has been a major source of nosocomial infection and has been reported in several disease surveillance surveys. Endogenous bacteria are believed to be the causal agents, colonizing the ulcer and causing secondary complicating infections of soft tissue and bone. *Staphylococcus aureus* have been linked to this type of infection (Smith, 1994). Cellulitis and skin abscesses are also very common in the long-term care environment. Group A Streptococci and *S. aureus* have been found to be the agents for these infections. Proper skin care and subsequent antibiotic therapy is usually the treatment protocol. The institutional reservoir of staphylococci and streptococci is people. Perls *et al.*, (1995) found an incidence rate for this group of infections to be between 0.1 and 0.7 cases per 1000 resident days.

(III) Respiratory Infections

There are a number of respiratory infections that are of importance in the long-term care facility. Pneumonia, tuberculosis, and influenza pose the biggest threats. *Streptococcus pneumoniae* is the leading cause of pneumonia in the elderly, although long-term care residents are also at increased risk for aspiration pneumonia (Smith, 1994). Mortality has been indicated to be as high as 30% for elderly residents (Fraser, 1993). Tuberculosis was once very common to long-term care facilities, but has since been highly controlled, especially in Canada. Influenza, being highly contagious and spread through the respiratory aerosol route, has caused several epidemics of respiratory disease. Mortality due to this agent among the elderly and chronically ill is very high (Smith, 1994). Control has stemmed from increased vaccination of residents and staff members. Studies have confirmed high variability in incidence rates. Perls *et al.* (1995) report an incidence rate of 1.4 to 4.6 cases per 1000 resident days.

(IV) Gastrointestinal Infections

Gastrointestinal pathogens also pose added risks for the long term care residents. *Salmonella* is the leading cause of confirmed food-borne outbreaks, but *S. aureus* and *C. perfringens* are also common (Smith, 1994). The presence of *E. Coli* 0157:H57 has been also linked to various outbreaks of gastrointestinal infection in the long-term care environment. Viral gastroenteritis is a very

common, self-limiting infectious disease that induces diarrhea and low-grade fever. Rotaviruses, Norwalk viruses, and enteroviruses are usually the cause of viral gastroenteritis. The incidence rates for these infections vary between 0.1 to 0.9 cases per 1000 resident days (Smith, 1994).

(V) Eye, Ear, Nose, and Mouth Infections

Infections of the eye, ear, nose and mouth conclude the major groupings of infection that predominate the long-term care environment. Conjunctivitis (commonly referred to as "pink eye") was found to be prevalent in 3.4% of the residents surveyed by Garibaldi *et al.* (1981). Nosocomial outbreaks have occurred with a number of viruses, especially adenoviruses and Coxsackie virus (Warren, 1994). Transmission is usually person-to-person, although transmission of adenoviruses have been linked to medical equipment. Perls *et al.* (1995) report an incidence rate between 0.02 to 0.7 cases per 1000 resident days for this group of infections.

2.4 Antibiotic Utilization

2.4.1 The Epidemiologic Transition Theory

The theory of Epidemiologic Transition originated in the 1960's. Originally, its premises were made popular by the proclamations made by the scientific and

political community. A tremendous success in fighting many infectious diseases had occurred in the mid 1960's, the most notable being the eradication of smallpox. Polio vaccination had resulted in a significant decrease in the prevalence of the disease worldwide The initial success gave the impression that the microbial world was being mastered. The theory professed that infectious disease would continue to decrease worldwide and be replaced in time by noninfectious causes of death.

As infectious disease experts cautiously embraced the new theory, much of society celebrated its proclamations. In the 1970's, the advancement of antimicrobial agents and the general decrease in many popular infectious diseases undoubtedly propelled acceptance of this theory. Newer, more powerful antibiotics, were produced in mass quantities. Penetrating the scientific and political arenas was the dawning of new excitement in antibiotics and therapy. Physicians where now looking at the once hostile *Staphylococcus* and *M. tuberculosis* as "easily managed, minor infections" (Garrett, 1994). Some individuals claimed that the defeat of the microbial world was imminent through the use of vaccines, antibiotics, and other modern day medicines. In 1967, U.S. Surgeon General William H. Stewart proclaimed the following to the White House gathering of health authorities: "*It is time to close the book on infectious*

diseases and shift all national attention to the new dimensions of health: chronic diseases" (Garrett, 1994).

In the 1980's, a startling revelation had occurred. The microbes had developed a defense system that was escaping the power of antibiotics. The World Health Organization (WHO) began to advise many nations to improve the utilization of antimicrobial agents. However, very little success was achieved by the WHO in initiating national or international policies in antibiotic utilization. Infectious disease experts were now claiming that the highly regarded theory needed to be revisited (Levins, 1995).

The ingenuity of the microbe became quite evident in the 1990's. Old infectious diseases were becoming commonplace again. One study released in the US revealed that between 1980 and 1992, the death rate due to infectious diseases increased by 58% (Pinner *et al.*, 1996). Despite historical predictions that infectious diseases would wane in the United States, mortality rates due to infectious diseases were showing the contrary.

2.4.2 Antibiotic Usage Patterns

(1) Appropriateness of Antibiotic Use

The recent concern over antibiotic use is well documented in many fields of medicine and public health. Over the past 40 years, many surveys have revealed the worldwide problems of the clinical misuse of antibiotics. Nolen and Dille, pioneers of research in antibiotic utilization, concluded in 1957 in the *New England Journal of Medicine* that "the medical profession was using antibiotics much too freely".

Since 1957, a significant amount of research has been conducted to confirm the statements made by Nolen and Dille. Table 2.5 summarizes the findings of major studies conducted in the area of antibiotic inappropriateness. The findings of these studies report that 11-63% of all antibiotic prescriptions prescribed by physicians are inappropriate. Although the studies used different study designs and methods, results are consistent which raise significant research issues in medical management. The ability to compare these results is difficult without applying some level of meta-analysis. However, the results should not be ignored bases on the principle of incomparability.

It is important to note that Canada has more antibiotics prescribed per capita than any other country of the developed world (Goldman *et al.*, 1997). The study of the clinical misuse of antibiotics in Canada is well documented.

Table 2.5: Survey results of inappropriate use of antimicrobial agents

Reference	Year of Study	Inappropriate Drug Utilization (%)
Nolen *et al.* (1957)	1952-56	52
Scheckler *et al.* (1970)	1967-69	62
Maki *et al.* (1978)	1975	41
Bernstein *et al.* (1982)	1978	22
Stevens *et al.* (1981)	1971-1979	11-20
Moss *et al.* (1981)	1978	40-50
Leigh (1982)	1980	14
Cooke *et al.* (1983)	1980	25
Swindell *et al.* (1983)	1979-80	28-35
de Haan (1990)	1987	30
Strong *et al.* (1990)	1987	42
Johnson *et al.* (1995)	1993-94	60
Levy (1995)	1994	50
Butler (1995)	1994	58
Lemire *et al.* (1996)	1994	31
Singer (1998)	1994	63

(2) Antibiotic Usage in Hospitals

Hospitals have served as the origin for much of the research conducted in the area of antibiotic utilization. The pattern of antibiotic use, found in many hospitals of the industrialized world, became evident in the late 1960's. With the United States being the home for many pharmaceutical companies and major teaching hospitals, much of the research in antibiotic utilization was conducted there. Table 2.6 summarizes the findings of this research.

Table 2.6: Research completed on antibiotic use in USA hospitals

Reference	Date	Number and Type of Hospital(s) Surveyed	Proportion of Patients Receiving Antibiotics (%)
Scheckler *et al.* (1970)	1967-69	7 Community Hospitals	30.6
Roberts *et al.* (1972)	na	1 Community Hospital	33
McGowan *et al.* (1974)	1973	Boston City Hospital, Mass.	42
Caldwell *et al.* (1974)	1969-72	Shands Teaching Hospital, Florida	37
Walker *et al.* (1979)	na	22 Hospitals	36
Castle *et al.* (1977)	1973	Duke Medical Centre, North Carolina	34.2
Shapiro *et al.* (1979)	1973-74	20 General Hospitals	28
Stevens *et al.* (1981)	1981	Salt Lake City Hospital, Utah	36.6
Jarvis *et al.* (1998)	1988-94	University Hospital, Atlanta	31.8 - 53.1

There exists a consistency of results in the US studies. Since the first survey conducted in 1967, the proportion of patients admitted to hospital receiving at

least one antibiotic was between 28.0% and 53.1%. Similar results were found in Australia (Mashford & Robertson, 1979) and Italy (Grassi, 1979).

Table 2.7: Research completed on antibiotic use in hospitals in other industrialized countries

Reference	Survey Date	Country	Proportion of Patients Receiving Antibiotics (%)
Lawson *et al.* (1977)	1973	Scotland	28
Perry & Guyatt (1977)	1975	Canada	23.6
Moss *et al.* (1981)	1978	UK	28
Leigh (1982)	1980	UK	22
Raymond *et al.* (1989)	1976-86	Australia	25 - 36
Cooke *et al.* (1983)	1980	UK	21
McConnell (1993)	1992	UK	22
Ternak *et al.* (1996)	1995	Hungary	27.6
Coambs (1996)	1995	Canada	48
Tarp *et al.* (1997)	1994	Holland	22

There is less information on hospital antibiotic use in other countries. The studies that have been conducted report lower percentages of hospitalized patients receiving antibiotics, ranging from 21% to 48%. Table 2.7 outline the

results of studies conducted in the Unitied Kingdom, Canada, Australia and some European nations.

(3) Antibiotics in Long-Term Care Environments

Several studies have evaluated the use of antibiotics in the long-term care environment. Lee *et al.* (1992), using prospective surveillance, documented that 33% of all residents surveyed received at least one course of antibiotics in a four month period. They found that the most frequently used antibiotics were trimethoprim-sulfamethoxazole, ampicillin and ciprofloxacin. Trimethoprim-sulfamethoxazole, a popular urinary anti-infective, had elevated usage due to the high prevalence of urinary tract infections found in the study. In another prospective study, 71% of all residents were prescribed a course of antibiotics over a one year period (Mylotte, 1996). The types of drugs prescribed in this study were mainly broad spectrum antibiotics, which are more expensive antibiotics that translate into higher treatment costs. Trimethoprim/sulfa and ciprofloxacin accounted for 55% of all antibiotics prescribed (Mylotte, 1996).

The inappropriate use of antibiotics in the long-term care environment is very similar to the inappropriate use experienced in the acute care sector. However, attempts to improve antimicrobial use in the long-term care environment is complicated by the characteristics of the resident population, the limited availability of diagnostic tests, and the virtual absence of relevant clinical trials

(Nicolle *et al.*, 1996). To set minimum standards for antimicrobial use and to initiate an effective antimicrobial review program should be a focus for all long-term care facilities in Canada. Very few facilities have developed any such standards and review systems.

2.4.3 Consequences of Antibiotic Use

(1) Financial Burden

In 1996, over 26 million antibiotic prescriptions were prescribed by physicians to Canadians (Health Canada, 1997). General practitioners and family medicine practitioners were responsible for approximately 80% of these prescriptions. In terms of actual financial cost, the annual Canadian expenditure on all prescription and over-the counter drugs have been estimated to be $10.8 billion, with a significant percentage of this total cost attributed to antibiotic sales (Anis *et al.*, 1996). In 1994, six out of the top ten prescribed generic drugs sold in Canada were antibiotics (Simonsen, 1995). Hence, it can be deduced that any misuse of antibiotics would translate into a significant financial expenditure for Canadians.

Inappropriate prescribing can cause adverse outcomes, deplete health care resources and compromise the quality of care (Anis *et al.*, 1996). For example, it is estimated that $200 million dollars, in extra antibiotic costs, are incurred in the

United States each year to treat resistant bacteria (Garrett, 1994). If one totals the longer hospital stays, the bill rises dramatically to $30 billion annually.

(2) Adverse Side Effects

As with all other drugs, taking an antibiotic can cause adverse reactions. One study has reported that 5% of hospitalized patients given an antibiotic have some form of adverse reaction to the drug, resulting in a longer hospitalization (Simmons *et al.*, 1974). The most common reaction to antibiotics is the allergic reaction. Penicillin and its derivatives, in particular, produce allergic reactions in a large proportion of the population. Other antibiotics, like cephalosporin, may be used as a substitute to prevent such reactions.

Several classes of antibiotics have been indicated to have other side effects, including gastrointestinal distress and yeast infections in women. The use of tetracycline or the quinolones has been shown to cause photosensitivity, producing a sunburn-like rash. Erythromycin has been indicated to inhibit the production of liver enzymes needed to metabolize other drugs like the antihistamines. A mixture of erythromycin and an antihistamine can be fatal (Zoler, 1993). In addition, certain types of antibiotics, particularly streptomycin, can cause damage to the nerves involved with balance and hearing.

(3) Resistance

The association between the rate of antibiotics use and increased levels of antimicrobial resistance have been documented for nosocomial infections in hospitals (McGowan, 1983) and community-acquired infections (Baquero *et al.*, 1991). In several case-control studies, it was reported that antimicrobial use was a significant precursor for increasing the risk of being infected with a resistant pathogen (Redetsky *et al.*, 1981). It is postulated that this increased risk is due to the selective advantage of resistant strains, conferred by the repeated use antimicrobial agents (Health Canada, 1997). In 1993, it was reported that every common pathogenic bacterial species had developed some degree of clinically significant drug resistance (Garrett, 1994). At least 24 strains have become life-threatening (Garrett, 1994). This resistance has been noted to occur in pathogenic and commensal bacteria, both of which can spread to other patients and transfer genetic resistance factors to other pathogenic bacteria not exposed to antibiotics.

Antibiotics have offered bacteria unexpected additional advantages. The resultant bacterial strains were found to be capable of withstanding higher temperature variations. They were also equipped with new mechanisms that acted as a defense against the host's immune system. In addition, the new strains had an increased virulence to kill the host cells with greater certainty. One study has shown that when a broad spectrum antibiotic was administered,

the oropharyngeal flora increased in number of pathogenic flora (Van Saene *et al.*, 1992). Two additional studies have reported that pathogenic bacteria like *enterobacteriaceae* and *Klebsiella* increased in colonization after a single dose of amoxicillin (Trigg *et al.*,1991; Van Saene *et al.*,1983).

The selective pressure exerted by frequent antibiotic use is known to encourage the emergence of more resistant bacterial strains (Gaynes *et al.*, 1985; McGowan, 1983). As indicated, one of the emerging problems is that many of the disease-causing bacteria like *Staphylococcus*, have become resistant to the effects of multiple antibiotics. The actual resistance mechanism appears to be quite simplistic. A member of the bacterial population (need be only a single cell) genetically acquires the ability to destroy the antibiotic or protect itself from its effect. Although all other members of the bacterial population may be killed upon treatment with the antibiotic, one resistant cell may survive and divide (as often as every 20 minutes in some cases) and produce a population that is now no longer harmed. The concern is great, because certain strains of disease-causing bacteria, like *Staphylococcus aureus*, are only susceptible to one remaining antibiotic. In the early 1980's, the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) was less than 3%, but 10 years later, it has risen to as high as 40% in many hospitals in the United States and Europe (Panilio *et al.*, 1992; Voss *et al.*, 1994). In 1997, it was reported that a strain of MRSA, isolated in Japan, had intermediate susceptibility to

vancomycin, the last effective anti-microbial to combat MRSA (Center for Disease Control and Prevention, 1997).

2.5 Vaccination Rates in Long-Term Care

The residents of long-term care facilities are increasingly susceptible to various infections primarily due to the higher prevalence of chronic conditions and debilitating diseases. The increased complications associated with influenza and pneumonia are of particular importance to the elderly, especially in the institutional setting. These infections can lead to significant levels of increased morbidity and mortality. It is recommended that the elderly, residing in long-term care facilities, receive an annual vaccination for influenza and a pneumonococcal vaccination on admission to the facility (Tamblyn *et al.*, 1993).

There have been a number of published works which have identified and examined the various rates of influenza and pneumococcal vaccinations in long-term care institutions. Arden *et al.* (1995) documented that higher rates of influenza vaccinations were found in smaller long-term care facilities (<100 beds) in comparison to larger facilities. They also used bivariate analysis to show that both the greater size of the long-term care facility and a lower frequency of vaccination were significant predictors of outbreak status. This study also

suggested that a requirement for written informed consent for vaccination lowered the frequency of vaccination among residents.

The rates of influenza vaccination in long-term care facilities are highly variable. Nichol *et al.* (1996), in a survey of 445 long-term care facilities in Minnesota, found that 84% of residents were annually vaccinated. In a similar type cross-sectional survey, MacArthur *et al.* (1995) surveyed 1,270 Canadian long-term care facilities and reported a mean influenza vaccination of 78.5%. In a survey of 143 long-term care facilities in Australia, 52% of the residents were vaccinated against influenza (MacIntyre *et al.*, 1993). In contrast, Warren *et al.*, (1995) reported an annual influenza vaccination rate of 39.6% from a comprehensive review of 49 long-term care facilities. Ganguly *et al.* (1995) reported an even lower vaccination rate of 34% for a multi-skilled Canadian long-term care facility. They also found that the mean vaccination rate was higher in provinces in which the vaccine was paid for by the government.

The rates of pneumococcal vaccination have been documented to be significantly lower than the rates observed for influenza. However, the results are far less variant. MacArthur *et al.* (1995) has reported a pneumococcal vaccination rate of 12% for approximately 1270 Canadian long-term care homes. Two studies from the United States have documented similar results. Nichol *et al.* (1996) reported a vaccination rate of 11.9% for 445 long-term care facilities in

Minnesota. Quick *et al* (1993) reported a pneumococcal vaccination of 22% in 44 randomly selected long-term care facilities in Washington.

2.6 Summary

The role of nosocomial infection in long-term care is a highly researched topic. It has not, however, been a topic widely researched in the protective care environment. The diverse findings reported in other studies can be attributed to inconsistent and often insufficient scientific rigour both in study design and definition usage. The host of factors that influence the advent of a nosocomial infection require appropriate epidemiological research methodologies and a vigorous study protocol.

It has been shown that the use of antibiotics and the elevation in resistant pathogens are correlated. More research is required in the long-term care sector to fully understand this relationship. This must be done through the critical assessment of antibiotic utilization, the monitoring of resistant pathogens and the constructive evaluation of vaccination practices.

Chapter 3:

Methods

3.1 Study Objectives

The goals and objectives of this study are outlined in Exhibit 3.1. These goals and objectives were used to guide the construction of the study protocols and the formulation of the data extraction form, as shown in Appendix A.

Exhibit 3.1 Study Goals and Objectives

1.	To identify the types of nosocomial infection existent in three metropolitan long-term care facilities
2.	To calculate the overall incidence rate of nosocomial infections for each facility.
3.	To calculate the incidence rate for each infection group under investigation .
4.	To document the development and progression of nosocomial infection, according to setting of inhabitance (protective care or traditional ward).
5.	To assess the risk for nosocomial infection for those residents residing on the protective care units compared to those residing on the traditional unit.
6.	To compare the incidence rates of infection among the three long term care facilities.
7.	To compare the incidence rates of infection on the traditional and protective care units from the three long term care facilities.
8.	To document antibiotic consumption of long-term care residents.
9.	To document the use of diagnostic testing to confirm suspected nosocomial infection.
10.	To identify pathogens associated with nosocomial infection in long-term care facilities.
11.	To identify antibiotic resistant pathogens associated with nosocomial infection.
12.	To document antibiotic resistance in pathogens by antibiotic drug class.
13.	To document influenza and pneumococcal vaccination rates.

3.2 Study Facilities

The city of St. John's, located on the northeast portion of the Avalon Peninsula on the island of Newfoundland, is a metropolitan city with a population of

174,051 (Statistics Canada, 1997). There are nine long-term care facilities licensed, at the provincial level, throughout the city. The three long-term care facilities included in this study are all located within the metropolitan area. All three facilities, selected for this investigation, house a protective care unit and a traditional ward unit. Using a retrospective study methodology, the units at each facility were studied for a period of two years, from September 1, 1994 to August 31, 1996.

The three facilities varied in size from 136 to 408 beds, with a mean bed allocation of 236. The protective care units studied ranged in size from 19 to 28 beds. Only one facility had an originally designed protective care unit. The other two protective care units were traditional units modified to meet protective care unit criteria. The protective care units were less than 6 years old at the initiation of the study.

All facilities studied maintain a very high occupancy rate. The greatest turnover in the resident population occurred on the protective care units where lengths of stay were significantly lower. All three long-term care facilities incorporated protective care unit staff which did not rotate working shifts with other units in the facility. Staff did not require any specialized training to work in any of the protective care units. The use of chemical restraint to control adverse

behaviours was acceptable in all of the facilities. Only one facility allowed the use of physical restraint in the behavioural management of residents.

The three facilities had implemented appropriate referral systems and protocols for the coordination of resident care. The microbiology and other laboratory work were referred to either the neighbouring hospitals or the provincial laboratory located in the city. Routine antibiotic susceptibility tests were conducted using disc diffusion and according to laboratory testing standards. All resident assessments and diagnosis were conducted under the auspices of a general practitioner, from the community, who had privileges within the facility. A geriatrician was consulted on specific resident conditions. Medications were provided by outside contracted pharmacies.

The use of stringent ethical standards were enforced throughout the entire period of study. A significant emphasis was placed on preserving the identity of each resident through the use of numerical coding. Every resident included in this study received an unidentifiable code. In addition, every resident chart was examined and replaced on the day of data collection so as to ensure no misplacement of the resident's medical chart. Any conversions with nursing staff and senior administrators were conducted in privacy and respective of residents, families, and visitors.

3.3 Chart Selection and Recruitment

Initial briefings were conducted with the site administrators at each of the facilities. As a result of each briefing, the administrator appointed appropriate nursing personnel to help facilitate the collection of charts and discuss the physical characteristics of the units to be studied. Orientation sessions between the researcher and the nursing personnel were conducted on the initial visit. The nurse provided the necessary information to determine which traditional ward unit to use as the comparison unit to the protective care unit. Information on the size of the unit, the number of beds, and the physical features of the unit were discussed. In addition, a general review of the nursing policy and procedure manual was conducted, particularly relevant sections on disease prevention, detection and reporting

Once the traditional unit was identified, the list of occupants for both the traditional ward unit and the protective care unit were generated by the nurse or health records personnel. The list of occupants contained all residents in the unit between September 1, 1994 and September 1, 1996. This included all deceased residents and any resident transferred to or from the unit. In order to be recruited into the study, a resident had to be residing on the particular unit greater than seven days. In addition, no respite care residents were admitted to

the study because they rotated living arrangements between the community and the facility. Such rotation could have biased the results.

The residents, meeting or exceeding these criteria, were placed on a working list and sequentially numbered. Residents were then selected at random by a random number generator. The numbers of the charts corresponding to the names of the randomly selected residents were then given to the nursing personnel. The nurse located the chart and stored them for review.

3.4 Sample Size

This retrospective cohort study required two elements in the compilation of its sample size. Both the relative risk and the attack rate had to be assessed either through previous research or through a pilot study. The only research on nosocomial infection rates, specifically from the protective care environment, was published by Perls *et al.*, 1995. The calculation of the sample size was primarily based on the previous results found by Perls *et al.*, 1995. In that particular study, the various incident infection rates were computed for 1990-1993. From these results, the relative risk of acquiring a respiratory infection while being a resident on protective care was calculated to be 1.89, for the combined four years of surveillance.

The attack rate in the unexposed group (traditional ward unit) was calculated at 24.3%. This attack rate calculation was based on the results of several previous

studies which examined nosocomial infection on traditional ward units (Garbaldi *et al.*, 1981; Jacobson *et al.*, 1990; Lee *et al.*, 1992). The average attack rate was then computed from the results of these studies.

Assuming the findings of these studies are valid, the number of charts required would be 170, assuming 80% power and a confidence level of 95%. This sample size translates into 85 charts from both the protective care units and the traditional ward units.

As stated earlier, the three long-term care facilities under study ranged in bed size on both the protective care units and traditional units. To compensate for this bed size variation, chart recruitment was performed according to the proportion of protective care beds included in the study. For example, Facility B had 38% of the total protective care unit beds included in the study. Therefore, this facility was given 38% of the total recruited charts, equating to 64 charts. This translates to 32 charts from the protective care unit and 32 charts from the traditional unit. Table 3.1 summarizes the required charts needed from each facility to gain statistical significance.

Table 3.1: Sample size required for each long-term care facility

Long-Term Care Facility	Protective Care Unit	Traditional
Facility A	31	31
Facility B	32	32
Facility C	22	22

3.5 Surveillance

The resident charts were reviewed at each facility. A data extraction form (Appendix A) was completed for each chart reviewed. The physician and nursing progress notes, culture and laboratory reports, standing orders, and pharmacy records were reviewed in the chart. The following data were included:

(1) *Resident* information, including underlying diseases and general clinical factors that might predispose to infection (e.g. malignancy, recent surgery, steroids, immobility),

(2) *Infection* information, including the site of infection, culture dates, onset date, specific predisposing factors (e.g. Foley catheter or tracheotomy), culture date, pathogens isolated, and antibiotic susceptibility patterns. Repeat specimens, from the same site, were not included in the database, unless there was reinfection occurring within 48 hours after classification of a nosocomial infection. Infections present in a resident, commencing from a recent hospital admission, were not recorded. A resident discharged from hospital would be reviewed for infection seven days after return to the facility. This was done to ensure the elimination of hospital acquired infection or community acquired infection.

(3) *Other laboratory data*, including complete blood counts, urinalysis, and chest x-rays were included, if available.

(4) *Antibiotic* treatments, including drug, dosage, start date, and duration of treatment.

(5) *Vaccinations* for influenza or pneumococcus.

The study documented antibiotic prescribing practices in each facility and there was no attempt to alter their usual practices. Only the information contained in the chart was used to identify an episode of infection, in accordance with the case definition for infection. There was no attempt to seek further information from other sources other than what was contained in the medical chart.

Data entry screens were developed using Microsoft Access. Information from the data extraction form was entered directly into the database. The information was then analysed using SPSS statistical software and Epi-Info disease surveillance software.

3.6 Data Extraction Instrument

The Data Extraction Form (Appendix A) was used for data collection purposes. The demographic information was obtained from the personal history section of the resident's chart. The physician and nursing progress notes were read to identify any signs or symptoms of infection. If an indication of infection was noted, the criteria for classing an infection (Appendix B) was used before a date

of infection was entered in the form. The case definitions of nosocomial definitions were those put forth by McGeer *et al.*, (1991). These definitions were designed and tailored for surveillance in long-term care facilities. If the criteria for an infection were met, a submission was entered with the date of the case. The physician notes were then examined for the writing of an antibiotic prescription. Pharmaceutical records and entries in the chart were then viewed for verification of administration of the antibiotic. The culture records were also viewed to identify which test was being performed for the indicated infection. The type of test, date, test result, pathogen, antibiotic resistance, and antibiotic susceptibility were then recorded.

3.7 Statistical Analyses

Upon completion of data collection, several outcome variables were examined. Firstly, the association between cases of nosocomial infection and the unit of habitation were investigated for each facility. The purpose of this comparison was to identify if infection rates were higher in either the protective care unit or the traditional unit. Between site comparison was then analysed and considered. The three centres were compared on overall incidence rates of infection, facility-based and unit-based. Secondly, the frequency of antibiotic use in the long-term care facility was determined. Within and between centre analysis was conducted. The within analysis was focussed on rates of antibiotic usage in the both the traditional and protective care unit environment. In

addition, the frequency of prescribing antibiotics by drug class was examined for all facilities. The proportion of resistant pathogens was also compared by facility.

The rate of nosocomial infection was calculated, per infection group, by dividing the number of infections, in that group, by the number of resident days at risk. This value was multiplied by 1,000 to yield the number of infections per 1,000 resident days. A comparison of mean infection rates between the comparison groups was performed using the Student's t-test and 95% Confidence Intervals. The Chi-square test was used to compare categorical variables, with alpha set to P= .05.

Chapter 4:

Results

4.1 Study Cohort

4.1.1 Sample Size

The sample size achieved during the study is shown in Table 4.1. A total of 184 resident charts were recruited, 99 charts from the protective care units and 85 charts from the traditional ward unit. The theoretical sample size required to reach statistical significance was obtained for the two year period.

Table 4.1: Sample size by long-term care facility

Long-Term Care Facility	Protective Care Unit	Traditional
Facility A	43	26
Facility B	32	32
Facility C	24	27
Total	**99**	**85**

The unequal distribution in cases by facility was due to the disqualification of various charts that were randomly selected but failed to meet study protocol criteria after acquisition. The resultant over sampling in Facility A, for example, was due to several disqualified resident charts from the traditional unit. Likewise, Facility C had some over sampling occur on the traditional unit due to disqualified resident charts on the protective care unit. To compensate for the inability to obtain 34 charts from Facility B, additional chart reviews were

conducted in the other facilities to ensure that the statistical sample size requirements were met.

4.1.2 Resident Characteristics

Table 4.2 provides baseline characteristics for the long-term care residents recruited in this study. There were no significant differences noted between the two unit types on the basis of age, gender or educational attainment. In terms of gender, 60.6% of residents on the protective care unit were female compared to 60.0% on the traditional ward unit. In age group composition, no significant differences were noted between the two units (p-value=0.53).

The majority of residents on both units had attained a very low level of formal education. The proportion of residents having less than a high school education on the traditional and protective care units were 54.4% and 65.8%, respectively. On the basis of marital status, most residents were widowed. However, a significantly larger percentage of protective care unit residents were married (p-value= 0.01). There were no significant differences noted between the two groups in terms of activities of daily living (ADL'S) (p-value=0.14). The majority of residents required some form of assistance in bathing and dressing.

Table 4.2: Demographic variables for two comparison groups: protective care unit versus traditional ward unit

		PCU Number (%)	Ward Number (%)	p-value
Population		99	85	-
Sex	F	60 (60.6%)	51 (60.0%)	0.93
	M	39 (39.4%)	34 (40.0%)	
Age				0.53
	<69	11 (11.1%)	5 (5.9%)	
	70-79	36 (36.4%)	30 (35.3%)	
	80-89	46 (46.5%)	38 (44.7%)	
	>90	6 (6.1%)	12 (14.1%)	
Education				0.67
	<High School	48 (48.5%)	37 (43.5%)	
	High School/College	22 (22.2%)	25 (29.4%)	
	University Degree	3 (3.0%)	6 (7.1%)	
	Not Indicated	26 (26.3%)	17 (20.0%)	
Marital Status				0.01
	Married/Common Law	45 (45.5%)	16 (18.8%)	
	Widowed	42 (42.4%)	50 (58.8%)	
	Single	7 (7.1%)	4 (4.7%)	
	Separated/Divorced	2 (2.0%)	5 (5.9%)	
	Not Indicated	3 (3.0%)	10 (11.8%)	
ADL's				0.14
	Bathing	87 (87.8%)	78 (91.8%)	
	Feeding	24 (24.2%)	28 (32.9%)	
	Transferring	18 (18.1%)	56 (65.9%)	
	Dressing	77 (77.8%)	67 (78.8%)	

4.1.3 Length of Stay

The length of stay (LOS) of the cohort varied significantly, both in terms of length of stay in the facility and the length of stay in the study. As indicated in Table 4.3, the length of stay on the protective care unit was significantly lower than the

length of stay found on the traditional unit (p-value<0.01). The average length of stay in the facility for the recruited cohort was 600 days for the protective care unit and 883 days for the traditional unit. Similarly, residents in the protective care setting stayed in the study an average of 327 days compared to 452 days for residents in the ward setting.

The facility LOS was calculated from the point of admission to discharge. The study LOS was calculated as the overall total resident days in the study period. For calculation purposes, the final discharge date was Sept 1, 1996 for those residents not discharged prior to the completion of the study.

Table 4.3: Length of stay (in days) of study participants

Parameter	Protective Care Unit	Traditional	p-value
Facility	600.41	882.55	<0.01
Study	327.43	451.59	<0.01

4.2 Nosocomial Infections

4.2.1 Predisposing Conditions

Table 4.4 summarizes the prevalence of disease and other predisposing factors that have been indicated, in previous research, to be conducive to the development of nosocomial infections. In comparing both units, no significant differences were noted. However, the prevalence of cerebral infarction and chronic obstructive pulmonary disease (COPD) did approach statistical

significance (p-value >0.08 and p-value>0.06 respectively). The prevalence of both conditions was higher on the traditional ward unit.

Table 4.4: Prevalence of diseases predisposing to infection of two comparison groups: protective care unit versus traditional ward unit

Variable	PCU Number (%)	Traditional Number (%)	p-value
Cerebral Infarction (past or present)	1 (1.0%)	6 (7.1%)	0.08
COPD	11 (11.1%)	19 (22.4%)	0.06
Diabetes mellitus	11 (11.1%)	11 (12.9%)	0.88
Pressure ulcer (past or present)	3 (3.0%)	4 (4.7%)	0.83
Rheumatoid arthritis	3 (3.0%)	3 (3.5%)	0.82
Lung cancer	1 (1.0%)	0 (0.0%)	0.94
Diverticulosis	3 (3.0%)	8 (9.4%)	0.13
Psoriasis	5 (5.1%)	3 (3.5%)	0.89
Peptic Ulcer	3 (3.0%)	3 (3.5%)	0.82

The most prevalent predisposing conditions documented on admission to the long- term care facility were COPD (16.3%), diabetes mellitus (12.0%) and diverticulosis (9.4%).

4.2.2 Prevalence of Nosocomial Infection

Among the 184 residents surveyed, 149 or 81% developed at least one nosocomial infection in the two year period, according to the criteria set out in the case definition. Table 4.5 summarizes the proportion of residents

developing a nosocomial infection by facility. The development of infection ranged from 76.5% to 85.9% for the various facilities under study.

Table 4.5: Proportion of residents developing at least one nosocomial infection by facility, 1994-1996

Facility	% of Residents
A	79.7%
B	85.9%
C	76.5%

The proportion of residents developing a nosocomial infection also varied by location within the long-term care facilities. Table 4.6 summarizes this variation by location and facility. The proportion of residents on the protective care unit developing a nosocomial infection ranged from 70.0% to 84.4% compared to a range of 81.2% to 96.2% for the traditional ward unit. On average, 74.7% of residents residing on the protective care units developed at least one nosocomial infection in the two year period compared to 88.3% of residents on the traditional ward units.

Table 4.6: Proportion of residents developing at least one nosocomial infection by location and facility, 1994-1996

Facility	Location	n	≥1 nosocomial Infection	% of Residents	p-value
A	PCU	43	30	69.7	<0.01
	WARD	26	25	96.2	
B	PCU	32	27	84.4	1.0
	WARD	32	28	87.5	
C	PCU	24	17	70.8	0.37
	WARD	27	22	81.5	

4.2.3 Incidence of Nosocomial Infection

The overall incident nosocomial infection rate (unweighed) for all facilities included in this study was 9.1 infections per 1000 resident days, with a range from 7.9 to 10.3 infections per 1000 resident days for the different facilities under surveillance. Table 4.7 summarizes the various nosocomial infection rates calculated for the various infection groups segregated by facility. The most common source of infection was respiratory tract infections (3.3 infections/1000 resident days), eye- ear-nose-mouth infections (1.9 infections/1000 resident days), and skin infections (1.8 infections/1000 resident days).

Table 4.7: Nosocomial infection rates by infection group and facility

Infection Group	Long-Term Care Facility			Total
	A	B	C	
Respiratory	4.2	2	4.7	3.3
Eye-Ear-Nose-Mouth	1.2	1.8	3.6	1.9
Skin	1.8	2.1	0.1	1.8
Urinary	1.2	1.6	1.3	1.4
Gastrointestinal	1.3	0.4	0.6	0.7
Total	**9.7**	**7.9**	**10.3**	**9.1**

Table 4.8 summarizes the various nosocomial infections rates for the various infection classes differentiated by unit. There were no statistically significant differences noted between those rates obtained on the protective care unit versus those found on the traditional ward unit. However, other respiratory tract infections, like bronchitis, did approach statistical significance (p-value=0.08). These infections were higher on the traditional ward unit.

The most common infections by class on the protective care unit were conjunctivitis (1.9 infections/1000 resident days), common cold (1.7 infections/1000 resident days) and urinary tract infections (1.4 infections/1000 resident days). In comparison, conjunctivitis led all infections classes on the traditional unit with 1.6 infections/1000 resident days followed by urinary tract

infections (1.4 infections/1000 resident days) and cellulitis (1.3 infections/1000 resident days).

Table 4.8: Nosocomial infection rates by infection class and location: protective care unit versus traditional ward unit

Infection Group	Infection Class	PCU*	Traditional*	p-value
Respiratory Tract	Cold	1.7	1.2	0.25
	Influenza	0.9	0.6	0.62
	Pneumonia	0.4	0.6	0.81
	Other Respiratory	0.4	0.9	0.08
Urinary Tract	Urinary	1.4	1.4	0.84
Eye-Ear-Nose-Mouth	Conjunctivitis	1.9	1.6	0.41
	Ear	0.06	0.05	0.99
	Mouth	0.1	0.08	0.99
	Sinusitis	0.03	0.05	0.99
Skin	Cellulitis	0.9	1.3	0.4
	Fungal	0.5	0.6	0.95
	Herpes	0.03	0.1	0.99
Gastrointestinal Tract	Gastrointestinal	0.7	0.8	0.97

*Expressed as the number of infections per 1000 resident days

4.2.4 Distribution of Nosocomial Infection

The total number of infections for the two year period was 647, of which 442 (68.3%) were in female residents and 205 (31.7%) in male (p-value >0.12). This distribution of disease by gender is similar to the gender distribution of the total population under study. Table 4.9 summarizes the total episodes of infection for the various infection groups. Of the 647 documented cases of nosocomial

infection, respiratory infections (36.6%), eye-ear-nose-mouth infections (21.0%) and skin infections (19.2%) composed the more common groups.

Table 4.9: Total episodes of infection by site of infection

Infection Site	Infection Episodes[1] N	%	Residents[1]
Respiratory	237	36.6	111
Eye-Ear-Nose-Mouth	136	21.0	64
Skin	124	9.2	62
UTI	96	14.8	55
Gastrointestinal	54	8.3	32
Total	**647**	**100.0**	**324**

Of the 96 episodes of UTI, 21 (21.9%) were associated with indwelling urinary catheters.

[1] Some residents developed infections at more than one site where others developed infections at the same site (repeat positive specimens within one episode are counted only once).

4.3 Pathogens

4.3.1 Diagnostic Testing

The ordering of diagnostic tests was evaluated and is summarized in Table 4.10. These tests were ordered at or near the documented date of infection. The requisition for such a diagnostic test was conducted, in lieu of, or in conjunction with any antibiotic treatment. The most frequent diagnostic test ordered was urinalysis, which was ordered on the medical suspicion of a urinary tract infection. The 111 requisitions for urinalysis were completed for 96 cases of urinary tract infections. Urinalysis testing, in some cases, proceeded over

several weeks in order to confirm the presence of the infection. Hence, multiple requisitions were completed for some cases.

The use of x-rays, as a diagnostic tool, was the second most prominent test ordered, with 43 requisitions being completed. The overall positive rate on all diagnostic testing was 29.3%, with culture testing having the lowest positive rate.

Table 4.10: Diagnostic tests ordered before or in concert with antibiotic treatment by site of infection, 1994-1996

Infection		**Diagnostic Test**				
Site	**N**	**Type**	**Ordered**		**Positive**	
			N	**%[1]**	**N**	**%[2]**
Respiratory	237	X-ray	43	6.6	5	38.5
		Culture	3	.01	1	33.3
		Urinalysis	13	5.5	2	15.4
Urinary Tract	96	Culture	1	.01	0	0.0
		Urinalysis	111	116.0	45	40.5
Skin	124	Culture	6	4.8	1	16.7
		Urinalysis	3	2.4	1	33.3
Eye-Ear-Nose-Mouth	136	Culture	1	.01	0	0.0
Gastrointestinal	54	Culture	7	13.0	1	14.3
		Urinalysis	3	5.6	0	0.0
Total	**647**	**All Types**	**191**	**24.9**	**56**	**29.3**

[1] Percent of total infections

[2] Percent of tests ordered

4.3.2 Pathogen Identification

Table 4.11 summarizes the various pathogens identified from the diagnostic testing differentiated by infection group. The four most common pathogens documented in culture results were *Escherichia coli* (31.3%), *Pseudomonas aeuroginosa* (17.6%), *Enterococcus faecalis* (9.8%), and *Klebsiella pneumoniae* (9.8%). *Escherichia coli* played a significant role in the development of urinary tract infections.

Table 4.11: Common pathogens isolated by site of infection

Pathogen	UTI		Respiratory		Skin		Eye, Ear, Nose & Mouth		Gastrointestinal		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
E. Coli	15	33.3	0	0	1	50	0	0	0	0	16	31.3
Pseudomonas aeuroginosa	8	17.7	1	33.3	0	0	0	0	0	0	9	17.6
Enterococcus faecalis	5	11.1	0	0	0	0	0	0	0	0	5	9.8
Klebsiella pneumoniae	5	11.1	0	0	0	0	0	0	0	0	5	9.8
Various	4	8.9	0	0	0	0	0	0	1	100	5	9.8
Proteus mirabilis	4	8.9	0	0	0	0	0	0	0	0	4	7.8
Candida albicans	1	2.2	0	0	0	0	0	0	0	0	1	2
Staphylococcus epidermidis	0	0	0	0	1	50	0	0	0	0	1	2
Klebsiella oxytoca	1	2.2	0	0	0	0	0	0	0	0	1	2
Enterococcus cloacae	1	2.2	0	0	0	0	0	0	0	0	1	2
Beta Haemolytic Streptococcus B	0	0	1	33.3	0	0	0	0	0	0	1	2
Enterococcus spp.	0	0	1	33.3	0	0	0	0	0	0	1	2
Acinetobacter antitratus	1	2.2	0	0	0	0	0	0	0	0	1	2
Total	**45**	**100**	**3**	**100**	**2**	**100**	**0**	**100**	**1**	**100**	**51**	**100**

4.4 Antibiotic Utilization

Antibiotic prescriptions by drug class are indicated in Table 4.12. The treatment classes prescribed with the greatest frequency were the flouroquinolones (19.6%). The use of the flouroquinolones was mainly due to the prescribing of Cipro, a broad spectrum antibiotic used in the treatment of various infections.

Table 4.12: Treatments prescribed by drug class

Antibiotic Class	Prescriptions Administered	% of Antibiotic Prescriptions
Flouroquinolones	80	19.6
Miscellaneous Antibiotics	78	19.1
Penicillins	75	18.4
Miscellaneous Anti-infectives	70	17.2
Aminoglycosides	37	9.1
Macrolides	25	6.1
Cephalosporins	24	5.9
Sulfonamides	8	2
Miscellaneous Antivirals	7	1.7
Tetracyclines	4	1

The various susceptibility levels for the different classes of antibiotics are included in Table 4.13. The penicillins were found to be ineffective against 56% of the documented *Escherichia coli* strains. The expensive broad spectrum flouroquinolones were 25% ineffective in treating the same strains. The *Pseudomonas* spp. were also highly resistant to the flouroquinolone class.

Similarly, the *Proteus* spp. showed high levels of antibiotic resistance in all the cases identified. All strains were resistant to the sulfonamides, penicillins, and a various group of combination antibiotics.

Enterococcus, a strain that causes significant gastrointestinal distress, was highly resistant to the both the flouroquinolones and the macrolides; antibiotic classes which are very powerful and costly. In all of the *Enterococcus* documented strains, 80 % were resistant to these antibiotic classes. Penicillin resistance was also noted in all strains of *Klebsiella* and *Enterobacter*.

Table 4.13: Antibiotic susceptibility by drug class

Antibiotic Class	Susceptibility n (% susceptible)													
	E. Coli		Pseudomonas		Proteus		Enterococcus		Klebsiella		Enterobacter		Acinetobacter	
Sulfonamides	0/16	(0%)	0/9	(0%)	4/4	(100%)	0/5	(0%)	1/6	(17%)	0/1	(0%)	1/1	(100%)
Flouroquinolones	4/16	(25%)	7/9	(78%)	0/4	(0%)	5/5	(100%)	0/6	(0%)	0/1	(0%)	0/1	(0%)
Penicillins	9/16	(56%)	1/9	(11%)	4/4	(100%)	0/5	(0%)	6/6	(100%)	1/1	(100%)	0/1	(0%)
Aminoglycosides	0/16	(0%)	0/9	(0%)	0/4	(0%)	0/5	(0%)	0/6	(0%)	0/1	(0%)	0/1	(0%)
Various	0/16	(0%)	3/9	(33%)	4/4	(100%)	0/5	(0%)	0/6	(0%)	0/1	(0%)	0/1	(0%)
Macrolides	0/16	(0%)	0/9	(0%)	0/4	(0%)	4/5	(80%)	0/6	(0%)	0/1	(0%)	0/1	(0%)
Cephalosporins	0/16	(0%)	1/9	(11%)	0/4	(0%)	0/5	(0%)	0/6	(0%)	0/1	(0%)	0/1	(0%)
Tetracyclines	2/16	(13%)	1/9	(11%)	0/4	(0%)	0/5	(0%)	0/6	(0%)	1/1	(100%)	0/1	(0%)

4.5 Vaccinations

The annual vaccination rates by unit are indicated in Table 4.14. There were no statistically significant differences noted between the rates of vaccination and the unit of inhabitance. The range of influenza vaccination on the protective care unit, for the two year period, ranged from 25.5 to 29.3%. Similarly, the rates for the traditional ward unit ranged from 32.9% to 36.5%. In review of the 184 resident charts, no evidence was found to indicate the administration of the pneumococcal vaccine.

Table 4.14: Annual vaccination rates: protective care unit versus traditional ward unit

Vaccine	**Unit**	**1994-1995**	**1995-1996**
Influenza	Protective Care	25 (25.3%)	29 (29.3%)
	Traditional	28 (32.9%)	31 (36.5%)
	p-value	0.33	0.38
Pneumococcal	Protective Care	0	0
	Traditional	0	0
	p-value	-	-

Chapter 5:

Discussion

5.1 Resident-based Outcome Assessment

The fundamentals of a resident-based surveillance system requires the use of practical definitions for the classification of infection. Written definitions of nosocomial infection have to define explicitly what will be counted as a case. In addition, the definitions must provide ease of application to enable data analysis to proceed as soon as possible.

The use of a rigid case definition was applied in this study. The definitions of nosocomial infection, provided by McGeer *et al.* (1991), are definitions specifically designed for field study in the long-term care environment. Prior to the release of the definitions by McGeer *et al.*, no standard guidelines for infection control practice were available for long-term care facilities (Lee *et al.*, 1992). Hence, the previous documentation of nosocomial infection rates, prior to 1991, were based on tailored definitions designed for the acute care environment. The validity of these results have been legitimately challenged as to there representation of the incidence of infection in the long-term care setting. The medical literature on infections in residents of long-term care facilities has increased significantly in the past fifteen years (Jacobson *et al.*, 1990). However, the variation in study design and multiple criteria in defining nosocomial infection, has made comparison of results problematic and

cumbersome. It is essential that research, in this field, proceed with the use of definitional criteria based on the long-term care environment.

5.2 Prospective versus Retrospective Surveillance

A retrospective surveillance study design incorporates the review of the medical record post infection. Such a design offers significant advantages and disadvantages. The use of retrospective surveillance is a less costly and less time consuming method that can be very beneficial in studying nosocomial infection. Previous research evaluated and documented the accuracy of retrospective chart review in measuring nosocomial infection rates. They found that both the retrospective and prospective techniques were similar, in terms of sensitivity and specificity (Abrutyn *et al.*, 1997). Abrutyn *et al.* (1997) documented that the sensitivities of retrospective and prospective designed studies were 0.74 and 0.76 respectively. In addition, a specificity of 0.94 was documented for retrospective reviews, when compared to its prospective counterpart (Haley *et al.*, 1980). Several other studies have reported favourably on the value of the retrospective chart review in measuring nosocomial infection (Wenzel *et al.*, 1976; Gross *et al.*, 1980; Blake *et al.*, 1980).

The retrospective research design also has several important disadvantages. The quality of documented information, in the resident's record, is completely out of the reviewer's control. The results of the study are dependent on the various charting procedures implemented in the long-term care facility. There is

also very little reviewer control over the medical assessments and infection surveillance process, by which signs and symptoms of infection are daily recorded. There is significant potential for the resident to have a documented infection, according to case definition, but not be recorded as such, due to insufficient recording of necessary signs and symptoms in the medical record.

In reviewing resident's records, from three different facilities in this study, it was clear that there was considerable variation in charting. Charts in some facilities were missing culture results that were requisitioned in the physician notes. In other situations, health care professionals charted resident progress by exception, a process that documents only adverse results in the medical record. Hence, the diagnosis of an infection, by the health care professional, was entered in the chart without any documentation of signs and symptoms of the infection. This method of charting obviously eliminated those possible infections from the study. In other situations, the case definition may have eliminated a possible positive case because the validity and reliability of the definitional criteria has not been established or published. There is also the occurrence where the case definition may have included a negative result as a documented case of infection due to the same reasoning.

Research studies , in this field, have been largely based on either retrospective or prospective study designs. For the typical long-term care facility, a prospective data collection would appear to be ideal in order to improve data

quality and to maximize the opportunity for educational intervention during surveillance (Smith, 1991). The question of high cost and time has to be fully assessed in conducting prospective field surveillance. The retrospective study, on the basis of specificity and sensitivity, compares adequately to the prospective research design.

5.3 Nosocomial Infection in Long-term Care

This retrospective cohort study incorporated a systematic random design to assess the level of nosocomial infection in a population of long-term care residents. Furthermore, the design was multi-institutional, with recruitment occurring from three similar facilities, based on the unit of inhabitance within the facility. The use of this design and the rigid use of a case definition, specifically tailored to the long- term care environment, was a departure from previous research conducted in this area. Previous studies based their findings on an acute definition of nosocomial infection (Jacobson *et al.*, 1990; Magaziner *et al.*, 1991; Hoffman *et al.*, 1990).

By using the new definitions for nosocomial infection for five major infection groups, this study concludes that there was no evidence to indicate that the nosocomial infection rate found in the protective care setting is statistically different than that found on the traditional ward setting (p-value>0.05). In addition, it can be concluded that there was no statistically significant differences noted for any infection class included in this study on the basis of unit of

residence (p-value>0.05). The findings, as described by Perls *et al.* (1995), that respiratory infections were higher on protective care units were not found in this study. The use of CDC definitional criteria and a single facility study may have contributed to the findings put forth by Perls *et al.* (1995).

The overall nosocomial infection rate calculated in this study was 9.1 infections per 1000 resident days for all infection groups combined. This incidence rate was higher than previously published research in this field (Mylotte *et al.*, 1996; Perls *et al.*, 1995; Lee *et al.*, 1992; Jackson *et al.*, 1992; Jacobson *et al.*, 1990; Vlahov *et al.*, 1987). The rates for the three facilities studied ranged from 7.9 to 10.9 infections per 1000 resident days . Previous research in this field has reported rates from 1.8 to 7.1 infections per 1000 resident days, as indicated in Table 2.4.

The higher rates found in this study can be attributed to several factors. The case definition used in this study was specially tailored to the long-term care environment. Previously published results used a case definition from the acute care setting. As indicated in Chapter 2, there are marked differences between the long-term care setting and the acute care setting. Hence, the use of an acute care case definition in a long-term care environment will lead to discrepancies and inconclusive calculation of incidence rates. The rates found in

this study are difficult to compare with other studies because of differences in case definition.

There are various differences between the definitions of nosocomial infection supplied by the Centre for Disease Control (CDC) and that of McGeer *et al.* (1991). For example, the CDC definitions define pneumonia as the presence of rales or dullness to percussion on physical examination of the chest in conjunction with one of the following: new onset of purulent sputum or change in character of sputum, organism isolated from blood culture, isolation of pathogen from specimen obtained by bronchial brushing (Garner *et al.*, 1988). This case definition does not require a chest radiograph. The long-term care definitions supplied by McGeer *et al.* (1991) require the interpretation of a chest radiograph, in addition to other signs and symptoms. It can be argued that the CDC definition for pneumonia could include cases that may be negative on a chest radiograph. In comparing the various incidence rates for pneumonia, it is quite conceivable that the rates could vary significantly, based on which definitional criteria was used in the study. The reason for increased rates of pneumonia found in this study, using the chest radiograph as confirmation, pose a difficult question. With 55% of the study population beyond the age of 80, it is conceivable that age and a weakened immune system are contributing to the

high rates. In addition, 40% of the study population was immobile and frail, predisposing the resident to pneumococcus.

In assessing the infection rates by unit, an evaluation was conducted on the demographics of the sample and prevalent predisposing conditions that lead to infection. In comparing age and gender, no significant differences were noted between the two resident groups (p-value>0.05). In comparing predisposing conditions that lead to infection, again, no statistically significant differences were noted in the two samples under surveillance (p-value>0.05).

In order to fully assess the validity of the results, a review was performed on the types of care provided and the activities of daily living (ADL's) of the two samples. The facilities had a consistent ratio of RN/RNA staff mix, which ranged from 0.32 to 0.45. The care provided was primarily skilled nursing care. No significant differences were noted on the basis of ADL dependency between the two settings (p-value>0.05). The average ADL dependency on the traditional ward units ranged from 1.0-1.4 activities compared to 0.9-1.3 activities in the protective care settings. Hence, the sample charts reviewed for the two units were homogenous in several aspects.

The most common group of nosocomial infection documented in this study was the respiratory tract infections. The mean nosocomial infection rate was 3.3 infections per 1000 resident days. These types of infections are common in the long-term care setting and have been reported before as the most prevalent

group of infections in this environment (Mylotte, 1996). The high incidence of respiratory tract infections is an important finding since they are the most common cause of death in the elderly in Canada (Health Canada, 1995). Bacterial pneumonia, in the elderly, is commonly associated with pneumococcus, but organisms like *Klebsiella* and *Staphylococcus aureus* play influential roles in the development of pneumonia. The common cold had the highest incident rate in the group, with 1.7 infections per 1000 resident days on the protective care unit compared to 1.2 infections per 1000 resident days in the traditional setting. The higher rates of the common cold on the protective care unit can possibly be attributed to the higher ambulation rates (p- value<0.01) and increased wandering behaviour related to dementia (p-value<0.01). The low rate of influenza vaccination, from 25.3 to 36.5%, probably increased the number of cases found in this group.

The eye-ear-nose-mouth group of infections was the second most prevalent group at 1.9 infections per 1000 resident days. The rates of these infections did not differ statistically between the two settings (p-value>0.05). However, rates were higher than expected. Previous research indicated a range for this group to be between 0.02-0.7 infections per 1000 resident days (Perls *et al.*, 1995). Conjunctivitis was the predominant infection, representing 89.7% of all cases in the group. The management of conjunctivitis requires proper management of other infected sites to prevent any contamination of the eye. This is particularly

important in the protective care environment where atypical behaviours, resultant from the onset of various forms of dementia, override many normal hygienic behaviours. The higher rates of conjunctivitis on the protective care unit can be possibly attributed to these atypical behaviours.

Skin infections were found to be persistent problems for the long-term care environment. The mean nosocomial infection rate for this group was 1.8 infections per 1000 resident days, four times higher than previous published research (Perls *et al.*, 1995). Cellulitis was the predominant infection, representing 60.1% of all cases in the group. The reason for the significant increase in cases, over other published findings, is unknown. The rates were somewhat higher on the traditional units. It is speculated that the slightly higher prevalence of pressure ulcers in residents of these units contributed to the observed higher rate. There was minimal information available on the source of these infections. Only nine culture tests were requisitioned for the 124 episodes of skin infection. Hence, conclusive results from diagnostic testing were not available to add insight into the predominant cause of these infections.

The only infection group found to have a lower incident infection rate than previously reported results in the literature were urinary tract infections. The mean nosocomial infection rate for the group was 1.4 infections per 1000 resident days. There were no significant differences noted between the two settings (p- value>0.05). The rates documented in this study are lower than

previously reported by Perls *et al.* (1995). The urinary tract infection has been documented in previous studies as being the most predominant infection, surpassing all infection groups, in the long-term care environment (Perls *et al*, 1995; Lee *et al.*, 1992; Jacobson *et al.*, 1990; Vlahov *et al.*, 1987). However, the rate of UTI's was found to be lower than previously reported rates. The difference in incidence rates of UTI's is probably due to the emphasis placed on these infections in the long-term care facilities. In reviewing the resident's chart, it was evident that the requisitioning of urinalysis testing to help diagnose urinary tract infection was conducted frequently and expeditiously. For the 96 documented cases of UTI's, 111 urinalysis requisitions were completed. This indicates that physicians are very concerned about these infections and are cautious in their medical management. This behaviour is obviously due to the heightened awareness of UTI's in the long-term care environment. In addition, the adequacy of fluid intake and the quality of personal hygiene probably contribute to the lower prevalence of this infection in this study population.

The higher incident infection rates shown by previous studies are also due to the increased usage of urinary catheters in the study population. The use of such a device increases the risk for the development of UTI's. The incident infection rate, documented in this study, can be attributed to a much lower utilization of the indwelling urinary catheter. Of all UTI cases documented, only 21% of the cases were using an indwelling urinary catheter. In comparison, Lee *et al.*

(1992) reported that 51% of all cases who developed an UTI, had an indwelling urinary catheter. The use of these devices can lead to multiple cases that usually correlate into higher incident infection rates. Indwelling catheters were used more by residents living on the traditional unit (p-value = 0.02). However, the usage did not result in higher incidences of UTI's because the rate on both units was 1.4 infections per 1000 resident days.

The rates of gastrointestinal infections were also higher than previously documented, three times those indicated by Perls *et al.* (1995). The mean nosocomial infection rate for the infection group was 0.7 infections per 1000 resident days. Cases of diarrhea were common in this study, contributing to the higher number of identified gastrointestinal cases. Such a condition is very common in elderly residents and consideration must be given to the infectious etiology. With limited culture requests documented in the medical chart, the source of these infections is unknown. There were no documented cases of *Salmonella* or *E. Coli* 0157:H57 as a pathogenic source in these cases. Of the 54 cases documented, only 10 diagnostic tests were performed. The higher rates are most likely due to the use of different definitional criteria. However, gastrointestinal infections are a prevalent infection group in the long-term care environment and attention should be directed toward their cause.

5.4 The Use of Antibiotics

Over the two year period, 70.1% of all residents received at least one course of antibiotic or anti-infective treatment. An average of 5.3 antibiotic prescriptions per resident were administered to the cohort throughout the study period. The rate of antibiotic use for the three long-term care facilities was much higher than previously documented in similar facilities (Lee *et al.*, 1992). These rates are also significantly higher than rates observed in the acute sector, where the proportion of patients receiving an antibiotic range from 28-42% (Table 2.6).

In order to accurately compare the various antibiotic utilization rates that have been reported in this area, it is necessary to do the comparison on the basis of prescriptions administered per 1000 resident days. Otherwise, by looking at the proportion of residents receiving antibiotics, the comparisons are based on rates which have varying study periods and extreme variations in sample size. Such comparisons can be misleading. If the incident rate was examined, the rate in this study would translate into 9.6 antibiotic prescriptions per 1000 resident days. Mylotte (1996) had previously reported an incident antibiotic use rate of 6.1 antibiotic courses per 1000 resident days. The higher rates found in this study are indicative of a problem that requires continued research and investigation.

This study concludes that there is a significant use of antimicrobials in the long-term care setting. It confirms the notion, put forth by Nicolle *et al.* (1996), that long-term care facilities require standards for a structured antimicrobial

review program. Such a program could evaluate and correct factors contributing to the elevated prescribing of these drugs. It has been reasoned that the increased use of antibiotics, in the long- term care environment, is due to several factors. Firstly, there is an intense pressure placed on physicians, who visit a long-term care facility only at certain times, to prevent and treat infections. It has been shown that health care professionals and families exert significant pressure on visiting physicians to prescribe antibiotics to prevent the transmission of pathogens in an environment highly conducive to transmission (Nicolle *et al.*, 1996). Secondly, there is the issue that physicians are treating a population that has a number of chronic and debilitating diseases. In practical medical management, there is a tendency to treat individuals more cautiously who manifest increased predisposition to disease. In the elderly, age, chronic disease, and human frailty provide all the necessary incentives to treat infections quickly and preemptively.

The high level of antibiotic use, documented in this study, poses several concerns. However, the use of costly, broad spectrum antibiotics is probably a greater concern. In review of all antibiotics prescribed to residents, the flouroquinolones were prescribed more than any other antibiotic and anti-infective drug class. These classes represented 19.6% of all treatments

prescribed in this study. The flouroquinolones are broad-based in their mode of action, interfering with DNA synthesis.

The use of flouroquinolones, as first-line treatments, are only recommended for the treatment of urinary tract infections (Gantz, 1995). This study has found that physicians prescribed flouroquinolones appropriately for the documented cases of urinary tract infections. Approximately 55.0% of all cases of UTI's were treated with one of the flouroquinolone drugs. However, 25.0% of all flouroquinolone prescriptions were used to treat respiratory tract infections as first-line treatments. Butler (1995) concluded that ciprofloxacin was prescribed, inappropriately, in 38-58% of all cases.

5.5 A Rationale for Standardized Infection Control Programs

This study assessed the risk of nosocomial infection and the utilization of antibiotics in the long-term care environment. The surveillance of nosocomial infection in the protective and traditional settings expanded on new areas of research. The infection rates from all three facilities were higher than previously reported (Perls *et al.*, 1995; Jackson *et al.*, 1992; Lee *et al.*, 1992; Farber *et al.*, 1984; Magnussen *et al.*, 1980; Nicolle *et al.*, 1984; Scheckler *et al.*, 1986). The consistency of nosocomial infection rates, in all three facilities under study, is

presumably a function of the precise definition of infection and the rigid use of study protocols over the surveillance period.

There is an indication, from the results reported in this study, that infections in the long-term care environment are a real concern that requires constructive intervention. It is apparent that facilities require a standardized and regulated infection control program, in order to decrease morbidity due to infectious disease. The long-term care environment, with its definable physical qualities and a population with endemic chronic disease, has to utilize a standard protocol to decrease the risk of infection. The individualized approach to programming and design of infection control programs only provide obstacles to the comparison of infection rates. A program with common definition and intervention protocols would provide comparability in results and an adequate assessment of interventions.

Long-term care facilities must monitor and review all antibiotic prescribing, particularly in cases were expensive, first-line treatments are being used for non-recommended infections. The implementation of an antibiotic screening program, at each facility, would increase the medical management of infection through peer review and education. The use of clinical practice guidelines should also be considered for all long-term care facilities.

5.6 Conclusions and Future Research Direction

The use of the protective care model, as a viable alternative to integration in the long-term care environment, should continue to be researched to understand and document its value in the management of dementia residents. The results reported in this study show no increased risk for infection, of any infection class, to residents residing on protective care units. It is recommended that interventions to curb the high rates of infections, observed on both units, proceed with some attention given to the mental and physical capability of the resident population occupying each unit. The medical management of infection, in a resident population suffering from dementia, has to account for greater interaction among residents in a segregated, enclosed design.

Research in this area must continue based on sound definitional criteria for nosocomial infections, particularly designed for the long-term care facility. Ongoing surveillance, whether it is conducted retrospectively or prospectively, should explore the elevated rates of infection documented in this study. It is particularly important to increase research of this nature to monitor the presence of antibiotic resistant pathogens in this environment which is highly sensitive and conducive to the spread of infection. In addition, some research effort has to be focused on the assessment of vaccination procedures and policies in the long-term care setting. Such an examination may have a significant impact on

nosocomial infection rates, and subsequent reduced morbidity in long-term care residents.

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APPENDIX A

Data Surveillance Form

Data Surveillance Form

Date: _____ **Patient ID:** _____ **Nursing Home # :** 1 2 3

Date of Admission:_____ **Age:** _____ **Patient Location:** PCU Ward

Date of Discharge:_____ **Sex:** _____ **Ambulation:** Y N

Length of Stay: _____

Medical Status (Shade, if appropriate)

Cerebral Infarction (Past or Present) ☐

Chronic Obstructive Pulmonary Disease ☐

Diabetes mellitus ☐

Pressure Ulcer (Past or Present) ☐

Rheumatoid arthritis ☐

Lung Cancer ☐

Sedative/Hypnotic Use ☐

Functional Status (Shade, if appropriate)

Require Assistance with:

- Bathing ☐
- Dressing ☐
- Feeding ☐
- Transferring ☐

Bowel Incontinent ☐

Bladder Incontinent ☐

Uses Catheter, ostomy, or similar device ☐

1. **Respiratory Tract Infections**

(i) Common Cold Syndromes/Pharyngitis

Two of:

-stuffy nose

-runny nose/sneezing

-sore throat/hoarseness or difficulty in swallowing

-dry cough

-swollen or tender glands in the neck (cervical lymphadenopathy)

(ii) Influenza-Like Illnesses

Both of:

-fever (≥38°C)

-**Three of** :

a) chills d) new headache or eye pain

b) myalgias e) malaise or loss of appetite

c) sore throat f) new or increased dry cough

Date	Antibiotic Prescription

(iii) Pneumonia

Both of:

-Interpretation of a chest radiograph demonstrating pneumonia, probable pneumonia, or the presence of an infiltrate. If a previous radiograph exists for comparison, the infiltrate should be new.

-The resident must have at least two of the signs and symptoms described under "other lower respiratory tract infections"

(iv) Other Lower Respiratory Tract Infections (bronchitis, tracheobronchitis)

Three of:

-new or increased cough

-new or increased sputum production

-fever (≥38°C)

-pleuritic chest pain

-new or increased physical findings on chest examination (rales, rhonchi, wheezes, bronchial breathing)

-one of the following indications of change in status of breathing difficulty:

new/increased shortness of breath

respiratory rate > 25/min

worsening mental or functional status

Date	Antibiotic Prescription

2. **Urinary Tract Infections (Symptomatic)**

One of:

-resident does not have an indwelling urinary catheter and has at least **three of**:

-fever ≥38°C or chills

-new or increased burning pain or urinating frequency or -urgency

-new flank or suprapubic pain or tenderness

-change in character of urine

-worsening of mental or functional status (may be new or increased incontinence)

-resident has an indwelling catheter and **two of**:

-fever ≥38°C or chills

-new flank or suprapubic pain or tenderness

-change in character of urine

-worsening of mental or functional status

Date	Antibiotic Prescription

3. Ear, Eye, Nose, and Throat Infections

(i) Conjunctivitis

One of:

-pus appearing from one or both eyes, present for at least 24 hours

-new or increased conjunctivitis redness, with or without itching or pain, present for at least 24 hours (also known as "pink eye")

(ii) Ear Infection

One of:

-diagnosis by a physician of any ear infections

-new drainage from one or both ears (non purulent drainage must be accompanied by additional symptoms, such as ear pain or redness)

(iii) Mouth and Perioral Infection

-oral and perioral infections, including oral candidiasis, must be diagnosed by a physician or a dentist

(Iv) Sinusitis

-diagnosis given by a physician

Date	Antibiotic Prescription

4. Skin Infection

(I) Cellulitis/Soft Tissue/Wound Infections

One of:

-pus present at wound, skin, or soft tissue site

-the resident must have one or more of the following signs or symptoms:

-fever (≥ 38°C) or worsening
-mental/functional status change *and at the affected site*;

-heat

-redness

-swelling

-tenderness or pain

-serious drainage

(II) Fungal Skin Infection

Both of:

-a maculopapular rash

-either physician diagnosis or laboratory confirmation

(III) Herpes Simplex and Herpes Zoster Infection

Both of:

-a vesicular rash

-either physician diagnosis or laboratory confirmation

Date	Antibiotic prescription

5. Gastrointestinal Tract Infection

One of:

-two or more loose or watery stools above what is normal for the resident within a 24 hour period

-two or more episodes of vomiting in a 24 hour period

Both of:

-a stool culture positive for a pathogen (*Salmonella*, *Shigella*, *E. coli* 0157:H7, *Campylobacter*) or a toxin assay positive for *C. difficile* toxin

-at least one symptom or sign comparable with gastrointestinal tract infection (nausea, vomiting, abdominal pain or tenderness, diarrhea)

Date	Antibiotic Prescription

Diagnostic Testing and Culture Data

Date	Diagnostic Test	Results	Resistance

Vaccination History **Date of Vaccination**

☐ Influenza _____

☐ Pneumovax _____

Mortality (Cause of Death) **Date of Death**: _____

1. _____
2. _____
3. _____

APPENDIX B

Case Definition

Case Definition

A case, for the purposes of this study, consists of any resident residing in any of the three institutions under investigation that fulfill any one of the below groupings or sub-groupings :

(Adopted from McGeer *et al.*, 1991)

1. **Respiratory Tract Infections**

(i) Common Cold Syndromes/Pharyngitis

Two of:

-stuffy nose

-runny nose/sneezing

-sore throat/hoarseness or difficulty in swallowing

-dry cough

-swollen or tender glands in the neck (cervical lymphadenopathy)

(ii) Influenza-Like Illnesses

Both of:

-fever (≥38°C)

-**Three of** :

a) chills

b)myalgias

c) sore throat

d) new headache or eye pain

e) malaise or loss of appetite

f) new or increased dry cough

(iii) Pneumonia

Both of:

-Interpretation of a chest radiograph demonstrating pneumonia, probable pneumonia, or the presence of an infiltrate. If a previous radiograph exists for comparison, the infiltrate should be new.

-The resident must have at least two of the signs and symptoms described under "other lower respiratory tract infections"

(iv) Other Lower Respiratory Tract Infections (bronchitis, tracheobronchitis)

Three of:

-new or increased cough

-new or increased sputum production

-fever ($\geq$38°C)

-pleuritic chest pain

-new or increased physical findings on chest examination (rales, rhonchi, wheezes, bronchial breathing)

-one of the following indications of change in status of breathing difficulty:

new/increased shortness of breath

respiratory rate > 25/min

worsening mental or functional status

Urinary Tract Infections (Symptomatic)

One of:

-resident does not have an indwelling urinary catheter and has at least **three of**:

-fever $\geq$38°C or chills

-new or increased burning pain or urinating frequency or urgency

-new flank or suprapubic pain or tenderness

-change in character of urine

-worsening of mental or functional status (may be new or increased incontinence)

-resident has an indwelling catheter and **two of**:

-fever $\geq$38°C or chills

-new flank or suprapubic pain or tenderness

-change in character of urine

-worsening of mental or functional status

Eye, Ear, Nose, and Mouth Infection

(I) Conjunctivitis

One of:

-pus appearing from one or both eyes, present for at least 24 hours

-new or increased conjunctivitis redness, with or without itching or pain, present for at least 24 hours (also known as "pink eye")

(ii) Ear Infection

One of:

-diagnosis by a physician of any ear infections

-new drainage from one or both ears (non purulent drainage must be accompanied by additional symptoms, such as ear pain or redness)

(iii) Mouth and Perioral Infection

-oral and perioral infections, including oral candidiasis, must be diagnosed by a physician or a dentist

(Iv) Sinusitis

-diagnosis given by a physician

Skin Infection

(I) Cellulitis/Soft Tissue/Wound Infections

One of:

-pus present at wound, skin, or soft tissue site

-the resident must have one or more of the following signs or symptoms:

-fever ($\geq$ 38°C) or worsening

-mental/functional status change *and at the affected site*;

-heat -redness

-swelling -tenderness or pain

-serious drainage

(II) Fungal Skin Infection

Both of:

-a maculopapular rash

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(III) Herpes Simplex and Herpes Zoster Infection

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-at least one symptom or sign comparable with gastrointestinal tract infection (nausea, vomiting, abdominal pain or tenderness, diarrhea)