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Essential Resources for

Effective Infection Prevention and Control Programs:

A Matter of Patient Safety: A Discussion Paper

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Foreward and Acknowledgements

This document, *Essential Resources for Effective Infection Prevention and Control Programs: A Matter of Patient Safety,* has been developed under the direction of the Public Health Agency of Canada's Infection Control Guidelines Steering Committee. Its main purpose is to help health care administrators and planners understand what resources infection control professionals require to provide effective Infection Prevention and Control Programs that will improve the quality and safety of health care. The information presented in this document is designed to assist in the development of policies, procedures, and evaluation mechanisms to ensure an optimal level of care as well as patient and staff safety.

The Public Health Agency of Canada invited experts to form the working group for Essential Resources for Effective Infection Prevention and Control Programs. Membership included paediatric and adult infectious diseases physicians, hospital epidemiologists, a medical microbiologist, paediatric and adult acute care infection control practitioners, health educators, long-term care and home care infection control practitioners, and administrators. The working group met in person and by teleconferences to formulate the information and recommendations in this document.

The Public Health Agency of Canada Infection Control Guidelines Steering Committee acknowledges, with sincere appreciation, the many practising health care professionals and others who contributed advice and information to this endeavour. The Public Health Agency of Canada is especially appreciative of the time and expertise contributed by the Working Group and to Dr. Dick Zoutman for chairing it.

The information in this document was current at the time of publication; nonetheless, areas of knowledge and aspects of medical technology advance with time. Health care professionals are encouraged to contact the Public Health Agency of Canada for updated information.

Professionals using this document are encouraged to refer to the Health Canada/Public Health Agency of Canada *Infection Control Guidelines* series for further information on Infection Prevention and Control.

The Prevention of Health Care Associated Pneumonia (in press)

Classic Creutzfeldt-Jakob Disease in Canada (2002) Revised addendum (2007)

Prevention and Control of Occupational Infections in Health Care (2002)

Routine Practices and Additional Precautions for Preventing Transmission of Infection in Health Care (1999) (under revision)

Infection Prevention and Control Practices for Personal Services: Tattooing, Ear/Body Piercing and Electrolysis (1999)

Hand Washing, Cleaning, Disinfection and Sterilization in Health Care (1998)

Preventing the Spread of Vancomycin-Related Enterococci (VRE) in Canada (1997)

Preventing Infections Associated with Foot Care by Health Care Providers (1997)

Preventing Infections Associated with Indwelling Intravascular Access Devices (1997)

Preventing the Transmission of Blood Borne Pathogens in Health Care and Public Services Settings (1997)

Canadian Contingency Plan for Viral Hemorrhagic Fevers and Other Related Diseases (1997)

Preventing the Transmission of Tuberculosis in Canadian Health Care Facilities and Other Institutional Settings (1996)

Long Term Care Facilities (1994)

Antimicrobial Utilization in Health Care Facilities (1990)

Prevention of Surgical Wound Infections (1990)

Prevention of Urinary Tract Infections (1990)

Organization of Infection Control Programs in Health Care Facilities (1990)

Perinatal Care (1988)

Another publication of the Nosocomial and Occupational Infections Section that complements the Infection Control Guidelines series is *Construction-related Nosocomial Infections in Patients in Health Care Facilities; Decreasing the Risk of Aspergillus, Legionella and Other Infections* CCDR 2001 27S2.

For information regarding these Public Health Agency of Canada publications, contact:

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Glossary of Terms, Abbreviations, and Acronyms

Ambulatory Care	Any medical services provided to patients/clients who are not admitted to inpatient units. For the purposes of this document, ambulatory care settings include emergency departments, hospital-based clinics, and outpatient diagnostic and treatment facilities (e.g., endoscopy suites, pulmonary function laboratories, ambulatory surgery centres).
Adverse Events	Adverse events are unintended injuries or complications that result from health care management rather than from the patient's underlying disease.[1]
AROs	Antibiotic/antimicrobial resistant organisms are organisms that have developed resistance to common antimicrobials. Infections with antimicrobial resistant organisms are likely to be more difficult to treat.[2]
Continuum of care	The term reflects the variety of environments within which health care is provided, ranging from acute to ambulatory, home, and long-term care settings.
HAIs	Health care associated infections are infections acquired while receiving health care irrespective of site: hospital; long-term care facility; ambulatory care; or home. This term reflects the shift away from hospitals as the predominant provider of health care services and has largely replaced the term nosocomial.
Home Care	Home care is care provided in the home to patients/clients of all ages with both acute and chronic conditions. The scope of services ranges from assistance with activities of daily living and physical/occupational therapy to the care of postoperative wounds, intravenous therapy, and chronic ambulatory peritoneal dialysis.
Hospital epidemiologist	An individual, usually a physician, with expertise in epidemiological principles and Infection Prevention and Control Program delivery and evaluation.
Infection control (IC)	The original term used to describe the hospital program responsible for monitoring and preventing nosocomial infections.
ICP	Infection Control Professional: A health care professional (e.g., nurse, medical laboratory technologist) with

	responsibility for functions of the Infection Prevention and Control Program. This individual, who must have specific Infection Prevention and Control training, is referred to as an infection control practitioner/professional or ICP.
IPCP	Infection Prevention and Control Program: The program consisting of the hospital epidemiologist, practitioners, and support staff charged with the responsibility to minimize the occurrence of infections in patients, health care workers, and visitors.
LTC	Long-term Care: This refers to the care delivered in a diverse group of residential settings, ranging from institutions for the developmentally disabled to nursing homes for the elderly to paediatric chronic-care facilities. Nursing homes for the elderly are the most common type of LTC facility. Long-term care facilities are different from other health care settings in that for most "residents" it is their home and an atmosphere of community is fostered through common eating, living and recreational areas.
MRSA	Methicillin-resistant *Staphylococcus aureus:* Strains of a common bacterium (*S. aureus*) that are resistant to beta-lactam antibiotics and that have been responsible for many outbreaks of infection over the past two decades.
Nosocomial Infection	The term used for an infection acquired while receiving health care. Since this is a term historically associated with infections acquired while in hospital, there has been a move to the term HAI (defined above) to more clearly reflect the continuum of care.
Restructuring	Refers to changes in the structure of a health care delivery system. For example, regionalization involves joining multiple facilities in an urban centre or joining facilities in a geographic region under a single administration. However, a "region" may include all settings in the continuum of care or it may only include one setting, e.g., acute care. Such inconsistency has created difficulty in defining the mandate/area of responsibility of infection prevention and control programs.
VRE	Vancomycin-resistant *enterococcus:* A strain of a common bacterium (*enterococcus*) that is resistant to many commonly used antibiotics, including vancomycin.

1.0 Executive Summary

The purpose of this document is to describe, using an evidenced-based approach, the resources necessary for Infection Prevention and Control Programs across the continuum of care in acute, long-term, ambulatory and home care settings. The intrinsic and explicit values of Infection Prevention and Control Programs are researched and presented from both human and economic perspectives.

Policy makers and administrators are committed to providing comprehensive, accessible, and affordable health care services of high quality for all Canadians. Changes in the Canadian health care system and in the demographics of the population have significantly affected the availability, quality, and ultimately the safety of health care services in Canada.

The mandate of an Infection Prevention and Control Program is to prevent and control health care associated infections. Examples of health care associated infections include bloodstream, surgical site, urinary tract, pulmonary, and skin and soft tissue infections. Other infectious diseases, including respiratory (e.g., severe acute respiratory syndrome or SARS, influenza, tuberculosis) and gastrointestinal (e.g., *Clostridium difficile* colitis, Norovirus) infections, and infections with antibiotic-resistant organisms (e.g., methicillin-resistant *Staphylococcus aureus,* vancomycin-resistant *enterococcus*) transmitted in health care settings are also considered health care associated infections.

Many patient factors increase a patient's risk of developing health care associated infections including advanced age, prematurity, and increasingly complex treatment modalities in both hospital and out-of-hospital settings.

Restructuring has occurred within the Canadian health care system, as it has in both the United States and Europe. Changes in nurse staffing numbers and staff mix related to restructuring have been associated with an increased risk for health care associated infections and have contributed to the deterioration in both quality and outcome of patient care throughout North America and Europe.

The emergence of new infectious agents such as the severe acute respiratory syndrome coronavirus (SARS-CoV) and the re-emergence of community-acquired communicable diseases such as group A streptococcal disease, community-acquired methicillin-resistant *Staphylococcus aureus* , and multi-drug resistant tuberculosis are also causes of concern for Infection Prevention and Control Programs.

Other concerns include infections due to contaminated drinking water (e.g., *E. coli* O157:H7), food borne infections (e.g., *Salmonella)*, zoonoses (e.g., plague), and the potential for bioterrorism events.

Evidence has been published in support of having an effective Infection Prevention and Control Program. The landmark Study on the Efficacy of Nosocomial Infection Control (SENIC) project estimated that one-third of health care associated infections in the

hospital setting could be prevented if hospitals instituted the essential components required for Infection Prevention and Control Programs. Recent data regarding Infection Prevention and Control Programs in Canada (Quebec and Ontario specifically), the United Kingdom, Italy, Belgium, Australia, and the United States have reported deficits in the essential resources and components of current Infection Prevention and Control Programs.

To meet its infection prevention and control mandate, staffing, training, and infrastructure requirements are needed**.** However, administrators may be tempted to reduce the infection prevention and control budget as it consumes resources and does not generate revenue.

Infection prevention and control is a critical component of patient safety, as health care associated infections are by far the most common complication affecting hospitalized patients. The human and economic burdens that health care associated infections place on Canadians and their health care system speak to the importance of an effective Infection Prevention and Control Program.

1.1 Recommended Resources and Activities for an Effective Infection Prevention and Control Program

1. Infection Prevention and Control Programs should be staffed appropriately to meet the goals of the Program.

2. Infection Prevention and Control Programs should have access to expert resources including an infectious disease physician and/or a medical microbiologist. These consultants should be reimbursed for their time and expertise.

3. To support the surveillance activities and to identify and manage outbreaks, Infection Prevention and Control Programs should have readily available access to microbiology and virology laboratory diagnostic services. This includes access to qualified reference laboratories that can provide timely molecular typing.

4. An effective Infection Prevention and Control Program should collaborate and consult with internal (e.g., patient safety, quality assurance, reprocessing, occupational health) and external (e.g., other facilities and local, provincial/territorial and national health agencies) partners to ensure appropriate communication and sharing of information.

5. Health care organizations should ensure that surveillance of both infection prevention and control processes and outcomes related to health care associated infections is performed; and that the data are analyzed appropriately, provided to front line staff, clinical leadership and administrators, and used to monitor and improve related patient outcomes.

6. Infection Prevention and Control Programs should conduct ongoing educational programs for health care providers (including volunteers, family members and students) to reinforce current standards of infection prevention and control practices, emphasizing the importance of hand hygiene.

7. Infection Prevention and Control Programs should have access to current infection control literature, textbooks, journals, standards and/or guidelines, in addition to Internet access.

8. Infection Prevention and Control Programs should have adequate office space and secretarial, data entry and computer support.

9. Health care organizations should ensure that there is adequate nurse staffing with the appropriate skills to apply infection prevention and control measures when providing patient care. Other health care providers in all settings where health care is delivered (e.g. respiratory therapists, physiotherapists) should also have the skills to apply infection prevention and control measures when providing patient care.

10. Health care organizations should ensure that there is adequate housekeeping staff with the appropriate training to provide a clean and safe environment for patient care.

2.0 Introduction

This document describes the human and economic burdens of health care associated infections (HAIs) as well as the appropriate resources and activities required for an effective Infection Prevention and Control Program (IPCP), to minimize the incidence and adverse outcomes of these infections. Recent experience with the severe acute respiratory syndrome (SARS) and *Clostridium difficile* associated diarrhea outbreaks demonstrates the negative impacts of HAIs and how such infections may contribute to poor patient outcomes, disrupt patient care, as well as negatively impact the larger national economy. The goals of IPCPs are to minimize these and other negative effects by

- contributing to patient safety through protecting patients from infections;[1;3-8] protecting health care workers and visitors to health care facilities from infections;[3;4;6] and
- accomplishing these goals in the most cost effective manner whenever possible,[4;6] thus reducing the economic impacts of HAIs on individual health facilities, health systems and the national health care industry.

Health care associated infections occur in relation to health care interventions including invasive, diagnostic, surgical, and medical procedures. Examples of HAIs include bloodstream, surgical site, urinary tract, pulmonary, and skin and soft tissue infections. Transmission of infectious diseases, such as SARS, tuberculosis, influenza, *Clostridium difficile* (*C. difficile*), Norovirus, and antibiotic resistant organisms (e.g., MRSA [methicillin-resistant *Staphylococcus aureus*] and VRE [vancomycin-resistant *enterococci*]) to patients within the health care delivery system are also considered HAIs.

Infection Prevention and Control Programs were first introduced in the1950s. Initially referred to as Infection Control Programs, these hospital-based programs focused on the control of hospital-acquired infections, which were referred to as nosocomial infections. As health care increased in complexity and sophistication and expanded beyond acute care, the mandate of IPCPs should have expanded to encompass infections in all settings across the health care continuum. Contrary to expectations, however, IPCPs have seen their resources either decrease or remain static, and consequently have failed to achieve the needs of the expanding mandate.

Health care associated infections contribute to significant morbidity, mortality, and economic costs[9-12] and the risk of hospital acquired infections is increasing.[13;14] These infections are the most common complication affecting hospitalized patients.[8] Effective IPCPs reduce nosocomial infections by at least 30%[10] and have repeatedly been shown to be effective in controlling infection outbreaks in the health care setting. Appropriate resources, both in quantity and in quality, are required to support effective IPCPs and contribute to the safety of Canadian patients.

3.0 Health care associated infections are an important problem

In 1985 there were an estimated 2.1 million nosocomial infections with 80,000 attributable deaths in the US.[15;16] Health care associated infections were the fourth most common cause of death.[15] Using this published data on the expected incidence of HAIs and the number of hospital discharges in Canada, Zoutman et al[17] estimate that 220,000 nosocomial infections, which result in more than 8,000 deaths, occur in Canadian hospitals each year.

Health care associated infections are extremely costly. No data or published total costs are available in Canada; however, the estimated costs of MRSA alone are between $42 and $59 million per year for Canadian hospitals.[18] In 2000, annual estimates of the total costs of HAIs in the US were $5 billion,[19] and in the United Kingdom (UK) these costs exceeded £930 million (in 1994–1995).[12] There is no reason to believe that the relative Canadian costs are any lower than those in the US or the UK. These estimates speak to direct costs and do not capture the huge indirect costs of HAIs.

3.1 Impacts of health care associated infections: an overview

Society as a whole suffers negative consequences from HAIs.[9;12;20] These infections, including their investigation and treatment, have both immediate and future implications for the individual, the health care system, and the local, national and global communities. Although there are limited data describing the societal impact of HAIs,[21] some emerging examples illustrate their breadth and gravity:

- There is a need for antimicrobial therapy that has long-term worldwide effects on health.[22-25]
- Medical care contributes significantly to environmental pollution and consumption of limited natural resources.[3]
- Many are concerned about safety in health care facilities. HAIs are a major contributor to significant adverse events in health care,[1;7;8;26-31] affecting between 3.18% and 19.73% of Canadian hospital admissions.[32] At least one-third of adverse events (including HAIs) are considered to be preventable.[10;28;29]
- The SARS epidemic in Toronto and elsewhere took a significant toll on the health care system.
- The impact of HIV and hepatitis C infections on the blood system is still being felt by the health care system.

The impact of HAIs on individuals is well documented:

- increased morbidity and mortality[4;9;33-37]
- decreased well-being and increased suffering[9;38]
- psychosocial effects as a result of isolation,[39] particularly in long-term care facilities that are considered home for many individuals[40-42]

- safety issues including reduced attention to isolated patients from health care personnel[43] (the impact of isolation is an important consideration as recent Canadian data show that 92% of VRE patients were isolated and 22% of these patients were on isolation for more than 28 days)[44]
- prolonged length of stay in hospitals with subsequent increased direct costs and reduced bed availability (e.g., prolonged waiting time for patients needing joint replacements)

As with HAIs in general, there are significant impacts on patients that have acquired antimicrobial resistant organisms (AROs). These may include the less tangible effects on the individual such as threats to the person's well-being and erosion of a sense of security.[2;45] The person's trust in the health care system diminishes and the perception of ill health increases in response to prolonged treatment time, social isolation, and time lost from work or family.[2;22;46] The consequences associated with AROs will burden future generations as well as our own.[22]

3.2 Costs and rates of health care associated infections

The management of HAIs exacerbates rising health care costs, although the exact attributable cost to society is unknown.[21] Related financial impacts of HAIs include an increased time away from home for the individual with an infection[20] and if employed, the individual experiences a loss of work and wages[47;48] or at least an increased use of sick leave. The indirect costs, such as a family members' time lost from work in caring for the affected individual, must be considered in addition to the direct costs of increased use of resources[12;21;47;49] but have not been well quantified. Overall, HAIs have a detrimental effect on the individual's quality of life[38;47;48] and are very costly.

The HAI financial burden to the health care system has been estimated by measuring a number of indices including increased

- number of readmissions to hospital[4;9;20]
- length of stay[9;18-20;33;34;49;50]
- use of antimicrobials[18;20;45;50;51]
- surveillance and isolation measures for AROs[18;51-56]
- laboratory[18;50;51] and radiological services[20] attributable to diagnosing and managing HAIs
- overall direct or indirect costs[4;9;19;20;33;35-37;49;57]
- cost attributable to outbreaks[53;58]

Tables 1 to 4 summarize reports describing rates and financial burdens associated with HAIs across the continuum of care in several countries. Although acute care institutions are best studied, the allocation of an infection to a particular setting is increasingly arbitrary because the boundaries of the health care sectors have become blurred due to changes in the level of care being provided in different settings.[4] For example, there is

an increasing amount of "acute care" (such as ventilator care) being provided in the home setting.

3.2.1 Acute care setting

The increased economic costs of HAIs are mainly a result of extra days the patient has to stay in hospital. Estimated increased length of stays published in the US in 2000 were 1–4 days extra stay for a urinary tract infection, 7–8 days for a surgical site infection, 7–21 days for a bloodstream infection, and 7–30 days for pneumonia. Costs of these infections vary from $600 for a urinary tract infection to over $50,000 for a bloodstream infection.[19]

Table 1: Acute care HAI rates, attributable costs and increased length of stay

Setting	P*	IR**	↑Costs	↑LOS***
All health care associated infections				
ICU[59]	21.6	20.3		
ICU[60]	36.0			
Gyn. & Ortho[61]	5.9	6.3		
NICU[34]	5.5		US$10,440	5.2
Hosp. wide[62]		5.7–6.9		
Hosp. wide[21]			US$13,973	
Surgery[63]	15			10.6
Paediatrics[64]	7.7			
Paediatrics[65]	5.7			
Blood stream infection				
Medicine[66]		1.22–1.36		
ICU[59]	4.5	4.2		
Gyn. & Ortho[61]	0.12			
Hosp. wide[36]			US$2,836 +	
Hosp. wide[67]		0.7–1.1	US$4,420–$7,229	
Hosp. wide[21]			US$38,703	
Central venous catheter blood stream infection				
Hosp. wide[68]		8.9		
ICU[59]	4.8	3.8		
ICU[69]	1.0–4.7	1.6–7.6		
Surgical Site Infection				
Gyn.& Ortho [61]	2.0			
Surgery[20]	1.96		Can$3,937–$4,228	10.2
Surgery[33]			US$53,000	12
Urinary tract infection				
ICU[59]	7.8	8.5		
Gyn. & Ortho [61]	3.3			
Hosp. wide[36]			US$676	1–2
Pneumonia				
Hosp. wide[21]			US$17,677	
Ventilator-associated pneumonia				
ICU[59]	9.6	9.4		
ICU[70]		19.5-21.7		
Methicillin-resistant *Staphylococcus aureus*				
Hosp. wide[21]			US$35,367	
Surgery[71]	5.4			

Orthopedic [71]	1.4			
Medicine[66]		1.93-2.19		
Vancomycin-resistant enterococcus				
Adult Oncology[72]		0.45-2.1 (BSI)		

Notes:

* Infections/100 patients

** Infections/1,000 patient or device days

*** Length of stay in days

3.2.2 Long-term care setting

The HAI rate in long-term care, estimated at 5–6/1,000 resident days, approximates the hospital HAI rate.[41] Urinary tract infections are the most common HAI found in long-term care facilities.[41;73;74] Wide variations in infection rates in long-term care are largely explained by the use of different definitions and case ascertainment methods[4;75] as well as the variation in types of long-term care settings.[74;75] Nonetheless, knowing the incidence of HAI in long-term care is particularly important in view of the increased morbidity, cost and negative impact on quality of life associated with these infections in the elderly population.[74] Along with emotional and psychological disruption, there are additional transportation and treatment costs should the long-term care resident need to be transferred to the acute care setting for treatment.

Table 2: Long-term care facility health care associated infection rates, attributable costs and hospital stay

ref #	IR*	↑costs	↑hospital LOS**
All health care associated infections			
(75)	3.82		
(41)			5.0–6.0
(76)			2.0–6.7
Blood stream infection			
(75)	0.06		
(76)	0.02		
Urinary tract infection			
(75)	1.51		
(76)	0.18		
Respiratory infection			
(75)	1.15		
(4)	0.7–4.4		
Pneumonia			
(77)	0.27–2.5	US$10,000	
Skin and soft tissue			
(75)	0.86		
(4)	0.1–2.1		
(76)	0.55		
Gastrointestinal infection			
(75)	0.27		
(76)	0.40		
Vancomycin-resistant e*nterococcus*			
(78)		US$12,061	

Notes:
*Infections/1,000 resident days
** Length of stay in acute care hospital

3.2.3 Ambulatory care setting

The costs of HAIs in non-hospital settings have not been estimated, at least partially because IPCPs, including their surveillance activities, are limited or absent in these settings.[4;41;79-84] In one Canadian study, surgical site infection rates in the ambulatory setting were 1.4-3.1% after hernia repair.

3.2.4 Home care setting

Despite a dramatic increase in the number of patients receiving care in the home, with an estimated 10% of these patients requiring invasive medical devices for their care, the infection rate in the home care sector is not generally known.[80;81] However, the Centers for Disease Control and Prevention, Atlanta,[19] cites a recent study reporting an infection rate of 16% in a home care population of 5,148 patients, and suggests home care patients are at risk for the same infections seen in hospitals.[79]

Table 3. Home care health care associated infection rates by study

Health care associated infection	Ref. #	I*	IR**
All			
	[85]	5.1%	
Central venous catheter-blood stream infection			
	[86]		0.3–1.4
	[87]		1.1
Catheter-associated urinary tract infection			
	[87]		4.5

Notes:
*Infections/100 patients
** Infections/1000 patient or device days

3.2.5 Antimicrobial resistant organisms

The emergence of AROs has compounded the impact of HAIs. The costs of antimicrobial resistance have been reported as crude estimates[88] based on the following indices[2;45]:

- increased length of hospital stay
- additional investigations required (e.g., laboratory and radiological)
- additional drug treatment courses because, with AROs , the person is less likely to respond to the first antimicrobial used to treat the infection
- increased costs for isolation procedures

Recent estimates, which are considered conservative, suggest that infections with AROs add between $39 and $52 million annually to the indirect and direct hospitalization costs of health care delivery in Canada.[45]

4.0 Changes in Health Care and their Impact on Infection Prevention and Control Programs

Health care reform over the past decades has resulted in a health system that looks and operates differently from the system that evolved during the previous century.[89] Administrators and policy makers have been required to make health care reform decisions with little empirical evidence to guide the decision-making process.[90-92] Other factors that have impacted changes include an aging and varied population, increasing complexity of patient conditions and clinical interventions, realignment of health care delivery including restructuring, and changes in health care funding. Each of these changes necessitates an expanding role[17;93-95] for IPCPs in an era of emerging and re-emerging infectious diseases, global health concerns, and limited resources.

4.1 Health care needs of specific populations

Those at the extremes of age require specialized health care. At one end of the scale, premature infants have an improved survival rate with a corresponding increase in the cost of their care. At the opposite end of the scale**,** there are greater numbers of older, frail seniors and a substantial increase in the incidence and prevalence of chronic diseases such as cardio- and cerebrovascular diseases, diabetes, dementias, and end-stage renal disease.[89;96] The treatment of these chronic health problems is increasingly successful, further prolonging life. In 1997–1998, patients over 65 years of age accounted for 52% of the hospital patient days, but represented only 12% of the population.[96] With an anticipated increase in the population of individuals older than 65 years of age over the next two or three decades, the allocation of health care dollars to the elderly population will continue to increase**.**

There are unique health care needs for specific populations such as children, First Nation's peoples, immigrants and refugees, those living in rural or remote areas,[89] the poor, and the homeless. There are implications for the prevention and control of infections for all of these groups. For example, the higher than national average rates for multi-drug resistant tuberculosis among the homeless population is well documented[97-101] and outbreaks of this infection in correctional facilities have occurred.[101]

4.2 Increasing complexity of patients

Irrespective of patient age, since the late 1970s, there has been an increase in the acuity of illness in Canadian hospitals coupled with a decrease in the patient length of stay.[13;96;102] The acute care hospital is not the only delivery site to experience an increase in patient acuity. Patients with multiple health problems and complex physical and psychosocial needs are increasingly being cared for in non-acute health care settings.[81;90;103] Both the acuity and the number of patients in the home care[79;81;86;87] setting have intensified and early discharge from acute care facilities challenges home care service providers and agencies.[104]

4.3 Increasing complexity of treatment interventions

Today's complex medical care requires multiple health care services and providers.[89] There has been an increase in the use of invasive medical devices such as tracheostomy tubes, respirators, feeding tubes, central venous catheters, medications delivered by daily injections, indwelling urinary catheters, and peritoneal dialysis catheters for the treatment of chronic renal failure.[42;74;105] These are all now commonly used in ambulatory,[82;106] long-term,[42;103;107] and home care settings.[79;81;86;87;90;108] Outpatient antibiotic therapy in the ambulatory care setting is well documented and shows positive economic and medical outcomes.[109-113]

There have also been substantive changes in health care design. Advances in technology, including telehealth and telemedicine, allow health care practitioners to provide sophisticated preventive, diagnostic and treatment services at distant sites.[89] The impact of these novel delivery systems on HAIs is unknown.

4.4 Realignment of health care delivery across the continuum of care

Canadian Institute for Health Information (CIHI) data[96] demonstrate that the hospital discharge rate (i.e., a measure of inpatient hospital use) decreased by 14% between 1994 and 1998. During the same time, the average length of stay decreased from 7.4 to 7 days and there was a 15% decline in acute inpatient hospital surgeries, with a corresponding increase in outpatient surgery. A continued reduction in the number of hospital beds is expected in the current decade.[82]

Canadian[103] and American analysts[82;92] predict that the majority of medical care will move to the ambulatory care setting during this century. This includes an estimated 75%–80% of surgical procedures[82;114] and oncology services[82] to be provided on an outpatient basis. The Centers for Disease Control and Prevention in Atlanta reports that the number of patients receiving care in their homes is increasing and notes that the amount spent on home health care in the United States rose from $2 billion in 1988 to an estimated $25 billion in 1999. Eight million Americans received medical care in their homes in 1996.[79] The Canadian Hospital Association[89;103] describes the same general trends for Canada. Employment data from CIHI[115] and other sources[102] demonstrate a shift of registered nurse employees from acute care hospitals to community-based settings. Between 1994 and 1999 the percentage of RNs employed in hospitals decreased (66.4%–62.5%), but increased in community health agencies (6.0%–8.1%), nursing homes (10.8%–11.7), and home care (3.5%–4.0%).[116]

4.5 Changes in health care funding

Three noteworthy trends in health care funding will affect all health programs. The first funding trend is seen in the proportion of spending among the health care sectors. Although current CIHI data show that hospital care is the leading category for health care spending,[117] starting in the mid-1970s, the portion of the total Canadian health

expenditure designated for hospitals declined.[102;117] The second trend is a steady—albeit gradual—shift in the ratio of public to private health care funding, with the proportion of public funding declining relative to private funding.[117] The third trend, a lack of sustained health care funding,[89] is probably the most significant in terms of health program development.

4.6 Implications for Infection Prevention and Control Programs

Changes in requirements for health care have implications for IPCPs. An interaction between chronic diseases and the physiological changes associated with aging sets the stage for the development of infections in the elderly.[42] Advanced age is associated with an increased risk of pneumonia because of decreased lung capacity and cough reflex, as well as increased co-morbidities.[77] The use of invasive devices such as tracheostomy tubes, respirators, feeding tubes, intravenous catheters, daily injections (e.g., insulin), indwelling urinary catheters, and peritoneal catheters for treatment of chronic diseases, along with the reduced mobility, bowel and bladder incontinence, and poor nutrition all compound the risk of infection.[42;74] Living in an institutional environment further increases the older person's risk for acquiring infection.[24;74]

Increased acuity of home care patients combined with the use of invasive devices necessary for home health treatment increases the patient's risk of infection.[79] Although a lack of epidemiological data and under-reporting of infections in the home health care environment is acknowledged,[4;24;81;83;118;119] outbreaks including bloodstream[86;120] and catheter-related genitourinary infections,[84] including candidemia,[121] have been reported among home care patients**.** Home care nurses have always faced a significant challenge in adapting acute care infection prevention and control strategies to the home care setting.[122]

In the past, the risk for infection in ambulatory care settings was considered to be low. Currently, with the varied patient mix (from well to acutely ill) and invasive procedures, risk management of infections in this population is increasingly complex. Three areas in ambulatory care are particularly important from an infection prevention and control perspective: the ambulatory surgical setting, the ambulatory infusion setting, and the dialysis centre setting.[4] Herwaldt et al.[82] list risk factors in the ambulatory care setting that include the following:

- greater potential for unsafe handling and disposal of infectious wastes
- inadequate ventilation, e.g., recirculation of unfiltered air, no negative pressure rooms
- inadequate cohorting of patients (one entrance, one waiting room)
- staff members' inadequate knowledge of infection control due to high staff turnover and the lack of dedicated education programs
- inappropriate disinfection practices for equipment
- inappropriate use of flash sterilization
- inadequate space to allow for separation of clean and dirty activities

Realignment of health care delivery within the institution frequently necessitates construction and renovation projects. These have resulted in documented outbreaks related to Legionnaires' disease[82;123] and *Aspergillus* species infections.[123] Infection prevention and control involvement during renovation and construction is necessary to prevent outbreaks related to such projects.[124-127] Both Health Canada (2001)[123] and the Canadian Standards Association (2003)[128] have published infection control recommendations for construction and renovation in a health care facility.

Restructuring of health care has been reported to contribute to an increased risk of HAIs[123;124;126;129] and to the transmission of AROs.[13] University of Alberta Hospital[130] investigators reported that changes in the health care system impacted their hospital's nosocomial infection rates. There were significant reductions in the number of hospital beds (↓10%), annual admissions (↓19%), and patient days (↓17%) between 1993–1994 and 1996–1997. During the same period there was a 31% increase in the number of and a 60% increase in the rate of blood stream infections.

Understaffing,[131-134] a decrease in the level and skill of health care providers,[135] understaffing and overcrowding[136] and lack of infection prevention and control education[13] are associated with the transmission of micro-organisms and the development of HAIs. It is important to note that a deterioration in the quality and outcomes of patient care has been reported.[26;91;137-139]

In the past decade, surveillance, prevention, and control of AROs have become a major component of IPCPs.[17;51;93;140] Antimicrobial resistance involves the emergence of drug-resistant bacteria, parasites, viruses and fungi.[141] The increasing prevalence,[46] the rapid emergence of new AROs,[140] and multi-drug resistance of many of these organisms[142] compound the resistance problem. Antimicrobial agents available to the practitioner for the management of infections with AROs are limited or, in some cases, non-existent.[46;141-143] Coexistent with this has been a decrease in the development of new antimicrobials.[22;142] Antimicrobial resistant organisms such as MRSA and VRE have been reported to lead to increased length of hospitalization, increased morbidity, and increased costs.[144]

Antimicrobial resistance, once seen primarily in intensive care unit settings, is now a problem throughout the acute care hospital[142] and in long-term care settings.[73;105;145-147] One American study reported MRSA colonization rates of up to 53% in the residents of some long-term care facilities.[140] Partly because of increasing patient movement between health care sectors (e.g., patients receive dialysis or chemotherapy in both the inpatient and outpatient settings),[140] AROs have been identified in all health care settings[46;142;148] as well as in the community.[149-153]

There is evidence to show that, along with the development of de novo community strains,[154] hospital-acquired strains of MRSA are being transmitted into the community.[149] Overcrowded living conditions, such as those still found in many First Nations and Inuit communities, are strongly implicated in the spread of community pathogens[155] including AROs.[149] According to data from the Canadian Nosocomial Infection Surveillance Program, there has been a continued increase of MRSA

colonization rates and infections in Canadian hospitals. For further information, please refer to the following website: http://www.phac-aspc.gc.ca/nois-sinp/projects/mrsa-eng.php. This poses a risk to patients and is a potential financial burden affecting health care resources. The Canadian Nosocomial Infection Surveillance Programs and others[93;156-158] recommend that IPCPs perform active surveillance to identify patients with AROs and implement other preventative measures to control their cross transmission.

Emergence or re-emergence of community-acquired, communicable diseases [(e.g., invasive group A streptococcal disease,[159] community-acquired MRSA, multi-drug-resistant tuberculosis,[160;161] and *C. difficile*,[14;162]), food- and water-borne infections (e.g., *E. coli* 0157:H7), zoonoses (e.g., *Salmonella*[163]), plague,[164] AROs,[42;142;165-168]] increased international air travel,[141] and potential bioterrorism[169] all provide an opportunity for the development and transmission of infections.[40;72;170] This is of concern not only within Canadian health care settings, but also throughout the world.[23;171] These concerns all point to an urgent need to expand IPCPs.

4.7 Limited resources for Infection Prevention and Control Programs

Changes in the health care system have expanded the range of IPCP activities.[93;95;172] These changes necessitate an increase in infection prevention and control resources in order to be effective in the current health care system and to maintain the essential IPCP components for acute care facilities that Haley[10] identified almost three decades ago.

The emergence of new infectious diseases such as SARS has emphasized the need for surge capacity in infection prevention and control as well as in other health care services. The concept of surge capacity is based on sufficient capacity or appropriate resources for day-to-day operation and an ability to redirect resources in a time of need.[173] Despite the need for more resources for effective infection prevention and control, and the need for a surge capacity for these programs, a survey conducted by the Association for Professionals in Infection Control and Epidemiology in the United States comparing data from 1994 and 1997 found that IPCP human resources had actually decreased.[95;174] The study cites the following examples:

- Seventy-six per cent of practitioners surveyed reported that their workload had increased.
- The number of locations where infection prevention and control practitioners must cover increased 63%.
- Forty-five per cent of infection prevention and control practitioners had additional jobs beyond infection control responsibilities.
- Infection control staffing levels decreased or remained the same for 83% of respondents.
- Eighty-three per cent of respondents said that funding for infection prevention and control had decreased or remained the same, despite increased workloads.

A recent report incorporating 20 years of data revealed a 145% increase in infection control activities whereas resources for IPCPs lagged far behind.[175] Inadequate staffing was cited as the most common reason for non-performance of essential infection prevention and control responsibilities. Competing infection prevention and control responsibilities had a negative influence on time available to perform surveillance,[94] even though surveillance is known to be an essential component of an effective IPCP.[10;176-178] In a 2003 survey of Canadian IPCPs, 23% of hospitals that responded were conducting fewer than half the recommended surveillance activities.[17] Other Canadian IPCPs have reported that surveillance activity is primarily related to AROs,[179;180] at the expense of other HAIs.[179;180] Yet, Canadian hospitals that perform aggressive surveillance for HAIs demonstrate fewer of these infections.[181]

A review to assess the human resources available to IPCPs in Ontario hospitals was conducted in 1999. Results of a survey mailed to all acute-care hospitals in Ontario concluded that infection control practitioner time in Ontario hospitals is well below the 1985 recommendation of one full time equivalent position per 250 beds.[179] This ratio was derived before the emergence of AROs, bioterrorism, emerging infections, patient safety issues, and infection prevention and control job responsibilities broadening across the continuum of care.[95;172] The authors noted that infection control practitioners in Ontario spent approximately 20% of their time on surveillance, prevention and control of antimicrobial resistant organisms, further reducing program resources within that province.[179] A later Canadian study[181] showed that investments in surveillance significantly reduced antimicrobial resistant organism rates.

5.0 Importance of Infection Prevention and Control Programs

5.1 Evolution of Infection Prevention and Control Programs

The problem of HAIs appeared as soon as sick people started being cared for in hospitals.[182] The introduction of infection control (IC) programs to monitor such infections did not occur until the mid-1950s, in response to a pandemic of hospital staphylococcal infections.[182-184] Initial IC programs were usually staffed by registered nurses, whose main function was to gather data through hospital-wide environmental surveillance and outbreak monitoring.[185] During the 1960s, with the rise of infectious diseases as a clinical specialty[184] and support from the fields of epidemiology and microbiology,[185] IC programs became increasingly outcome oriented. Thus, the seeds for evidence-based best practices were sown and the initial foundation for a scientific basis for infection prevention formally developed.

Infection prevention in the 1970s addressed new issues about disinfection and sterilization as well as new risks for hospital-acquired infections associated with the increasing use of invasive medical devices (e.g., peritoneal dialysis catheters, central lines for total parenteral nutrition).[185] At about the same time, the risk of transmission of

infections (e.g., tuberculosis, hepatitis B) between health care workers and patients and occupational health issues also became infection control considerations.[185] The Association of Practitioners in Infection Control was established in Toronto, Canada, in 1972 and the Canadian Hospital Infection Control Association, now with over 1,000 members, was formed in 1976. *L'Association des Infirmières en Prévention des Infections* in Québec, founded in 1978, currently has over 150 members. These professional organizations work to provide support and training to ICPs across Canada.

The introduction of accreditation requirements for a comprehensive IC program and designation of an ICP to manage the program were important milestones in the development of infection control during the 1970s.[182-184] The most significant development for infection control during that decade, however, was the US Centers for Disease Control and Prevention's ten-year study on the efficacy of nosocomial infection control (SENIC) project.[182;185] Health care delivery had been consuming a steadily increasing percentage of the gross domestic product and there was a concern that the resulting pressures on hospitals to reduce costs would prompt the elimination of preventive programs of unproven value.[183] The SENIC report, published in 1985, provided evidence that organized IC programs are not only effective, they are also cost-effective.[10] Thus, the value of a formal IPCP was well established more than two decades ago.[10]

In 1980, the Bureau of Infection Control was instituted at Health Canada's Laboratory Centre for Disease Control, with a mandate to produce national infection control guidelines to serve as a basis for the provinces and territories in developing local practices. In 1985 the Canadian Hospital Infection Control Association was renamed the Community and Hospital Infection Control Association-Canada to acknowledge the role of infection prevention and control in facilities (i.e., acute care, long term/extended care) as well as community (i.e., ambulatory care, home care) settings. Throughout the 1980s, infection control resources were continually stretched by the appearance of acquired immune deficiency syndrome (AIDS)[182;185] and AROs.[185]

By the 1990s patient care beyond the traditional health care settings and the focus on knowledge management, together with complex moral and legal considerations, made decision making regarding infection prevention and control issues increasingly challenging[95;183] while resources were stagnant or decreasing.[9;95;186] A plethora of guidelines to control and promote the rational use of antimicrobials[2;46;187] has not curtailed the plague of antimicrobial resistance.[140;142] In addition, while appropriate hand hygiene reduces the risk of infection[188] and antibiotic resistance,[189] ensuring optimal handwashing practice remains problematic in hospitals.[189]

Toward the end of the decade, experts called for IPCPs to take on new leadership roles within health care organizations[140;186;190-192] to achieve the goal of these programs, minimizing infections related to the delivery of health care.

The new millennium has seen infection prevention and control teams contributing to pandemic influenza planning, responding to the SARS outbreak in Toronto,[173] revisiting practices to prevent the transmission of respiratory infections in light of the SARS

experience,[193] and responding to the outbreaks of severe *C. difficile* infections.[14;162] Critical issues facing an IPCP today include demonstrating its value,[9;185;194] and considering the cost-effectiveness of its policies and procedures[21;47;49] within a complex and economically challenged system.

5.2 Infection prevention and control programs and patient safety

The prevention of HAIs will result in increased safety of patients within the Canadian health care system.[1;7;28-30] Health care associated infections are the most common adverse event affecting hospitalized patients.[8] Surgical site infections are the second single largest category of adverse events as reported by the Harvard Medical Practice Study.[195] It is reported that more than 30% of HAIs can be prevented with effective IPCPs.[10]

Effective IPCPs reduce the financial and human burden of HAIs[4;6;9-11;177;196] and are an integral component of an overall patient safety strategy. The Canadian *Safer Healthcare Now!* and the American *100,000 Lives* campaigns recognize the efficacy of IPCPs. The purpose of both these initiatives is to reduce the incidence of preventable morbidity and mortality associated with the delivery of health care. Three of the original six strategies for the *Safer Healthcare Now!* campaign are aimed at preventing HAIs: central line infections, surgical site infections and ventilator-associated pneumonia.[197]

Infection control's integral role in patient safety is also recognized by the Canadian Council on Health Services Accreditation,[198] whose patient safety goal is to reduce the risk of HAIs and their impact across the continuum of care/service. Health care organizations are required to do the following:

- adhere to federally and/or provincially-developed infection control guidelines
- deliver education and training for staff, other providers and volunteers on handwashing/hygiene
- monitor infection rates and share this information throughout the organization
- examine, and where indicated, improve the processes for sterilization of medical equipment

The evidence to support the efficacy of IPCPs is unequivocal and organizations like the Canadian Council on Health Services Accreditation are relying on these programs to improve our patient safety record; however, these programs are only effective when they have adequate resources.[35].

5.3 Evidence of efficacy of infection prevention and control programs

Infection Prevention and Control Programs need to have benefits that outweigh their costs.[199] IPCPs are considered one of the most cost-effective activities in health care because they can reduce costs and improve the quality of health care

simultaneously.[9;11;35;38;47;171;191;196] Infection Prevention and Control Programs have been credited with significant cost savings including the following:

- a reduction in hospital health care costs[62] and lengths of stay
- a reduction in incidence and costs of surgical site infections[200;201] including post-Cesarean section[202] and post-cardiac surgery[203]
- a 19%–22% decrease in antibiotic expense without negative impact on patient outcomes[204]
- a process improvement project that achieved increased accountability and improved compliance with isolation precautions to control the transmission of MRSA that resulted in a sustained 30% decrease in its incidence over two years even though the number of days at risk increased, with a cost avoidance of more than $2 million[205]

Different types of cost analyses are reported in the literature.[49] For example, in 1995 Wenzel[38] compared the cost utility ratio (adjusted cost/quality of life years saved) and found that IPCPs save between $1,786 and $7,143 compared with $5,100 for bypass surgery for left main disease (of the coronary artery). Other studies used a cost-benefit analysis to measure the feasibility of infection prevention and control measures. Based on data from the SENIC project, a 1:5 cost-benefit ratio for IPCPs was reported.[16] This measure comes from dividing the money spent on the program by the value of the benefit derived from that program. The expenditures of an IPCP for a 250-bed hospital were estimated at US$60,000[16] in 1985 and had risen to $200,000 by 1995.[38]

The efficacy of IPCPs is demonstrated by these different cost analyses. A cost-benefit analysis performed to determine the net benefit and costs associated with the use of gowns in preventing the transmission of VRE found that while gown use adds costs, the benefits of preventing VRE transmission outweighed the costs.[206] A ten-year survey in the Netherlands demonstrated that funding the implementation of a strict infection prevention policy resulted in epidemiological and financial benefits.[55]

There are further studies and reports supporting the efficacy of IPCPs in all health care settings. Several examples are listed below for each setting.

5.3.1 Acute care setting

- The reduction of the surgical site infection rates following the introduction of surveillance programs[200;207-210] with a system of reporting infection rates back to surgeons in a timely fashion[10] led to the endorsement of this practice by the American College of Surgeons[211] and the Centers for Disease Prevention and Control.[212]
- A study of post-discharge surveillance for surgical site infection reported a reduction in the infection rate from 16% to 3% over a three-year period.[213]
- The reduction by ≥10% of surgical site infections in all patients and all HAIs in intensive care unit patients between 1990 and 2000 indicated the durability of IPCPs.[196]

- There was a 10-year decline of more than 30% in rates of HAI (with the largest reduction in blood stream infections occurring in hospitalized patients). The Centers for Disease Control and Prevention, Atlanta, credited participating facilities for recognizing the critical importance of an appropriate level of qualified ICPs who contributed to the steady and significant rates of decline.[196]
- A policy change in the screening of patients previously infected with *C. difficile* prior to readmission resulted in savings of $48,500 annually and contained the *C. difficile* infection rate below the threshold.[214]
- An enhanced infection control policy significantly reduced the endemic rate of *C. difficile* in acute elderly patients, helped maintain a lower incidence of MRSA, and resulted in eliminating prolonged ward closures.[215]
- Infection prevention and control interventions for neutropenic patients resulted in a significant decrease in health care associated invasive aspergillosis (an invasive infection associated with high mortality and morbidity) during hospital construction.[216]
- A multi-disciplinary group led by the IPCP implemented hospital-wide infection prevention practices, resulting in a reduction and stabilization of ventilator associated pneumonia rates.[217]
- The implementation of a comprehensive IPCP resulted in a prompt and significant reduction in the rates of cardiac device–associated infections,[218] potentially saving the institution the enormous cost of health care expenses treating these infections.
- When published infection prevention and control guidelines for tuberculosis control were fully implemented, transmission of multi-drug-resistant *Mycobacterium tuberculosis* among HIV patients[219;220] and to health care workers[220] ended.
- In an oncology setting,[72] enhanced infection prevention and control strategies significantly reduced both the VRE colonization and bloodstream infection rates.
- Boyce[157] demonstrated that MRSA control programs that include active surveillance cultures combined with barrier precautions were successful in reducing MRSA rates.[157] Others have also found such strategies to be cost-effective.[52-56]
- Introduction of an enhanced integrated IC Program that included a molecular epidemiology program lowered actual health care costs by $4,368,100 over two years, and reduced nosocomial rates by more than 10% (6.49 per 1,000 days to 5.79 per 1,000 days).[62]
- To control the spread of MRSA, admission screening and preventative isolation were found to be cost-effective in 14 intensive care units in France as determined during a six-month study.[56]
- A ten-year review of a strict policy that consisted of screening and isolating MRSA colonized or infected patients in a Dutch University hospital determined the policy to be cost-effective compared with the projected increased incidence of MRSA and subsequent related expenditures.[55]
- An enhanced infection prevention and control policy resulted in a significant reduction of *C. difficile* infection and MRSA colonization in elderly patients,

preventing ward closures and thereby netting an estimated extra five beds per day during the winter months.[215]

5.3.2 Long-term care setting

- Influenza A is the most costly infection in long-term care settings in terms of morbidity and mortality.[221] Although antiviral prophylaxis is effective in the control of an influenza outbreak,[221-225] vaccination of both residents and staff against the influenza virus is a more effective infection control strategy.[226;227] It has been demonstrated that increased vaccination rates are associated with the presence of an ICP[222] in the facility.
- An interventional study[228] showed that infection containment practices were effective in reducing the residents' MRSA colonization rate from 52% to 2% and their infection rate to 1.4% with a net savings of $429,500. The savings were calculated on 93 infections prevented at $5,000/acute care admission.

5.3.3 Ambulatory care setting

- Outbreak prevention and containment is a function of an IPCP. An investigation[229] of epidemic keratoconjunctivitis in an ambulatory clinic revealed that all the infections were linked with four physicians and 61% of the infections were linked with one particular physician. Lack of routine handwashing and inappropriate disinfection of instruments between patients were identified as the sources for HAI in this physician's practice. These factors were brought to the physician's attention and there was an immediate elimination of the infection. Within a year, there was a second outbreak of epidemic keratoconjunctivitis that was once again traced to this one physician. The outbreak was controlled as soon as infection prevention and control practices were applied consistently. The surveillance component of the IPCP identified and described the problem and the infection prevention and control practices eradicated this HAI.
- With the addition of postoperative surveillance to a program of direct observational surveillance and reporting of surgeon-specific surgical site infection rates, an outpatient clinic study demonstrated a reduced infection rate from 16% to 3% in three years.[213]
- The presence of a dedicated ICP in an ambulatory setting with 62 associated clinics was reported to be instrumental in improving infection control practices.[230]

5.3.4 Home care setting

- Four home care agencies participated in an infection survey reporting that their surveillance methods could be implemented by other agencies, thus creating infection control benchmarking between home health agencies.[87]
- An important function of the IPCP is to determine the level of safety, in terms of infection control, for the provision of care. In a study of blood stream infections,[231] the maintenance of a central line for paediatric patients receiving total parenteral nutrition in the home care setting compared with the hospital setting proved more efficacious in reducing both costs and health care associated infection rates.
- Infection Prevention and Control Programs also evaluate the safety of products. For example, needleless intravascular access systems have been introduced to reduce the risk of needlestick injuries among health care providers. These devices seem like the product of choice for home care, especially with family members often providing some or all of the care. However, a case-control/cohort study[232] demonstrated that needleless infusion systems used for total parenteral nutrition were associated with an increased risk of blood stream infection. A similar device was identified through an infection prevention and control investigation to be responsible for an outbreak of bloodstream infections in patients receiving home intravenous infusion therapy.[86]

6.0 Resources for Effective Infection Prevention and Control Programs

Requirements for optimal infrastructure and essential activities of effective IPCPs have been published for hospital[6] and out-of-hospital settings.[4]

The integrated nature of IPCPs must be considered when making decisions regarding their funding. For example, introducing computer programs to enhance data collection capabilities for surveillance while cutting back on laboratory funding will not improve the program. The data conversion process is complex and involves technical and professional laboratory staff to prepare and interpret the samples, office staff to produce the reports, an epidemiologist to analyze and interpret the reports, an infectious disease physician or medical microbiologist for appropriate clinical practice, and an adequate number of appropriately trained ICPs to communicate with and instruct the front line staff in infection prevention and control measures. IPCP personnel should include dedicated trained ICP(s), an infection prevention and control physician and/ or hospital epidemiologist, technical and clerical support staff, as well as access to professionals with a background in microbiology, biostatistics, informatics, health care management and adult education.[105;233;234] The following recommendations outline resources that are required to develop and maintain effective IPCPs across the health care continuum.

6.1 Recommendations

The following recommendations support the IPCP goal of reducing HAIs to the lowest possible level and incorporating the essential components of an IPCP, namely surveillance, case management, outbreak management and preparedness, education, policy and procedures, audit and feedback, construction planning and auditing, and reporting outcomes.

1. **Infection Prevention and Control Programs should be staffed appropriately to meet the goals of the Program.**

   A Canadian expert panel developed a model to identify the human resources required to support an effective IPCP. The model recommends, as a minimum, three full time equivalent ICPs per 500 beds in acute care hospitals and one full time equivalent ICP per 150–250 beds in long-term care facilities.[235] This same recommendation was provided to the National Advisory Committee on SARS and Public Health by the Community and Hospital Infection Control Association Canada, 2003. The province of Quebec mandated one ICP per 133 beds in acute care and recommended a ratio of one ICP per 100 beds in acute care settings with specialized programs, e.g., transplants, burns, etc. as seen in tertiary-quaternary care centres.[236] Staffing requirements of IPCPs have been reviewed in the United States as well. The results of the Delphi project[94] recommended a ratio of 0.8–1.0 ICPs for every 100 occupied acute care beds. The authors noted that recommendations for infection prevention and control staffing and resources should not be made on the basis of bed size or patient

census alone; IPCP staff requirements must take into account the intricacies of the health care facility or program, the different types of settings within the program, the complexity of the patient population and the needs of the community and or facility.

The IPCP should be positioned within the organizational structure of the facility or agency so that the ICP has direct access to decision makers and the ability to implement critical infection control measures in a timely fashion. As recent experience with SARS has demonstrated, IPCP staffing must incorporate a reasonable surge capacity.

Table 5. Minimum Ratio of Infection Control Practitioners to Number of Beds

Standard/Group	Acute Care	Specialty Acute	LTC
Alliance/CHICA[235;237]	3:500		1:150-250
Quebec[236]	1:133	1:100	
Delphi[94]	0.8 to1.0:100		

In addition to the appropriate number of staff, ICPs must have basic training in infection prevention and control from a recognized course such as those available at the University of Calgary; Queen's University, Kingston; the University of British Columbia; and Centennial College, Toronto. A professional who has worked as an ICP for two years may qualify to write the certification examination in infection control offered by the Certification Board in Infection Control. Obtaining this certification within five years of entering the infection control profession is part of the ICP's professional standards.[238]

2. **Infection Prevention and Control Programs should have access to expert resources including an infectious disease physician and/or a medical microbiologist. These consultants should be reimbursed for their time and expertise.**

   Over two decades ago, the SENIC study identified a trained infection control physician as an essential component of an effective IPCP[10;11].

3. **To support the surveillance activities and to identify and manage outbreaks, Infection Prevention and Control Programs should have readily available access to microbiology and virology laboratory diagnostic services. This includes access to qualified reference laboratories that can provide timely molecular typing.**

   As well as helping to determine treatment options, the microbiology laboratory is pivotal in the detection, investigation and control of outbreaks of infection.[239] High volume laboratories can serve a reference function by tracking AROs and other events in both individual patients and in populations within different health care facilities or settings.[240] Examples are the molecular/genetic fingerprinting of MRSA,[241;242] and *C. difficile* isolates.

4. **An effective Infection Prevention and Control Program should collaborate and consult with internal (e.g., patient safety, quality assurance, reprocessing,**

occupational health) and external (e.g., other facilities and local, provincial/territorial and national health agencies) partners to ensure appropriate communication and sharing of information.

Collaboration and consultation between infection prevention and control and other health care disciplines or settings is a responsibility of IPCPs. Examples include, but are not limited to, working with occupational health to prevent the transmission of infectious diseases to staff who may in turn transmit to patients, health care workers or visitors[243] or with the reprocessing department to ensure standards are maintained for the cleaning, disinfection and sterilization of patient care equipment.[244-247]

5. **Health care organizations should ensure that surveillance of both infection prevention and control processes and outcomes related to health care associated infections is performed; analyzed appropriately; provided to front line staff, clinical leadership, and administrators; and used to monitor and improve related patient outcomes.**

   Surveillance is an essential component of any effective IPCP.[178] The effectiveness of reducing the number of nosocomial infections by providing feedback of surveillance data to key stakeholders is well documented.[177] A region-wide database is needed to identify and track health care associated infection trends such as *C. difficile* diarrhea, MRSA, and infections such as SARS among all health care settings, as patients move between health care facilities and health care settings. This type of surveillance, however, requires effective IPCPs that cooperate and communicate among the various settings and facilities to ensure there are standardized data collection, analysis, and interpretation methods so that the reported rates and estimated costs of HAIs are reliable.

   Surveillance should not be solely limited to an outcome. Identifying processes that influence the outcome and perhaps require improvement is one of the lessons learned from industrial applications. Process surveillance is required to link the final outcome with related processes.[178;248] An example within infection prevention and control would be to recognize the relationship of a process (timing of antibiotic prophylaxis) with the result (prevention of surgical site infection) as the timing directly influences surgical site infection rates.[201;249]

6. **Infection Prevention and Control Programs should conduct ongoing educational programs for health care providers (including volunteers, family members and students) to reinforce current standards of infection prevention and control practices, emphasizing the importance of hand hygiene.**

   Infection prevention and control programs should provide basic and continuing education to health care providers regarding principles of infection prevention and control[250;251] to help prevent the transmission of emerging infectious diseases such as SARS[252] and the re-emergence of infections such as *C. difficile.*[14] These programs should include comprehensive risk reduction strategies necessary to minimize the risk of HAIs to patients, staff and visitors.[92;253] Education is an important tool in ensuring

that health care personnel and visitors comply with IPCP policies. The importance of this compliance can be demonstrated by recognizing the failure to use basic infection control techniques such as appropriate hand washing[254;255] as the major factor for cross transmission in hospitals, including the dissemination of AROs.[13;140;256] Educational programs should be evaluated regularly and include auditing compliance of infection prevention and control measures with timely feedback for optimal improvement.

7. **Infection Prevention and Control Programs should have access to current infection control literature, textbooks, journals, standards and/or guidelines, in addition to Internet access.**

   Members of the IPCP require appropriate knowledge-based information to keep current with infection prevention and control literature, standards, and guidelines.

8. **Infection Prevention and Control Programs should have adequate office space and secretarial, data entry and computer support.**

   Secretarial support providing computer data entry; typing of minutes, documents and reports; answering telephones; and arranging meetings is essential for the IPCP.[6]

9. **Health care organizations should ensure that there is adequate nurse staffing with the appropriate skills to apply infection prevention and control measures when providing patient care. Other health care providers in all settings where health care is delivered (e.g. respiratory therapists, physiotherapists) should also have the skills to apply infection prevention and control measures when providing patient care.**

   The evidence[13;26;104;130-133;135;137-139;257-260] is consistent that deteriorating nursing care associated with understaffing results in negative patient outcomes and contributes to the risk of HAIs. This emphasizes the need not only for effective IPCPs, but also for adequate numbers of health care providers with the proper skill sets.

10. **Health care organizations should ensure that there is adequate housekeeping staff with the appropriate training to provide a clean and safe environment for patient care.**

    A 2004 study[261] demonstrated that high levels of cleaning played an important role in controlling a 14-month outbreak of *Acinetobacter baumannii* in an intensive care unit. The authors noted that failure to follow strict cleaning protocols resulted from problems recruiting, retaining and training cleaning staff and appeared to exacerbate the outbreak. The patient's right to be cared for in a clean, safe environment is irrefutable.[262;263] An integrated cleaning and monitoring program as well as basic training and regular updates for housekeeping staff are crucial components of an effective IPCP.[264;265] A new role of "clinical housekeeper" is emerging in the fight against HAIs.[266] This worker's main responsibility is to prevent the spread of infection through the cleaning of clinical equipment and the health care environment.[266]

7.0 Conclusion

Infection prevention and control programs are of demonstrated value in improving the quality and safety of health care and in reducing its costs. Effective IPCPs minimize the risk of infection in all health care settings and are important to the health and safety of Canadians and to the global community. However, in order for the IPCP to implement, monitor, and evaluate all the infection prevention and control interventions recommended, appropriate resources are required. The ultimate goal of the IPCP is to reduce HAIs to the lowest possible level. The resources must support this goal.

Infection prevention and control is a public health issue of great concern. Decision makers need to recognize the essential components of Canadian health care settings and thereby devote adequate resources to this end. It is a matter of protecting the health and safety of Canadians.

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