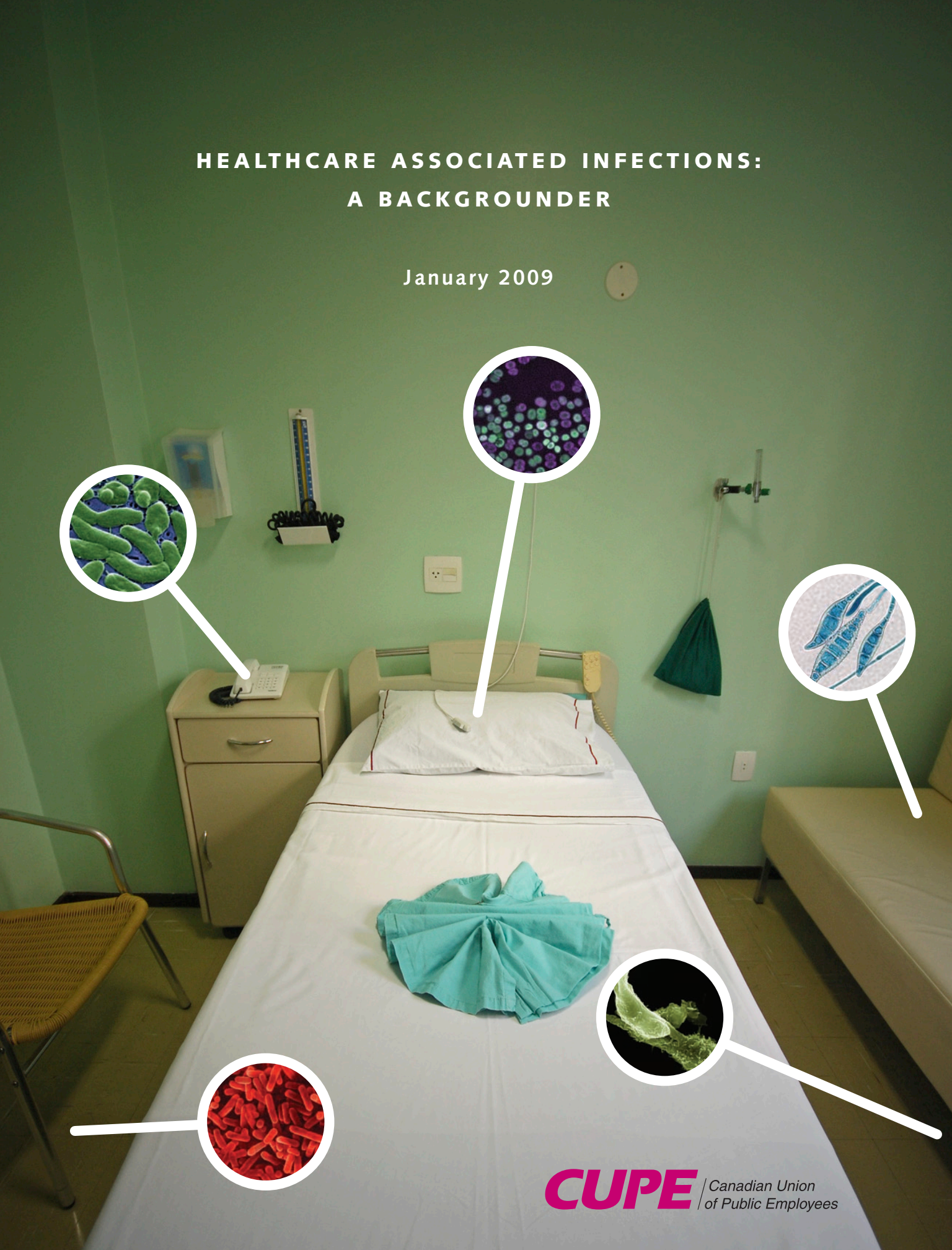
HEALTHCARE ASSOCIATED INFECTIONS: A BACKGROUNDER

January 2009



CUPE | Canadian Union of Public Employees

CONTENTS

Executive Summary

Healthcare associated infections develop in a patient as a result of their exposure to healthcare facilities or procedures. They include methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), *C. difficile* and other infections caused by bacteria and viruses encountered in healthcare facilities.

Rising infection rates are causing unnecessary suffering and death and are taxing the healthcare system as well as patients and families.

- Each year in Canada, more than 220,000 healthcare associated infections result in 8,500-12,000 deaths, and the rates are rising.
- One in nine hospital patients in Canada get a healthcare associated infection.
- Infections are the fourth leading cause of death in Canada.

The incidence of methicillin-resistant *Staphylococcus aureus* (MRSA) in Canadian hospitals increased 17-fold between 1995 and 2006. The rate of patients contracting *C. difficile* increased almost five-fold between 1991 and 2003. Outbreaks of other types of healthcare associated infections are also on the rise.

The direct costs of hospital acquired infections in Canada are estimated to be $1 billion annually. On top of that are costs borne by patients and volunteer caregivers as well as program costs for home and community care.

Much of the suffering and death caused by HAIs is needless. The Canadian Committee on Antibiotic Resistance estimates that at least 30 per cent of healthcare associated infections can be prevented.

Cleaning, laundry, and other support services are a vital element of infection prevention and control strategies. Pathogens such as *C. difficile*, VRE, MRSA, norovirus, influenza, and severe acute respiratory syndrome (SARS) associated coronavirus can survive in the healthcare environment for extended periods of time, even months. In fact, these infections are inherently well adapted to survive in dust and on floors, bedrails, telephones, call buttons, curtains and other surfaces. Washing hands is important, but if bacteria and viruses are not eliminated from the environment, hands will quickly become contaminated again.

“Breaking the chain of infection” requires well-resourced, well-trained, and stable in-house healthcare teams attacking all of the links of transmission; sufficient beds, equipment and staff to achieve best practice occupancy rates; modern high-quality infrastructure and equipment, and; standardized procedures, monitoring and public reporting.

Solution One: More healthcare cleaning and infection control staff, with proper training and continuity

- Hospital spending on support services in Canada fell from 26 per cent of total budgets in 1976 to 16 per cent in 2002. Most of those cuts applied to staffing, with cleaning departments taking a major hit.

- Clinical studies and audits have linked healthcare associated infection outbreaks with understaffing, increased workload, high turnover, and inadequate training.

- Hospitals in Canada and Europe have demonstrated that investment in more cleaning and infection control staff, training and workforce stability has brought infection rates down.

Solution Two: More rigorous cleaning and proper supplies

- Studies and guidelines from infection control specialists recommend intensive cleaning with proper materials to eradicate healthcare associated infections.

Solution Three: Stop and reverse contracting-out

- Contracting-out leads to cuts in staff, lower wages, fewer benefits, higher turnover rates, less training, and a rift between clinical and support services. High turnover, poor training, and the breakdown in team work are factors in HAI outbreaks.

- Investigations into HAIs in the United Kingdom have found that infection rates spiked after contracting-out and cuts in hospital support services. Scotland and Wales have decided to halt and reverse the privatization of hospital cleaning as part of aggressive campaigns against HAIs.

Solution Four: Reduce occupancy rates

- Overcrowding and rapid turnover between patients seriously hamper infection control procedures and are a major factor in infection outbreaks.

- Across Canada, hospital beds were cut by 36 per cent between 1998 and 2002, and bed occupancy reached 95 per cent by 2005.

- The Netherlands, which has one of the lowest rates of MRSA, had a bed-occupancy rate of 64 per cent in 2005.

Solution Five: Mandatory standards, monitoring and public reporting

- Healthcare facilities should adopt strict microbiological standards to replace the current standard that rooms and equipment “appear clean.” In a UK study,

researchers found that 90 per cent of the wards that had been declared clean in a visual assessment were shown by microbiological testing to have an unacceptable load of microorganisms.

- Mandatory public reporting of healthcare associated infection rates and deaths by healthcare facilities and by departments are also necessary to improve transparency and accountability.

What are healthcare associated infections, and how common are they?

Healthcare associated infections (also called nosocomial infections or hospital acquired infections) develop in a patient as a result of their exposure to healthcare facilities or procedures.[1] Healthcare associated infections are caused by bacteria (e.g. *Staphylococcus*) and viruses (e.g. noroviruses). They are an increasing threat to patient safety in Canada,[2] especially those difficult-to-treat organisms that are resistant to antibiotics (e.g. MRSA, VRE, and CDAD).[3] The most serious and deadly healthcare associated infections (HAIs) are bloodstream infections, pneumonia, gastrointestinal tract infections, infections involving more than one site, skin and soft-tissue infections, and surgical site infections.[4] Other common types of HAIs are urinary tract infections and catheter-related local infections.

Canadians suffer more than 220,000 healthcare associated infections annually, and HAI rates are on the rise. One in nine hospital patients in Canada gets a healthcare associated infection that may force a longer stay, cause greater pain, or even death.[5]

The Canadian Nosocomial Infection Surveillance Program (CNISP) that has monitored healthcare associated infections since 1995[6] reports that rates of methicillin-resistant *Staphylococcus aureus* (MRSA) in Canadian hospitals have increased more than 17-fold from 1995 to 2006.[7] MRSA commonly causes skin, lung, surgical site, and bloodstream infections that are very difficult to treat.[8] Similarly, the CNISP reported that the incidence of infections caused by vancomycin-resistant *Enterococcus* (VRE), which can survive for weeks on surfaces and be transferred by touch, more than tripled between 1999 and 2006.[9]

The incidence and severity of *C. difficile* associated infections has also risen over the past ten years, with more patients dying or experiencing serious illnesses resulting from *C. difficile*.
C difficile is highly infectious and can be spread from person-to-person or via the healthcare environment. *C. difficile* is very hardy and can live on toilets, floors, sheets, and other surfaces for months if not eradicated with special cleaning procedures.[10] The rate of patients contracting *C. difficile associated infections*, the chief cause of healthcare associated diarrhea,[11] increased almost five-fold in Canada from 3.6 cases per 10,000 admissions in 1991 to 15.6 per 10,000 in 2003.[12] In the United Kingdom (UK), the

number of deaths involving *C. difficile* recently increased 72 per cent between 2005 and 2006—from 3,757 to 6,480 respectively.[13]

A. baumannii antibiotic resistant infections, which cause healthcare associated bloodstream, urinary tract, and wound infections, have been reported worldwide and are also becoming increasingly resistant to commonly prescribed antibiotics.[14]

Likewise, reports of the persistence and transmission of Norovirus in healthcare facilities—particularly affecting seniors in long term care facilities—have increased dramatically over the past ten years. In British Columbia, norovirus (NV) related gastroenteritis outbreaks in 2007 were more than double those reported in 2002.[15]

If more isn't done to eliminate these "superbugs" from our healthcare facilities, the rates of HAIs will continue to rise exponentially.[16]

How do HAIs affect us?

HAIs are imposing avoidable suffering on patients and residents and their families as well as extra costs on the healthcare system and the wider economy.[17] When patients get an infection, they experience increased morbidity (i.e. disease), increased risk of death, and longer hospital stays. Infections mean extra treatments, lab tests, medications, isolation supplies, cleaning, laundry, and nursing and physician care, all of which tie up scarce healthcare resources.[18]

Increased suffering and death

There have been numerous studies worldwide on the increased mortality associated with HAIs. In Canada, researchers estimate that healthcare associated infections are linked to between 8,500 and 12,000 deaths per year.[19] This makes healthcare associated infections the fourth leading cause of death for Canadians (behind cancer, heart disease and stroke), up from the top eleven causes two decades ago.[20]

The United States Centres for Disease Control and Prevention considers HAIs one of the top ten causes of death in the US.[21] The UK Health Protection Agency found that patients with a healthcare associated infection were 7.1 times more likely to die than uninfected patients.[22]

In Québec, where C. *difficile* infections increased to record high rates of 15 per 10,000 patient days, an estimated 2,000 elderly patients were killed by *C. difficile* related infections between 2003 and 2004.[23] In an Ontario study, the mortality rate of *A. baumannii* infected patients (24 per cent) on a burn unit was twice that of non-infected patients (12 per cent).[24] In Calgary, Alberta, intensive care unit (ICU) patients who acquired a bloodstream infection were 2.64 times more likely to die.[25] In the US, bloodstream infection due to MRSA has been associated with mortality rates of 15 to 60

per cent.[26] The SARS (Severe Acute Respiratory Syndrome) epidemic, which resulted in 44 Canadian deaths, showed what devastating impact infection outbreaks can have on patients and the healthcare system.[27]

Increased strain on our healthcare system

Healthcare associated infections not only increase patient suffering and cause preventable deaths; they also place an avoidable burden on healthcare workers and the healthcare system.[28] Numerous studies have conclusively shown that healthcare associated infections substantially increase patients' length of stay in hospital and increase healthcare spending, both in hospital and after discharge.

In the UK, researchers found that after adjusting for other factors that might influence length of stay, patients with a healthcare associated infection, compared to uninfected patients, on average:

- stayed in hospital 11 days longer
- incurred 2.9 times greater hospital costs, and
- incurred 3.2 greater post-discharge costs.[29]

A report by Cambridge University Hospitals reported that "*C. difficile* diarrhea can delay a patient's discharge from hospital by up to three weeks."[30]

A survey of Canadian hospitals (reported in 2000) estimated the direct costs of hospital acquired infections in Canada to be approximately $1 billion annually.[31] In 2007, MRSA alone was estimated to be costing Canada's healthcare system $200-250 million per year.[32]

Estimates of the cost per patient in hospital vary by type of infection and hospital department:

- A survey of Canadian hospitals found that managing the care of a patient infected with MRSA cost between $16,836 and $35,000 (2004 dollars).[33]

- In 2007, British Columbia health authority officials estimated that seven percent of all patients infected with *C. difficile* are readmitted to hospital, requiring an additional 13.6 days of hospital care, costing an extra $18,000 or more each ($900 per day plus an additional $5,800 in treatment costs). In 2002/2003, the Vancouver Coastal Health Authority spent over $3 million treating 2,526 readmitted patients with *C. difficile*[34]

- In Calgary, Alberta, researchers found that ICU acquired bloodstream infections cost an extra $25,144 per patient.

The costs of healthcare associated infections are now being compounded by lawsuits on behalf of patients who have suffered or died from HAIs. In Ontario, there is a $50 million lawsuit arising from the 20-month Joseph Brant outbreak in Burlington in which 91 patients infected with *C. difficile* died.[35] Patients and family members in Quebec are similarly seeking $10 million compensation from the hospital for the suffering and death of patients infected during an outbreak of *C. difficile* at Honoré-Mercier hospital near Montreal.[36]

The cost of HAIs extends beyond the hospital. There are costs borne by home and community care services as well as by individual patients and their families. After discharge, patients with HAIs (compared to uninfected patients) have significantly higher personal medical costs, more visits from community nurses, greater reliance on hospital outpatient and emergency services, and more visits to their family doctor.[37]

The benefits of preventing HAIs far outweigh the costs of treating them.[38]

Hospitals in the Netherlands have maintained low levels of MRSA infections (approximately one percent) because of their "search and destroy" strategy. The "search and destroy" approach includes screening, isolation cohorting[39], decolonization of MRSA infected patients[40], education of healthcare workers, daily disinfection of rooms and the healthcare environment.[41] While it can be argued that the "search and destroy" approach is costly because it is very labour intensive, recent economic analysis of the approach revealed that the "search and destroy" policy was cheaper to implement than the cost of treating MRSA infections.[42]

The added and avoidable strain that HAIs place on the healthcare system is happening at a time when staff is in short supply and the healthcare system is under pressure.

Breaking the chain of infection: the role of cleaning

Much of the suffering and death caused by HAIs is needless. The Canadian Committee on Antibiotic Resistance estimates that following infection prevention and control strategies could prevent at least 30 per cent of healthcare associated infections.[43]

Health employers have attempted to stem the tide of healthcare associated infections by focusing primarily on one strategy: hand washing. Hand hygiene is inarguably crucial to infection control and prevention.[44] Cleaning is equally important but has received far less attention and resources; in fact, cleaning budgets across Canada have been cut, and cleaning services in many facilities have been contracted-out.

Infection control specialists agree that one strategy alone cannot win the battle against HAIs: "the evidence supports the effectiveness of multifaceted interventions."[45]

Outbreaks of healthcare associated infections occur when there is 1) a susceptible host, 2) a source of microorganisms, and 3) a means of transmission.[46] In healthcare settings filled with sick patients and frail residents, there are many susceptible hosts. Infection prevention and control must therefore focus on eradicating the source of the microorganisms from the environment and preventing any means of transmission.[47] To understand how this can be done, we need to first understand where infectious pathogens live and how they spread.

Where do infectious pathogens live?

The healthcare environment can become highly contaminated with nosocomial pathogens that are able to survive for long periods of time - on bedrails, telephones, call buttons, taps, door handles, mattresses, chairs, floors, and other surfaces, as well as in the air and in dust. Patients and healthcare workers can and do acquire HAIs directly from the healthcare environment.[48] Pathogens such as *C. difficile*, VRE, MRSA, norovirus, influenza virus, and severe acute respiratory syndrome (SARS) associated coronavirus can survive in the healthcare environment for extended periods of time – some for weeks and even months.[49] "One characteristic that connects [MRSA, *C. difficile*, VRE, and *Acinetobacter* spp. and Norovirus] is that they are inherently well adapted to survive in the healthcare environment, in dust, on floors, or on surfaces frequently touched by hand, long enough to be transmitted to cause infection."[50]

MRSA has been recovered from every side room, ward bay, and bathroom occupied by patients colonized with MRSA. More shocking, MRSA was recovered from 50 per cent of sites in bathrooms of non-MRSA patients.[51] High levels of contamination have also been found underneath beds.[52] Although floors are not usually touched by hands, researchers have shown that MRSA, carried on dust particles on floors and bedsheets, has been found in the respirable range.[53]

Bedside curtains - one of the least frequently cleaned items in a healthcare facility - are a potential reservoir of infectious pathogens[54] and a hazard in the transmission of superbugs in healthcare facilities.[55] A recent US study found that 42 per cent of curtains were contaminated with VRE, 22 percent with MRSA, and four percent with *C. difficile* and that after touching MRSA, VRE, or *C. difficile* contaminated curtains, respectively 45 per cent, 20 per cent and 100 per cent of hand print cultures were positive.[56]

Studies of VRE and *C. difficile* contamination have also found abundant evidence of the contamination of the environment by infected patients.[57] Prior to cleaning, 100 per cent of the rooms occupied by patients with *C. difficile* had positive environmental cultures. In rooms occupied by patients infected with VRE, 94 per cent had one or more positive cultures.[58] Researchers have found that VRE transfers relatively efficiently from environmental surfaces compared to body surfaces, reinforcing the potential role of environmental surfaces as reservoirs of infectious microorganisms.[59] A study of a SARS

outbreak in Taiwan also determined that environmental contamination was likely responsible for the infection of six healthcare workers who developed SARS without having had any direct contact with a SARS patient.[60]

Researchers appear to have only scratched the surface in identifying the reservoirs of infectious pathogens. While many have studied patient rooms, equipment, wards, and operating rooms, others have recently identified pathogens on MRI machines and worn and torn fabrics in MRI suites.[61] Dirty ambulances have also raised serious concerns.[62]

How do infectious pathogens spread?

The National Institute for Occupational Safety and Health has identified five factors that make it easier for infectious microorganisms to be transmitted, referred to as the "5 C's."[63]

5 C's	Factors contributing to the 5 C's[64]
• Crowding	• high bed occupancy
• Contact	• high bed occupancy • lack of private rooms (for isolation)
• Compromised skin (i.e., cuts or abrasions)	• open (i.e. uncovered) wounds
• Contaminated items and surfaces	• insufficient front-line and professional healthcare staff for the workload • worn-out facilities & fabrics • lack of patient-designated equipment
• lack of Cleanliness	• insufficient front-line and professional healthcare staff for the workload • lack of commitment and priority given to infection control and prevention

A review of the causes of a deadly outbreak of *C. difficile* at an Ontario hospital by infectious disease expert Dr. Michael Gardam revealed that several of these factors contributed to the outbreak: lack of cleanliness - the number of cleaning staff had been cut back and cleaning staff had too many duties, hence cleaning procedures were not followed; overcrowding - the bed occupancy was so high that some patients were treated in the hallway; and a contaminated environment - because of overcrowding, some patients shared space with dirty equipment that would normally be housed in a dirty-utility storage room.[65]

Investigations into healthcare associated infection outbreaks in the UK also cited these factors: poor leadership, inadequate teamwork, the use of temporary staff, lack of clarity and priority about infection control responsibilities, and staff being too rushed to take basic precautions such as washing hands and cleaning equipment properly.[66]

Solutions for preventing and controlling HAIs

"Breaking the chain of infection"[67] requires well-resourced, well-trained, and stable in-house healthcare teams attacking all of the links of transmission. Well-resourced means enough staff and equipment to do the job, with proper supplies; well-trained means that all staff follows the best practices in infection control; a stable in-house team means that all of the healthcare employees work together under a dedicated organizational leadership with minimal turnover and no outsourcing.

It is also important that healthcare facilities have sufficient beds, equipment, and staff to achieve best practice target occupancy rates and that the healthcare infrastructure and equipment be in good condition.

In addition, tackling HAIs effectively requires standardized procedures and performance measures and a government system for monitoring and public reporting.

Solution: Well-staffed, well-trained and stable teams

Healthcare cleaning has been devalued and underfunded, and lapses in hygiene standards have contributed to the rise in HAIs.[68] Without a clean environment, other measures such as screening and hand washing are futile.[69] Only recently has cleaning begun to gain attention, with enhanced cleaning seen a key factor in preventing and terminating infection outbreaks.[70]

Cleaning budgets and staffing have been cut across Canada. The Canadian Institute for Health Information reports that hospital spending on support services – of which cleaning is a major category - dropped from 26 per cent of expenditures in 1976-77 to 16 per cent in 2002-03.[71] Hospital cleaning specifically was cut by an average of 1.8 per cent per year in that time period.[72] Staff costs account for 93 per cent of hospital cleaning budgets[73], so when cleaning budgets are cut, staff is cut.

Meanwhile, workload has gone up with higher patient turnover (as lengths of stay in hospital decrease) and as demand for "isolation" and other forms of cleaning increase with rising HAI rates.[74]

Several clinical studies and audits have linked healthcare associated infection outbreaks with understaffing, increased workload, high levels of absence, and high turnover.[75] A number of studies have also linked increases in HAIs and worsening in patient outcomes with increased reliance on temporary workers, inadequate training and poor supervision of cleaning staff.[76] Below is just a sample of recent reports.

- The coroner investigating deaths of Québec hospital patients from *C. difficile associated infections* in 2006 determined that "the way to avoid an outbreak is to prioritize cleanliness and hygienic measures in every facility."[77] The coroner

found that the hospital was only able to control the outbreak after providing additional infection prevention training and adding 10 new cleaners to the staff.[78]

- A 14-month outbreak of *Acinetobacter baumannii* (*A. baumannii*) on an ICU in the UK ended after additional cleaning staff were hired to make sure that all bed spaces were completely cleaned between patient admissions.[79]

- In a survey of 74 hospitals, the Auditor General of Scotland suggested that cleaning quality was likely compromised because of lack of time and coverage by relief staff unfamiliar with the facility.[80]

- St. Michael's Hospital in Toronto achieved a 60 percent decrease in MRSA after implementing increased environmental cleaning.[81]

- *C. difficile* outbreaks in two British Columbia health authorities were brought under control with enhanced cleaning and an integrated infection control plan.[82]

- A program of enhanced environmental cleaning and improved hygiene helped significantly decrease the number of cases in a UK 1000-bed teaching hospital.[83]

- The University of Pittsburgh hospital was able to reduce its *C. difficile* infections by 50 per cent after instituting stringent cleaning procedures as well as other infection control measures.[84]

Solution: More rigorous cleaning and proper supplies

Researchers and infection control experts are calling for more rigorous cleaning protocol and for procedures and materials tailored to the different infectious pathogens. Without thorough cleaning, in fact, some procedures simply spread the pathogens. Fawley and colleagues found that some detergent-based cleaning procedures without adequate disinfection can actually increase contamination of the environment.[85]

Recent studies have recommended more intensive cleaning and the use of particular disinfectants and cleaning materials:

- In one case study, MRSA was significantly reduced on geriatric wards of a Japanese hospital after floors were mopped daily (twice daily in ill patients' rooms) and then disinfected with 0.1 percent benzalkonium chloride solution.[86]

- Norovirus outbreaks have only been conquered with "intensive cleaning using measures such as double-strength chlorine-based detergents."[87]

- The Ontario Provincial Infectious Disease Advisory Committee (PIDAC) recommends that "if the patient has or is suspected of having *C. difficile*, hospitals should clean all horizontal surfaces in the patient's room and all items within reach of patients twice daily with a hospital-grade disinfectant. Staff should pay particular attention to cleaning frequently touched areas such as bed side-rails, telephones, and toilets. Hospitals should develop and use a checklist twice daily to monitor the cleaning."[88]

- A United States study concluded that routine cleaning (using phenolic disinfectant) was not enough to eradicate VRE. It took a more thorough four-hour cleaning protocol to eliminate VRE from the ICU.[89]

- Williams and colleagues have been conducting studies into the ability of different types of surface wipes to eliminate HAIs from the environment. They recommend that wipes should only be used for small areas and should never be re-used or used on consecutive areas because they can transfer infectious pathogens.[90]

Solution: Stop and reverse contracting-out

While understaffing of cleaning departments has been a chronic problem since the 1990s across Canada and is now increasingly recognized as a factor in HAIs, contracting-out is a newer phenomenon whose contributing role is documented but largely ignored.

The evidence is clear: contracting-out leads to cuts in staff, lower wages, fewer benefits, higher turnover rates, less training, and a rift between clinical and support services.[91]

At the root of the problem, private for-profit cleaning companies face a conflict of interest between profits and hygiene standards.[92] Privatization by its very nature is about squeezing budgets to increase profits. When the work is very labour-intensive, as it is with healthcare cleaning, investors can only make a profit if they cut staff and their wages and conditions.

Contracting-out is frequently associated with inadequate training and high turnover due to poor wages and benefits. Contracted-out employees receive fewer hours of training and orientation than do in-house employees. The problem of poorly trained staff is compounded by high turnover. With fewer experienced staff in place, new hires have no one to mentor them or turn to if they are uncertain about some aspect of their job.[93]

When healthcare facilities in British Columbia contracted-out roughly 8,500 healthcare jobs between 2003 and 2005, wages were cut by 40 per cent, pensions and benefits were eliminated, and team-based care broke down.[94] Contracting out led to a breakdown in teamwork, which is an essential determinant of high quality care in healthcare facilities. When cleaners are part of the healthcare team, they are able to respond to nursing and

patient requests for extra help. When cleaners were contracted out at St. Paul's hospital in British Columbia, they were not allowed to talk with patients or to ask nursing staff for help.[95] In some facilities, nurses were prohibited from speaking directly with cleaners, having to call an external number to register spills, for example.

In 2007, the Auditor General of British Columbia reported that the contracting-out of cleaning at BC's Children's and Women's Hospitals "was initially acceptable, but that it began to slip when the cleaning staff continually changed."[96]

Another harmful practice associated with contracting-out is reduced spending on supplies. Cleaners working for private cleaning firms in BC hospitals reported having to use only one pair of disposable gloves per shift.[97] UNISON cleaners in the UK report similar problems.[98]

The cost-cutting tactics of contractors are HAI risk factors. Investigations into outbreaks of HAIs in the UK found that spiking infection rates followed contracting-out and cuts in hospital support services. The Auditor General of Scotland found in a 2003 review of 74 hospitals that hospitals with contracted-out cleaning, compared to those with in-house cleaning, had fewer cleaning hours, less monitoring and supervision, greater use of relief staff, and lower scores on cleanliness.[99]

After 15 years of experimenting with contracting-out in Britain, the number of cleaning staff in hospitals dropped from nearly 100,000 to 55,000.[100] The outbreak of infectious diseases and concerns over dirty hospitals became a major pubic policy issue[101], resulting in dramatic increase in spending on hospital cleaning and in some jurisdictions, the end of contracting-out.[102]

- The Scottish government announced in October 2008 that it will halt and reverse the privatization of hospital cleaning over the next three years as part of an aggressive campaign against HAIs. In a nationwide letter to hospital chief executives, the Scottish Health Secretary wrote, "The provision of... services such as cleaning and catering play a key role in the delivery of clinical services … The Scottish government believes that NHS Scotland should therefore be responsible for the direct delivery of these services wherever possible."[103]
- In July 2008, the Welsh Labour government announced that it would end contracting out of hospital cleaning and bring cleaning staff back in-house.[104]
- The vast majority of services in Northern Ireland have stayed in-house.[105]

Other jurisdictions are also questioning the wisdom of contracting-out in the context of infectious disease outbreaks. Following the SARS outbreak in Taiwan, the Director of their Center for Disease Control recommended that hospitals bring all cleaning services back in-house, saying that "the SARS outbreak has revealed the impropriety of hospitals outsourcing jobs…these nursing aides, cleaners and laundry workers were not the

hospitals' formal employees. The hospitals, therefore, could not efficiently manage these workers."[106]

Proponents of contracting-out of healthcare cleaning use faulty comparisons with "hotel" services to justify privatization. Research has demonstrated that the level of skills, responsibilities and working conditions of healthcare support workers are significantly different from those of workers in the hotel sector.[107] Nowhere is this truer than in hospital cleaning departments. The undermining of cleaners' credentials is a common precursor to privatization campaigns.

Solution: Reduce occupancy rates

High bed occupancy and patient turnover rates are significant contributors to breakdowns in infection control practices[108]. Overcrowding, rapid turnover between patients, and overworked healthcare staff seriously hamper infection control procedures, risking severe infection outbreaks.[109]

Current policies promoting higher patient turnover have resulted in many hospitals working at near or full capacity.[110] The Organisation for Economic Co-operation and Development (OECD) reported that "the average occupancy rate of acute care beds in OECD countries was 75% in 2005, slightly above the 1990 level. This average hides considerable cross-country variations … Canada, Norway, Switzerland, Ireland and the United Kingdom - all of which display acute care beds per capita below the OECD average - had the highest occupancy rates (at around 85% or more). In all these countries, occupancy rates have increased and acute care beds have decreased over time."[111] In comparison, the Netherlands, which has one of the lowest rates of MRSA, had a bed-occupancy rate of 64 per cent in 2005.

In Canada, steady cuts to hospital beds are at the root of the problem. Across Canada, hospital beds were cut by 36 per cent from 1998 to 2002.[112] Bed occupancy averaged 95 per cent in 2005.[113]

Research shows that high bed occupancy contributes to the spread of HAIs:

- The UK Department of Health found that high bed occupancy rates and movement of patients are associated with the spread of HAIs.[114]

- A study of MRSA rates and UK bed occupancy levels for the period 2001-04 found that "hospitals with occupancy levels of 90% or over can expect a 10.3% higher MRSA rate, compared to trusts with an occupancy level of 85% or below."[115]

- In another study of the rate of MRSA infection in English hospitals, it was found that 70 per cent of the trusts exceeded the recommended 82 per cent bed occupancy and that there was a relationship between occupancy rate, turnover intervals and rate of MRSA infection.[116]

- A national study of UK deaths following MRSA infections identified high bed occupancy as a key factor affecting patient care, alongside high patient/nurse ratios, inadequate ward cleaning, and lack of isolation facilities.[117]

- A study of MRSA rates and bed occupancy levels at St Luke's Hospital, Malta, found a significant positive correlation between new cases of MRSA infections and overall levels of bed occupancy.[118]

Solution: Mandatory standards, monitoring and public reporting

Both the monitoring and reporting regimes for HAIs in Canada fall far short of what is needed to ensure transparency, accountability and effectiveness in fighting HAIs.

Current standards for healthcare cleaning in Canada are that rooms and equipment "appear clean"[119]. Research shows that visual assessments of cleanliness are poor indicators of cleaning efficacy.[120] In a UK study, researchers found that 90 per cent of the wards that had been declared clean in a visual assessment were, when microbiologically tested, found to have an unacceptable load of microorganisms.[121]

Although visual inspections should be used as the first stage in an integrated infection control monitoring program, there is growing recognition that a visual inspection will not detect microbial contamination. A recent report on the prevention and control of HAIs published by the Ontario Auditor General recommended "that new technologies for monitoring cleanliness in hospitals should be evaluated, with a focus on surfaces that are often touched by hospital staff, patients and others"[122]

To assess clinical surface hygiene, Dr. Stephanie Dancer from the Scottish Centre for Infection and Environmental Health recommends that hospitals adopt microbiological standards similar to those already used for food preparation surfaces.[123] Using a standardized measure of cleaning efficacy, infection control personnel could better assess infection risks to patients/residents and staff, and cleaning staff could clean more effectively.

Standards for other hospital services are also required. Healthcare laundry processing needs strict time/temperature requirements to prevent and control HAIs.[124]

Mandatory public reporting of healthcare associated infection rates and deaths by healthcare facilities and by departments are necessary to improve transparency and accountability. Standardized measures and data on outcomes would enable local, provincial and pan-Canadian audits as well as comparisons of hygiene in healthcare facilities. To build public confidence in our healthcare facilities, comprehensive information should be made public on a regular basis.[125]

Pan-Canadian HAI monitoring and reporting is weak. The federal government's current efforts to even track these infections are insufficient and reportedly crumbling due to lack of investment and leadership.[126]

Summary

We need coordinated, multifaceted infection control strategies that include all healthcare staff. Beyond the focus on hand hygiene, these strategies must emphasize cleaning, laundry, sterilization and other support services that are vital to preventing and controlling infection outbreaks.

"Breaking the chain of infection" requires well-resourced, well-trained, and stable in-house healthcare teams attacking all of the links of transmission; sufficient beds, equipment and staff to achieve best practice occupancy rates; modern high-quality infrastructure and equipment, and; standardized procedures, monitoring and public reporting.

The problem is not a lack of information on how to prevent and control infections; there is a wealth of evidence and recommended practices. The problem is that governments and health authorities have shown a lack of will and provided inadequate funding for the fundamentals of cleaning and infection control.[127] Many are also determined to contract out services, despite clear evidence that this hampers infection control and contributes to deadly outbreaks.

Some jurisdictions in Europe have recognized that cleaning and other support services are critical to battling HAIs and have moved to lower bed occupancy, higher staffing levels, stringent standards and public reporting, and a ban on contracting out. Canadian governments should follow their lead.

Abbreviations

A. baumannii	*Acinetobacter baumannii*
CDAD	*clostridium difficile* associated disease
C. difficile	*clostridium difficile*
HAIs	healthcare associated infections
MRSA	methicillin-resistant *Staphylococcus aureus*
NI	nosocomial infections
NV	noroviruses
SARS	Severe Acute Respiratory Syndrome
spp.	species
UTI	urinary tract infection
VRE	vancomycin-resistant *Enterococcus*

Information on the key micro-organisms causing healthcare associated infections

Acinetobacter species
There are at least 25 different *Acinetobacter* species, though it is primarily *Acinetobacter baumannii (A. baumannii)* that cause infections, such as wound infections, urinary tract infections, pneumonia, and blood stream infections in healthcare patients. These HAIs are often resistant to antibiotics.

Clostridium difficile (*C. difficile* or clostridium *difficile* associated disease, CDAD): "A bacterium that is one of the most common causes of infection of the large bowel (colon)…*C. difficile* is now recognized as the chief cause of nosocomial (hospital-acquired) diarrhea."[128] *C. difficile* is able to persist in the environment—on hospital cart handles, bed rails and telephones, etc.—for months.[129] In addition, *C. difficile* spores are resistant to a number of chemicals and therefore are difficult to kill, requiring special cleaning procedures.[130]

Extended-Spectrum Beta-Lactamase (ESBL) producing *Escherichia coli*
ESBL-producing *E. coli* are strains of *E. coli* that are resistant to antibiotics. *E. coli* is one of the most common bacteria causing infections in people. Infections (most often urinary tract infections) can sometimes progress to cause more serious life threatening infections such as blood stream infections (blood poisoning).[131]

Healthcare Associated Infection
A healthcare associated infection (HAI) is "an infection that occurs in the period beginning more than 48 to 72 hours after admission to within 10 days following discharge."[132]

Methicillin-resistant *Staphylococcus aureus*
Staphylococcus aureus, also called "staph," can live harmlessly on the skin or in the nose of healthy people[133] and can live on surfaces for months.[134] But "staph" that becomes resistant to the antibiotic methicillin—methicillin-resistant *Staphylococcus aureus* or MRSA—can cause a wide range of infections from minor skin infections to severe surgical wound infections and bloodstream infections (bacteraemia), and in some cases, death.[135]

Norovirus
Noroviruses are a group of viruses that are the most common cause of gastroenteritis. The symptoms can include the sudden onset of nausea followed by projectile vomiting and watery diarrhea. Norovirus spreads very easily from one person to another and can be transmitted by contact with infected individuals, by consuming contaminated food or water, or by contact with contaminated surfaces or objects. The virus can survive in the environment for several days.[136]

Severe Acute Respiratory Syndrome (SARS)

SARS is a droplet-spread viral illness that in 2002, spread across the globe over the course of several weeks. The virus can live up to three days in the environment, on walls and plastic surfaces.[137] Approximately 8,500 people worldwide were diagnosed with SARS during the 2002 epidemic and over 900 people died. Canada was hard hit by the SARS epidemic—by August 2003, there had been 438 probable cases of SARS, including 44 deaths.[138]

Vancomycin-Resistant *Enterococcus* (VRE)

Vancomycin-Resistant *Enterococcus* or VRE is a group of bacterial species that are resistant to the antibiotic Vancomycin. VREs are especially dangerous to patients and residents with compromised immune systems. Vancomycin-resistant *enterococci* can live on dry environmental surfaces for up to 4 months[139] and on hands for several hours.[140] VRE bacteria can be killed with disinfectants as long as the bacteria are in contact with the disinfectant long enough.[141]

*Summary: How healthcare associated infection outbreaks occur and **how** to "Break the Chain of Infection"*[142]

The link	How infection outbreaks occur	How to break the link
1. Agent	• microorganisms like bacteria (MRSA) or viruses (noroviruses) that are able to cause infections and sometimes death	• eliminate infectious agents—clean, disinfect and sterilize the healthcare environment and equipment
2. Reservoir	• the place where the infectious organism lives and reproduces and can then be transmitted—a person, animal, insect, water, soil, etc.	• test (screen) patients to determine who is infected • isolate infected patients—have enough beds, private rooms, equipment and healthcare staff • clean, disinfect and sterilize the healthcare environment and equipment • regularly check the environment is microbiologically clean
3. Portal of Exit	• how the infectious microorganism leaves its host reservoir—blood, respiratory tract, gastrointestinal tract, skin and mucous membrane, etc.	• cover open wounds • provide infected patients with their own room/equipment (e.g. their own bathroom) • wear personal protective equipment (i.e. protective gowns, masks, gloves, etc. when needed) • don't visit or work if you are sick
4. Mode of Transmission	• how the infectious agent transfers from its reservoir to another host—physical contact (touching), contaminated environment, air droplets, shared contaminated equipment, etc.	• clean, disinfect and sterilize environment and equipment • wash hands • wear personal protective equipment
5. Portal of Entry	• how the infectious microorganism infects a person—same as the portals of exit (i.e. blood, skin, gastrointestinal tract, etc.)	• wear personal protective equipment • cover wounds
6. Susceptible Host	• a person who doesn't have the needed immune resistance to the infectious microorganism—the very young, very old, very sick, immune compromised, etc.	• protect patients by keeping the environment and equipment clean & disinfected

*sc/cope491

Endnotes

[1] Provincial Infection Control Network - BC (PICNet) (2006). *An Assessment of Infection Control Activities Across the Province of British Columbia* (Corrected v1.0-2007). Accessed October 19, 2008 at http://picnetbc.ca//sites/picnetbc2/files/PICNet_Publications/PICNet_Needs_Assessment_Part_1_Corrected_final_2.pdf

[2] Simor, A. E., Ofner-Agostini, M., Bryce, E., Green, K., McGeer, A., Mulvey, M., Paton, S. and the Canadian Nosocomial Infection Surveillance Program, Health Canada (2001). "The evolution of methicillin-resistant *Staphylococcus aureus* in Canadian hospitals: 5 years of national surveillance." *Canadian Medical Association Journal* Vol. 165(1):21-26.

[3] The "superbugs" most frequently associated with HAIs include: methicillin-resistant *Staphylococcus aureus, (*MRSA); vancomycin-resistant *Enterococcus* (VRE); clostridium *difficile* associated disease (CDAD), and *Acinetobacter baumannii* or *A. baumannii*. For additional information on bacteria and viruses causing HAIs, see the "*Information on the key micro-organisms causing health care associated infections*" in this backgrounder.

[4] Fabbro-Peray, P., Sotto, A., Defez, C., Cazaban, M., Molinari, L., Pinède, M., Mahamat, A., and Daurès, J.P. (2007). "Mortality attributable to nosocomial infection: A cohort of patients with and without nosocomial infection in a French University Hospital." *Infection Control and Hospital Epidemiology* Vol. 28(3):265-272; Health Protection Agency (2007 October). *Surveillance of Healthcare Associated Infections Report 2007.* Accessed September 15, 2008 at http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1196942166935?p=1158945066450

[5] Zoutman, D.E., Ford B.D., Bryce E., Gourdeau M., Hébert G., Henderson E., Paton S. and the Canadian Hospital Epidemiology Committee; Canadian Nosocomial Infection Surveillance Program; Health Canada. (2003 Aug). "The state of infection surveillance and control in Canadian acute care hospitals." *American Journal of Infection Control* Vol. 31(5):266-72. Accessed September 25, 2008 at http://www.phac-aspc.gc.ca/nois-sinp/pdf/inf_surv-eng.pdf

[6] Eggertson, L. (2007 May). "Hospitals to report *C. difficile* and MRSA." *CMAJ* Vol. 176(10):1402-1403.

[7] National Statistics (2008 February). "Reported deaths involving *Clostridium difficile* rise by 72 per cent." *Heath Statistics Quarterly* Spring 2008. Accessed September 17, 2008 at http://www.statistics.gov.uk/pdfdir/mrsa0208.pdf ; Ofner-Agostini, M., Varia, M., Johnston, L., Green, K., Simor, A., Amihod, B., Bryce, E., Henderson, E., Stegenga, J., Bergeron, F., Canadian Nosocomial Infection Surveillance Program (CNISP), and Gravel, D. (2007 November). "Infection control and antimicrobial restriction practices for antimicrobial-resistant organisms in Canadian tertiary care hospitals." *American Journal of Infection Control* Vol. 35(9):563-568.

[8] King's Fund Briefing (2008). *Healthcare-associated infections: Stemming the rise of the 'Superbug'?* London: King's Fund. Accessed September 9, 2008 at http://www.kingsfund.org.uk/publications/briefings/index.html

[9] McCarter, J. (2008 September). *Special Report on the Prevention and Control of Hospital-acquired Infections.* Office of the Auditor General of Ontario. Queen's Printer for Ontario. Accessed September 30, 2008 at http://www.auditor.on.ca/en/reports_en/hai_en.pdf

[10] King's Fund Briefing (2008).

[11] Medicinenet.com "Definition of Clostridium difficile." Accessed October 1, 2008 at http://www.medterms.com/script/main/art.asp?articlekey=2760

[12] Johnston, B.L., and Conly, J. (2007). "Clostridium difficile: The evolving story." *The Canadian Journal of Infectious Diseases & Medical Microbiology* Vol. 18(6): 341-345.

[13] National Statistics (2008 February).

[14] Cambridge University Hospitals NHS Foundation Trust. *Infection Control Annual Report: 2005*, p. 9. January 2006. Accessed October 5, 2008 at

http://www.addenbrookes.org.uk/resources/pdf/patient_visitors/infection_control/Infection_Control_Annual_Report2005.pdf

[15] BC Centre for Disease Control (2007). *Monthly Enterics Surveillance Report.* Reports 14, 15, 16, 17 and 18 (weeks one to 27 of 2007). Accessed August 29, 2007 at: www.bccdc.org/content.php?item=259

[16] Simor, A. E. et al. (2001).

[17] Graves, N., Halton, K., and Lairson, D. (2007).

[18] Graves, N. (2004). "Economics and preventing hospital-acquired infection." *Emerging Infectious Diseases* Vol. 10(4):561-566; Gould, I.M. (2006). "Costs of hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) and its control." *International Journal of Antimicrobial Agents* Vol. 28(5):379-384.

[19] Van Iersel, A. (2007a). *Infection Control: Essential for a Healthy British Columbia. The Provincial Overview.* Victoria BC: Office of the Auditor General of British Columbia. Accessed September 15, 2008 at http://www.bcauditor.com/PUBS/2006-07/Report11/ProvincialOverview.pdf

[20] McGeer, A. (2007 November). "Hand Hygiene by Habit". Infection prevention: practical tips for physicians to improve hand hygiene. *Ontario Medical Review* 74 (10). Accessed November 28, 2008 at http://www.oma.org/pcomm/OMR/nov/07hands.htm

[21] Bascetta, C.A. (2008). *Health-care-associated infections in hospitals: Leadership needed from HHS to prioritize prevention practices and improve data on these infections*. US Government Accountability Office, GAO-08-673T. Accessed September 15, 2008 at http://www.gao.gov/new.items/d08673t.pdf

[22] Plowman, R., Graves, N., Griffin, M., Roberts, J., Swan A.V., Cookson, B. and Taylor, L. (1999). *Socio-economic Burden of Hospital Acquired Infection*. London: Public Health Laboratory Service. Accessed September 25, 2008 at http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4089725.pdf .

[23] Pindera, L. (2007 March 27). "C. Difficile too narrow as 'Quebec strain' goes international." *CMAJ* Vol. 176(7):915-916. Accessed September 25, 2008 at http://www.cmaj.ca/cgi/content/full/176/7/915

[24] Simor, A.E., Lee, M., Vearncombe, M., Jones-Paul, L., Barry, C., Gomez, M., Fish, J.S., Cartotto, R.C., Palmer, R., and Louie, M. (2002). "An Outbreak Due to Multiresistant *Acinetobacter baumannii* in a Burn Unit: Risk Factors for Acquisition and Management." *Infection Control and Hospital Epidemiology* Vol. 23(5):261-267.

[25] Laupland, K.B., Lee, H., Gregson, D.B., and Manns, B.J. (2006 June). "Cost of intensive care unit-acquired bloodstream infections." *Journal of Hospital Infection* Vol. 63(2):124-32.

[26] Cosgrove, S.E., Sakoulas, E.N., Perencevich, E., Schwaber, M.J., Karchmer, A.W., and Carmeli, Y. (2003). "Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: A meta-analysis." *Clinical Infectious Diseases* Vol. 36:53-59. Accessed September 25, 2008 at http://www.journals.uchicago.edu/doi/pdf/10.1086/345476

[27] Public Health Agency of Canada (2003 March 30). *Summary of Severe Acute Respiratory Syndrome (SARS) Cases: Canada and International.* Accessed September 25, 2008 at http://www.phac-aspc.gc.ca/sars-sras/eu-ae/sars20030330-eng.php

[28] National Infectious Disease Day (NIDD) Secretariat. (2007 Oct). Position paper: *A Call for a National Infectious Disease Strategy.* Ottawa, Ont. Accessed October 19, 2007 at: http://www.nidd.ca/pdf/positionPaper.pdf.

[29] Plowman, R. et al. (1999).

[30] Cambridge University Hospitals NHS Foundation Trust. *Infection Control Annual Report: 2005.* Page 16. January 2006. Accessed October 5, 2008 at http://www.addenbrookes.org.uk/resources/pdf/patient_visitors/infection_control/Infection_Control_Annual_Report2005.pdf

[31] Van Iersel, A. (2007a).

[32] National Infectious Diseases Coalition (September 22, 2008). *A Battle We Can Win: Reducing Healthcare Associated Infections by 50%.* Accessed September 24, 2008 at http://www.nidd.ca/pdf/positionPaper08.pdf

[33] Ontario Ministry of Health and Long Term Care, Provincial Infectious Diseases Advisory Committee (PIDAC) (2007 March). *Best Practices for Infection Prevention and Control of Resistant Staphylococcus aureus and Enterococci*. Toronto, Ont. Page 17. Accessed October 21, 2007 at: http://www.health.gov.on.ca/english/providers/program/infectious/diseases/best_prac/bp_staff.pdf.

[34] Van Iersel, A. (2007a).

[35] The Globe and Mail (July 10, 2008). "Suit filed against hospital in C. difficile case." *The Globe and Mail*. Page A8. Accessed November 25, 2008 at http://www.theglobeandmail.com/servlet/Page/document/v5/content/subscribe?user_URL=http://www.theglobeandmail.com%2Fservlet%2FArticleNews%2Ffreeheadlines%2FLAC%2F20080710%2FTORSHOOT10-3%2Fhealth%2FHealth&ord=3529556&brand=theglobeandmail&force_login=true

[36] Legault, J-B. (August 28, 2008). "Deadly *C. difficile* outbreak sparks lawsuit against Quebec hospital." *The Canadian Press*. Section: National General News. Accessed November 26, 2008 at http://ca.news.yahoo.com/s/capress/080828/national/que_c_difficile

[37] Perencevich, E.N., Sands, K.E., Cosgrove, S.E., Guadagnoli, E., Meara, E., and Platt, R. (2003 Feb). "Health and economic impact of surgical site infections diagnosed after hospital discharge." *Emerging Infectious Diseases*. Vol. 9(2):196-203; Plowman, R. et al. (1999).

[38] Graves, N., Halton, K., and Lairson, D. (2007).

[39] Isolation cohorting refers to physically separating a group of patients with, for example, MRSA, who are cared for by staff who do not care for MRSA negative patients.

[40] Decolonization of an infected patient refers to the elimination of MRSA through the use of infection control measures and/or antibiotics. Decolonization reduces the risk of MRSA being transmitted to others in an outbreak situation.

[41] Vos, M.C. (2007 March 26). "The secrets of MRSA control in the Netherlands." In *MRSA - Learning from the Best* conference. Department of Health. National Health Service, Government of the UK. Accessed September 25, 2008 at http://www.dh.gov.uk/en/Publichealth/Healthprotection/Healthcareacquiredinfection/Healthcareacquiredgeneralinformation/ThedeliveryprogrammetoreducehealthcareassociatedinfectionsHCAIincludingMRSA/DH_4102049

[42] Nulens, E., Broex, E., Ament, A., Deurenberg, R., Smeets, E., Scheres J., van Tiel, F., Gordts, B., Stobberingh, E. (2008 April). "Cost of the meticillin-resistant Staphylococcus aureus search and destroy policy in a Dutch university hospital." *Journal of Hospital Infection* Vol. 68(4): 301 – 307.

[43] Canadian Committee on Antibiotic Resistance (2007). *Infection Prevention and Control Best Practices for Long Term Care, Home and Community Care including Health Care Offices and Ambulatory Clinics*. Accessed October 19, 2008 at http://www.ccar-ccra.com/english/pdfs/IPC-BestPractices-June2007.pdf ; McCarter, J. (2008 September).

[44] The use of alcohol-based hand gels is often part of "clean hands" programs. There is new evidence that alcohol-based hand cleaners may not be effective and may in fact spread pathogens. See McCarter, J. (2008 September); Landro, L. (2008). "Rising foe defies hospitals' war on superbugs." *Wall Street Journal*. September 17, 2008. Accessed September 26, 2008 at http://online.wsj.com/article/SB122160848756745487.html

[45] Griffiths, P., Renz, A., Rafferty, A.M., & The Florence Nightingale School of Nursing & Midwifery at King's College London. (2008). "The Impact of Organisation and Management Factors on Infection Control in Hospital: A Scoping Review." Page 11. London: King's College London. July 2008. Accessed September 29, 2008 at http://www.kcl.ac.uk/content/1/c6/04/08/39/Infectioncontrolreport.pdf.

[46] Canadian Committee on Antibiotic Resistance (2007).

[47] Dancer, S.J. (2007). "Importance of the environment in meticillin-resistant *Staphylococcus aureus* acquisition: The case for hospital cleaning." *The Lancet*. Published online October 31, 2007 DOI: 10.1016/S1473-3099(07)70241-4. Accessed November 10th, 2007 at http://www.alphagalileo.org/nontextfiles/TLIDMRSAFinal.pdf

[48] Johnston, C.P., Cooper, L., Ruby, W., Carroll, K.C., Cosgrove, S.E., and Perl, T.M. (2006 October). "Epidemiology of Community-Acquired Methicillin-Resistant *Staphylococcus aureus* Skin Infections Among Healthcare Workers in an Outpatient Clinic." *Infection Control and Hospital Epidemiology* Vol. 27(10):1133-6.

[49] Bridges, C.B., Kurehnert M.J., and Hall, C.B. (2003). "Transmission of influenza: Implications for control in health care settings." *Clinical Infectious Diseases* Vol. 37(8):1094-1101. Accessed October 17, 2008 at http://www.journals.uchicago.edu/doi/pdf/10.1086/378292 ; Hota, B. (2004). "Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection?" *Clinical Infectious Diseases* Vol. 39:1182-1189; Kramer, A., Schwebke, I., and Kampf, G. (2006 Aug). "How long do nosocomial pathogens persist on inanimate surfaces? A systematic review." *BMC Infectious Diseases* Vol. 6:130; doi:10.1186/1471-2334-6-130; Asoh, N., Masaki, H., Watanabe, H., Watanabe, K., Mitsusima, H., Matsumoto, K., Oishi, K., and Nagatake, T. (2005). "Molecular characterization of the transmission between the colonization of methicillin-resistant *Staphylococcus aureus* to human and environmental contamination in geriatric long-term care wards." *Internal Medicine* Vol. 44(1):41-5.

[50] Pickup, J. (2005). "Getting to grips with hygiene in hospitals: The dirty war." *Health & Hygiene*. Supplement March 2005. Page 6. Accessed September 26, 2008 at http://www.riphh.org.uk/pdf/Health_and_Hygiene_March2005.pdf

[51] French, G.L., Otter, J.A., Shannon, K.P., Adams, N.M., Watling, D., and Parks. M.J. (2004 May). "Tackling contamination of the hospital environment by methicillin resistant *Staphylococcus aureus* (MRSA): A comparison between conventional terminal cleaning and hydrogen peroxide vapour decontamination." *Journal of Hospital Infection* Vol. 57:31-37; Hardy, K.J., Oppenheim, B.A. Gossain, S., Gao, F., and Hawkey, P.M. (2006). "A study of the relationship between environmental contamination with methicillin-resistant *Staphylococcus aureus* (MRSA) and patients' acquisition of MRSA." *Infection Control Hospital Epidemiology* Vol. 27:127-132.

[52] Hardy, K.J. et al. (2006).

[53] Shiomori, T., Miyamoto, H., Makishima K., Yoshida, M., Fujiyoshi, T., Udaka, T., Inaba, T., and Hiraki, N. (2002). "Evaluation of bedmaking related airborn and surface methicillin-resistant *Staphylococcus aureus* contamination." *Journal of Hospital Infection* Vol .50(1):30-35; Boyce, J.M. (2007 June). "Environmental contamination makes an important contribution to hospital infection." *Journal of Hospital Infection* Vol.65, S. 2:50-54. Page 51; Sexton, T., Clarke, P., O'Neill, E., Dillane, T., and Humphreys, H. (2006). "Environmental reservoirs of methicillin-resistant Staphylococcus aureus in isolation rooms: correlation with patient isolates and implications for hospital hygiene." *Journal of Hospital Infection* Vol. 62(2):187-94.

[54] Das, I., Lambert, P., Hill, D., Noy, M., Bion, J., and Elliott, T. (2002). "Carbapenem-resistant Acinetobacter and role of curtains in an outbreak in intensive care units." *Journal of Hospital Infection* Vol. 50(2):110-4.

[55] White, L.F., Dancer, S.J., Robertson, C. (2007 August). "A microbiological evaluation of hospital cleaning methods." *International Journal of Environmental Health Research* Vol. 17(4):285-295.

[56] Trillis III, F., Eckstein, E.C., Budavich, R., Pultz, M.J., and Donskey, C.J. (2008). "Contamination of Hospital Curtains With Healthcare-Associated Pathogens." *Infection Control and Hospital Epidemiology* Vol. 29(11):1074-1076.

[57] Mayer, R.A., Geha, R.C., Helfand, M.S., Hoyen, C.K., Salata, R.A., and Donskey, C.J. (2003 June). "Role of fecal incontinence in contamination of the environment with vancomycin-resistant *Enterococci*." *American Journal of Infection Control* Vol. 1(4):221-5; Sehulster, L., Chinn R.Y., Centers for Disease Control and Prevention (CDC), HICPAC (2003). *Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection*

Control Practices Advisory Committee (HICPAC). Atlanta, GA: Centers for Disease Control and Prevention. Accessed October 16, 2008 at http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Enviro_guide_03.pdf ; Ray, A.J., Hoyen, C.K., Das, S.M., Taub, T.F., Eckstein, E.C., and Donskey, C.J. (2002). "Nosocomial transmission of vancomycin-resistant *Enterococci* from surfaces." *Journal of the American Medical Association* Vol. 287(11):1400-1401.

[58] Eckstein, B. C., Adams, D.A., Eckstein, E.C., Rao, A., Sethi, A.K., Yadavalli, G.K., and Donskey, C.J. (2007). "Reduction of *Clostridium Difficile* and vancomycin-resistant *Enterococcus* contamination of environmental surfaces after an intervention to improve cleaning methods." *BMC Infectious Diseases* Vol. 7:61 doi:10.1186/1471-2334-7-61.

[59] Duckro, A.N., Blom, D.W., Lyle, E.A., Weinstein, R.A. and Hayden, M.K. (2005). "Transfer of Vancomycin-Resistant *Enterococci* via Health Care Worker Hands." *Archives of Internal Medicine* Vol. 165:302-307. 10.1001/archinte.165.3.302.

[60] Chen, Y-C., Huang, L-M., Chan, C-C., Su, C-P., Chang S-C, Chang, Y-Y., Chen, M-L., Hung, C-C., Chen, W-J., Lin, F-Y., Lee, Y-T., and the SARS Research Group of National Taiwan University College of Medicine and National Taiwan University Hospital (2004 May). "SARS in hospital emergency room." *Emerging Infectious Diseases* [serial online] . Accessed October 18, 2008 at http://www.cdc.gov/ncidod/EID/vol10no5/03-0579.htm The researchers collected 119 environment samples, including 100 surface samples and 19 air samples. "Nine samples were positive for SARS-CoV RNA. These included the buttons of the drinking water fountains in the triage and the observation unit; a bedside chair in the observation unit; the outlet of the central air supply, a table top, bedding and bed edge in a SARS area; and a bookshelf and bedding in the clean area. None of 19 air samples tested positive for viral RNA." Page 785.

[61] Rothschild, P. (2008). "Preventing infection in MRI: Best practices for infection control in and around MRI suites." *White Paper*. Accessed September 26, 2008 at www.Auntminnie.com

[62] UNISON (2007 Nov 26). "UNISON calls for action over dirty ambulances." *Press Releases*. UNISON. Accessed October 3, 2008 at http://www.unison.org.uk/asppresspack/pressrelease_view.asp?id=1066 ; Canadian Union of Public Employees (2003 October 29). *SARS and Infection Control*. Accessed October 3, 2008 at http://cupe.ca/sars/ART3fa0241b0685a

[63] National Institute for Occupational Safety and Health (2007). *NIOSH Safety and Health Topic: MRSA and the Workplace*. Accessed September 25, 2008 at http://www.cdc.gov/niosh/topics/mrsa/

[64] British Medical Association (2006). *Healthcare associated infections: A guide for healthcare professionals.* February 2006. Accessed September 29, 2008 at http://www.bma.org.uk/ap.nsf/AttachmentsByTitle/PDFHealthcareAssocInfect/$FILE/HCAIs.pdf page 21.

[65] Powell, N., and Walters, J. (2008). "Jo Brant had major infection control flaws; Report on C. diff outbreak shows staffing, hygiene and other problems." *Hamilton Spectator* Fri 26 Sep 2008: Section: Local, Page A1. Accessed September 26, 2008 at http://www.thestar.com/News/Ontario/article/506628

[66] Healthcare Commission (2008). *Learning from Investigations.* Accessed October 16, 2008 at http://www.healthcarecommission.org.uk/_db/_documents/Learning_from_investigations.pdf

[67] Emergency Health Services Branch – Ontario Ministry of Health and Long-Term Care (2007 March). *Infection Prevention and Control: Best Practices Manual for Land Ambulance Paramedics.* Version 1.0. Ontario Ministry of Health and Long-Term Care. Accessed October 3, 2008 at http://www.ambulance-transition.com/pdf_documents/infection_prevention_&_control_best_practices_manual.pdf

[68] National Health Services (NHS) Department of Health (2003). *Getting ahead of the curve: A strategy for combating infectious disease. A report by the Chief Medical Officer*. London, UK: Department of Health. Accessed July 13, 2007 at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4

007697 Davies, S. (2005 January). *Hospital contract cleaning and infection control*. London: UNISON. Accessed July 10, 2007 at: http://www.unison.org.uk/acrobat/14564.pdf

[69] Department of Health (2008 January). *Clean safe care: Reducing infections and saving lives*. London: Department of Health, National Health Services. Page 22. Accessed September 24, 2008 at http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_081650

[70] Christiansen, K.J., Tibbett, P.A., Beresford, W., Pearman, J.W., Lee, R.C., Coombs, G.W., Kay, I.D., O'Brien, F.G., Palladino, S., Douglas, C.R., Montgomery, P.D., Orrell, T., Peterson, A.M., Kosaras, F.P., Flexman, J.P., Heath, C.H., McCullough, C.A. (2004 May). "Eradication of a large outbreak of a single strain of vanB vancomycin-resistant *Enterococcus faecium* at a major Australian teaching hospital." *Infection Control and Hospital Epidemiology* Vol. 25(5):384-90; Lynn, S., Toop, J., Hanger, C., Millar, N. (2004). "Norovirus outbreaks in a hospital setting: The role of infection control." *Journal of the New Zealand Medical Association* Vol.117(1189); Accessed July 10, 2007. http://www.nzma.org.nz/journal/117-1189/771; Pimentel, J.D., Low, J., Styles, K., Harris, O.C., Hughes, A., and Athan, E. (2005). "Control of an outbreak of multi-drug-resistant *Acinetobacter baumannii* in an intensive care unit and a surgical ward." *Journal of Hospital Infection* Vol. 59(3):249-53; Sample, M.L., Gravel, D., Oxley, C., Toye, B., Garber, G., Ramotar, K. (2002 Aug). "An outbreak of vancomycin-resistant *Enterococci* in a hematology-oncology unit: control by patient cohorting and terminal cleaning of the environment." *Infection Control and Hospital Epidemiology* Vol. 23(8):468-70; Simor, A.E. et al. (2002); Tadros, M.A.H., Almohri, H., Vearncombe, M., Simor, A., Callery, S. (2007). "An outbreak of VanB Vancomycin Resistant *Enterococcus faecium* in a cardiovascular surgical unit." *SHEA 2007 Outbreak Abstracts*. Accessed July 13, 2007 at: http://www.shea-online.org/Assets/files/07_Outbreaks_Abstracts.pdf; Van Iersel, A. (2007c). *Infection Control: Essential for a Healthy British Columbia. Northern Health Authority*. Victoria BC: Office of the Auditor General of British Columbia. Accessed October 18, 2008 at http://www.bcauditor.com/AuditorGeneral.htm

[71] Canadian Institute for Health Information. *Hospital Trends in Canada*, 2005. Page 59. Accessed October 18, 2008 at http://secure.cihi.ca/cihiweb/products/Hospital_Trends_in_Canada_e.pdf

[72] Canadian Institute for Health Information. *National Health Expenditure Trends* 1975-2002.

[73] Auditor General for Wales, 2003, cited in UNISON (2005). *Hospital contract cleaning and infection control*. Page 20. Accessed December 9 at http://www.unison.org.uk/acrobat/14564.pdf

[74] Carling, P.C., Briggs, J., Hylander, D., and Perkins, J. (2006 Oct). "An evaluation of patient area cleaning in 3 hospitals using a novel targeting methodology." *American Journal of Infection Control* Vol. 34(8):513-9.

[75] Andersen, B. M., R. Lindemann, K. Bergh, B. I. Nesheim, G. Syversen, N. Solheim, and F. Laugerud (2002). "Spread of methicillin-resistant *Staphylococcus aureus* in a neonatal intensive unit associated with understaffing, overcrowding and mixing of patients." *Journal of Hospital Infection* Vol. 50:18-24; Archibald, L.K.; Manning, M.L.; Bell, L.M.; Banerjee, S.; and Jarvis, W.R. (1997). "Patient density, nurse-to-patient ratio and nosocomial infection risk in a pediatric intensive care unit." *Pediatric Infectious Disease Journal* Vol. 16(11):1045-48; Denton, M., Wilcox, M.H., Parnell, P., Green, D., Keer, V., Hawkey, P.M., Evans, I., and Murphy, P. (2004). "Role of environmental cleaning in controlling an outbreak of *Acinetobacter baumannii* on a neurosurgical intensive care unit." *Journal of Hospital Infection*. Vol. 56(2):106-110; Hugonnet, S., Chevrolet, J.C., and Pittet, D. (2007). "The effect of workload on infection risk in critically ill patients." *Critical Care Medicine*. Vol. 35: 76-81; Griffiths, P., Renz, A., Rafferty, A.M., & The Florence Nightingale School of Nursing & Midwifery at King's College London (2008 July). *The Impact of Organisation and Management Factors on Infection Control in Hospital: A Scoping Review*. London: King's College London. Accessed September 29, 2008 at http://www.kcl.ac.uk/content/1/c6/04/08/39/Infectioncontrolreport.pdf

[76] Griffiths, P., Renz, A., Rafferty, A.M., & The Florence Nightingale School of Nursing & Midwifery at King's College London (2008 July).

[77] Rudel-Tessier, C. (2007 Sept). *Coroner's Inquest on the Causes and Circumstances in the Deaths of Rita Sanscartier, Gemma Côté, Lise Dubois, Anna Therrien, André Michaud, Marie-Andrée Dorion, Marcel Guilman, Thérèse Bonin, Hélena Fontaine, Michael Haskell, Julienne Blanchard, Roger Gravel, Mario Messier, Héctorine Blitz, Madeleine Lapierre, and Albert Huard* (p. 3), translation of the original French report, *Rapport d'enquête de M. Catherine Rudel-Tessier*, by the Canadian Union of Public Employees.

[78] Rudel-Tessier, C. (2007 Sept).

[79] Denton, M., Wilcox, M.H., Parnell, P., Green, D., Keer, V., Hawkey, P.M., Evans, I., and Murphy, P. (2004).

[80] Auditor General of Scotland (2003 January). *Hospital Cleaning: Executive Summary*. Edinburgh, Scotland: Auditor General for Scotland. Accessed at November 26, 2008 at http://www.nhsgrampian.org/grampianfoi/files/f1-HospitalCleaningExecutiveSummary.pdf.

[81] Salaripour, M., McKernan, P. Devlin, R. and the Infection Prevention and Control Team. (2006). "A multidisciplinary approach to reducing outbreaks and nosocomial MRSA in a University-Affiliated Hospital." *Healthcare Quarterly* Vol 9. Special Issue:54-60

[82] Van Iersel, A. (2007c); Van Iersel, A. (2007d). *Infection Control: Essential for a Healthy British Columbia. Vancouver Island Health Authority*. Victoria BC: Office of the Auditor General of British Columbia. Accessed October 18, 2008 at http://www.bcauditor.com/AuditorGeneral.htm

[83] Sule, O., Fitzgibbons, L., Trundle, C., Tilley, R., Smith. R., and Brown. N. (2006). "Reducing the Incidence of *Clostridium difficile*-Associated Diarrhoea (CDAD) by Improving Environmental Cleaning and Hand Hygiene." *Journal of Hospital Infection* Vol. 64, S. 1:S75-S76.

[84] Landro, L. (2008). "Rising foe defies hospitals' war on superbugs." *Wall Street Journal* September 17, 2008. Accessed September 26, 2008 at http://online.wsj.com/article/SB122160848756745487.html

[85] Fawley, W.N. and Wilcox, M.H. (2001). "Molecular epidemiology of endemic *Clostridium difficile* infection." *Epidemiology and Infection* Vol. 126(3):343-350. ISSN 0950-2688.

[86] Masaki, H., Watanabe, H., Degawa, S., Yoshimine, H., Asoh, N., Rikitomi, N., Matsumoto, K., Ahmed, K., Nagatake, T. (2001). "Significant reduction of methicillin-resistant *Staphylococcus aureus* bacteremia in geriatric wards after introduction of infection control measures against nosocomial infections." *Internal Medicine* Vol. 40(3): 214-220.

[87] Pickup, J. (2005).

[88] McCarter, J. (2008 September).

[89] Martínez, J.A., Ruthazer, R., Hansjosten, K., Barefoot, L., and Snydman, D.R. (2003 Sep). "Role of environmental contamination as a risk factor for acquisition of vancomycin-resistant *enterococci* in patients treated in a medical intensive care unit." *Archives of Internal Medicine* Vol.163(16):1905-12.

[90] Williams, G.J., Denyer, S.P., Hosein, I.K., Hill, D.W., & Maillard, J.Y. (2008). "Determining the ability of surface wipes to remove, kill and prevent the transfer of *Staphylococcus aureus* from contaminated surfaces." Poster presentation: Welsh Office for Research and Development (WORD). Accessed September 15, 2008 at http://www.cardiff.ac.uk/phrmy/research/[hidden]images/GWFinalASMposter08.pdf ; Williams, G.J., Denyer, S.P., Hosein, I.K., Hill, D.W., & Maillard, J.Y. (2007). "The development of a new three-step protocol to determine the efficacy of disinfectant wipes on surfaces contaminated with *Staphylococcus aureus*." *Journal of Hospital Infection* Vol. 67(4):329-35.

[91] Pollack, N., M. Cohen, and J. Stinson (2005). *The Pains of Health Care Privatization*. Canadian Centre for Policy Alternatives. Accessed November 26, 2008 at http://www.policyalternatives.ca/documents/BC_Office_Pubs/bc_2005/pains_priv_summary.pdf; Jaffe, M., B. McKenna, and L. Venner (2008). *Equal Pay, Privatisation and Procurement*. Liverpool: The Institute of Employment Rights. Accessed November 26, 2008 at http://www.ier.org.uk/node/293; Cohen, M.G. and Cohen, M. (2004). *A Return to Wage Discrimination: Pay Equity Losses Through the Privatization of Health Care*. Accessed October 23, 2008 at http://www.policyalternatives.ca/documents/BC_Office_Pubs/bc_pay_equity.pdf; UNISON (January

27, 2005). *Cleaners' Voices*. Accessed December 11, 2008 at http://www.unison.org.uk/healthcare/cleanerhospitals; Office for Public Management (2008). *Driven by Dogma? Outsourcing in the health service.* Research study for UNISON. Accessed December 11, 2008 at http://www.unison.org.uk/positivelypublic/news_view.asp?did=5042; Davies, S. (Jan 2005); Aronson, J., Denton, M., and Zeytinoglu, I.U. (2004). "Market-modelled home care in Ontario: Deteriorating working conditions and dwindling community capacity." *Canadian Public Policy* 30 (1): 111-125; Aronson, J., Denton, M., and Zeytinoglu, I.U. (2006). "The Impact of Implementing Managed Competition on Home Care Workers' Turnover Decisions. *Canadian Public Policy* 1(4): 106-123.

[92] Dancer, S.J. (2004). "How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals." *Journal of Hospital Infection* Volume 56(1): 10-15.

[93] Scottish Executive (2002). *Preventing Infections Acquired While Receiving Health Care: The Scottish Executive's Action Plan to Reduce the Risk to Patients, Staff and Visitors, 2002-2005.* Accessed October 18, 2008 at http://www.scotland.gov.uk/Publications/2002/10/15677/12344

[94] Pollack, N., M. Cohen, and J. Stinson (2005).

[95] Pollack, N. (October 2004). *Falling Standards, Rising Risks: Issues in Hospital Cleanliness with Contracting-out.* Vancouver, BC. Available online at http://www.heu.org/~DOCUMENTS/research_reports/falling_standards_rising_risks.pdf

[96] Van Iersel, A. (2007e). *Infection Control: Essential for a Healthy British Columbia. Provincial Health Services Authority.* Page 33. Victoria, BC: Office of the Auditor General of British Columbia. Accessed October 18, 2008 at http://www.bcauditor.com/AuditorGeneral.htm.

[97] Pollack, N., M. Cohen, and J. Stinson (2005).

[98] UNISON (January 27, 2005).

[99] Auditor General of Scotland. (2003 January). *Hospital Cleaning.* Edinburgh, Scotland: Auditor General for Scotland. Retrieved December 10, 2008 from http://www.audit-scotland.gov.uk/docs/health/2002/nr_030130_hospital_cleaning.pdf

[100] UNISON (2007, April). *UNISON Fact-sheet on Healthcare Acquired Infections.* Accessed October 18, 2008 at http://www.unison.org.uk/acrobat/B3176.pdf.

[101] Butler, P. and Batty, D. (2001). "'Filthiest' NHS hospitals cleaned by private contractors." Guardian, 10 April. Accessed December 10, 2008 at http://www.guardian.co.uk/society/2001/apr/10/hospitals.nhs1

[102] Welsh NHS Confederation (2005 April). *MRSA - Key facts and how it's being tackled.* Accessed October 21, 2007 at: http://www.welshconfed.org/reso/1776/image/MRSA%20E.pdf

[103] Scottish Health Finance Directorate (October 20, 2008). *Outsourcing of Soft Facilities Management Services in NHS Scotland*. Accessed October 24, 2008 at http://cupe.ca/updir/LetterreScottishcontractingout.pdf

[104] Welsh Labour (July 7, 2008). *One Wales: One year on – Welsh Labour delivering for the people of Wales*. Accessed October 24, 2008 at http://www.welshlabour.org.uk/one_wales_one_year_on

[105] Northern Ireland Assembly (June 7, 2007). Northern Ireland Assembly Committee for Health, Social Services and Public Safety Official Report: PFI/PPP Issues." *Hansard*. Accessed November 26, 2008 at http://www.niassembly.gov.uk/health/2007mandate/moe/PFI_PPP.htm

[106] Chen, M. (2003 Jun 10). "Outsourcing played role in outbreaks: CDC head." *Taipei Times.* Page 2. Accessed October 18, 2008 at http://www.taipeitimes.com/News/taiwan/archives/2003/06/10/2003054672

[107] Cohen, M.G. (October 2001). *Do comparisons between hospital support workers and hospitality workers make sense?* Prepared for Hospital Employees' Union. Accessed October 24, 2008 at http://www.heu.org/~DOCUMENTS/research_reports/Comparison_Hospital_Support_Workers_1.pdf

[108] King's Fund Briefing (2008).

[109] Ibid.

[110] Clements, A., Halton, K., Graves, N., Pettitt, A., Morton, A., Looke, D., & Whitby, M. (2008). "Overcrowding and understaffing in modern health-care systems: Key determinants in meticillin-resistant *Staphylococcus aureus* transmission." *The Lancet Infectious Diseases* Vol 8(7):427-434.

[111] Organisation for Economic Co-operation and Development (2007). "Health at a Glance 2007: OECD Indicators." Accessed October 1, 2008 at http://www.oecd.org/document/11/0,3343,en_2649_33929_16502667_1_1_1_37407,00.html

[112] Canadian Institute for Health Information, *Hospital Trends in Canada*, 2005, Pages 2-3. Accessed October 18, 2008 at http://secure.cihi.ca/cihiweb/products/Hospital_Trends_in_Canada_e.pdf

[113] Canadian Association of Emergency Physicians (June 16, 2005). *Taking Action on the Issue of Overcrowding in Canada's Emergency Departments.* Accessed November 26, 2008 at http://www.waittimealliance.ca/waittimes/CAEP.pdf

[114] Department of Health (December 2007). *Hospital organisation, specialty mix and MRSA*. Accessed September 29, 2008 at http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_081283

[115] Griffiths, P., Renz, A., Rafferty, A.M., & The Florence Nightingale School of Nursing & Midwifery at King's College London. *The Impact of Organisation and Management Factors on Infection Control in Hospital:" A Scoping Review."* London: King's College London. July 2008. Accessed September 29, 2008 at http://www.kcl.ac.uk/content/1/c6/04/08/39/Infectioncontrolreport.pdf. Page 14.

[116] Cunningham, J.B., Kernohan, W.G., and Rush. T. (2006 June-July). "Bed occupancy, turnover intervals and MRSA rates in English hospitals." *British Journal of Nursing*. Vol. 15(12):656-660.

[117] Health Protection Agency (2007 November). *National Confidential Study of Deaths Following Meticillin Resistant Staphylococcus aureus Infection.* Page 26. London: Health Protection Agency. Accessed September 15, 2008 at http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1202487101288?p=1158945066450

[118] Borg, M.A. (August 2003). "Bed occupancy and overcrowding as determinant factors in the incidence of MRSA infections within general ward settings." *Journal of Hospital Infection* Vol.54(4):316-8.

[119] Westech Systems FM Inc. and British Columbia Participating Health Authorities (2007 October). *Healthcare Cleaning Outcome Standards – V6B.* Accessed October 19, 2008 at http://www.fraserhealth.ca/AboutUs/Organization/Reports/Documents/Westech-BCHA%20Cleaning%20Outcome%20Standards%20-%20V6B-%20Oct%2024,%202007.pdf

[120] Dancer, S.J. (2004).

[121] Malik, R.E., Cooper, R.A. and Griffith, C.J. (2003) "Use of audit tools to evaluate the efficacy of cleaning systems in hospitals." *American Journal of Infection Control* Vol. 31(3):181-187.

[122] McCarter, J. (2008 September).

[123] Dancer, S.J. (2004).

[124] Orr, K.E., Holliday, M.G., Jones, A.L., Robson, I., and Perry, J.D. (2002 February). "Survival of enterococci during hospital laundry processing." *Journal of Hospital Infection* Vol 50, Issue 2, pp. 133-139.

[125] McCarter, J. (2008 September); Eggertson, L. (2007 May). "Hospitals to report *C. difficile* and MRSA." *CMAJ* Vol. 176(10):1402-1403; Silversides, A. (2008 June 17). "Ontario's hospitals surpass those of Quebec in *C. difficile* rates." *CMAJ* Vol. 178(13):1649.

[126] "Canada's hospital-infection watchdog in need of help." *Canadian Healthcare Technology*. Accessed May 2, 2008 at: http://www.canhealth.com/News796.html

[127] Bascetta, C.A. (2008); Collingnon, P.J., Grayson, M.L., & Johnson, P.D.R. (2007). "Methicillin-resistant *Staphylococcus aureus* in hospitals: Time for a culture change." *The Medical Journal of Australia* Vol. 187(1):4-5. Accessed September 16, 2008 at http://www.mja.com.au/public/issues/187_01_020707/col10403_fm.html

[128] Medicinenet.com "Definition of Clostridium difficile."

[129] Boyce, J.M. (2007 June).

[130] McCarter, J. (2008 September). Page 6.

[131] Board of Science, British Medical Association (February 2006). *Healthcare associated infections: A guide for healthcare professionals.* Accessed September 29, 2008 at http://www.bma.org.uk/ap.nsf/AttachmentsByTitle/PDFHealthcareAssocInfect/$FILE/HCAIs.pdf

[132] McCarter, J. (2008 September). Page 30.

[133] National Institute for Occupational Safety and Health (2007).

[134] McCarter, J. (2008 September). Page 6.

[135] Hardy, K.J., Hawkey, P.M., Gao, F., and Oppenheim, B.A. (2004). "Methicillin-resistant *Staphylococcus aureus* in the critically ill*." British Journal of Anaesthesia*. Vol. 92(1):121-130. doi: 10.1093/bja/aeh008. Accessed September 25, 2008 at http://bja.oxfordjournals.org/cgi/reprint/92/1/121

[136] BC Ministry of Health (2005 October). *BC HealthFile* #87. Accessed October 19, 2008 at http://www.bchealthguide.org/healthfiles/hfile87.stm

[137] Hota, B. (2004). "Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection?" *Clinical Infectious Diseases* Vol. 39:1182-1189, p. 1184.

[138] National Advisory Committee on SARS and Public Health Agency of Canada (2003 October). *Learning from SARS - Renewal of Public Health in Canada - Executive Summary*. Accessed September 25, 2008 at http://www.phac-aspc.gc.ca/publicat/sars-sras/pdf/exsum-e.pdf Page 1.

[139] Boyce, J.M. (2007 June).

[140] McCarter, J. (2008 September). Page 7.

[141] Ibid.

[142] Emergency Health Services Branch – Ontario Ministry of Health and Long-Term Care (2007 March).