Evidence Review:

Communicable Disease
(Public Health Measures)

Population and Public Health
BC Ministry of Healthy Living and Sport
This paper is a review of the scientific evidence for this core program. Core program evidence reviews may draw from a number of sources, including scientific studies circulated in the academic literature, and observational or anecdotal reports recorded in community-based publications. By bringing together multiple forms of evidence, these reviews aim to provide a proven context through which public health workers can focus their local and provincial objectives. This document should be seen as a guide to understanding the scientific and community-based research, rather than as a formula for achieving success. The evidence presented for a core program will inform the health authorities in developing their priorities, but these priorities will be tailored by local context.

This Evidence Review should be read in conjunction with the accompanying Model Core Program Paper.

Evidence Review prepared by:
Lilian Yuan, Shaun Peck and Bonnie Henry

Evidence Review accepted by:
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Core Functions Steering Committee (January 2009)

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1.0 OVERVIEW/SETTING THE CONTEXT

In 2005, the British Columbia Ministry of Health released a policy framework to support the delivery of effective public health services. The Framework for Core Functions in Public Health identifies communicable disease as one of the 21 core programs that a health authority provides in a renewed and comprehensive public health system.

The process for developing performance improvement plans for each core program involves completion of an evidence review used to inform the development of a model core program paper. These resources are then utilized by the health authority in their performance improvement planning processes.

This evidence review was developed to identify the current state of the evidence-based on the research literature and accepted standards that have proven to be effective, especially at the health authority level. In addition, the evidence review identifies best practices and benchmarks where this information is available.

1.1 An Introduction to This Paper

The focus of this paper is public health measures which are used to prevent and control outbreaks in the community and within facilities. These include quarantine and isolation, restriction on public gathering, school and facility closures, patient and health care worker (HCW) screening, and cohorting of patients and HCW. Some of these measures are controversial and highly unpopular. As seen in the severe acute respiratory syndrome (SARS) outbreak, quarantine of large numbers of people was instituted quickly because of incomplete information about disease transmission (National Advisory Committee on SARS 2003).

This paper does not review infection control, which is defined by the Centers for Disease Control and Prevention (CDC) as “measures practiced by health care personnel in health care facilities to decrease transmission and acquisition of infectious agents.” Important aspects of outbreak prevention and control such as hand washing and immunization are also not covered since they have been reviewed in other core program papers. For an assessment of disinfection and environmental cleaning, readers are referred to Health Canada’s Infection Control Guidelines: Handwashing, Cleansing, Disinfection and Sterilization in Health Care, available at: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/98pdf/cdr24s8e.pdf.

An effective public health response requires adequate public health infrastructure. The National Advisory Committee on SARS and Public Health (2003) states that this includes organizational capacity, an adequate public health workforce, optimal business processes and information/knowledge systems. Coordinated efforts are also required by all levels of governments and partner agencies involved in managing the outbreak.

In British Columbia, the legal authority for public health action rests mostly with the Medical Health Officer and the Provincial Health Officer whose powers are described under the Health Act and Regulations. The Medical Officer of Health also has the authority to control
communicable diseases under the *Venereal Diseases Act* and Regulations, as well as the *School Act*.

Legal authority to protect public health also exists within municipalities, regional districts and many other organizations such as BC Ambulance Service, Ministry of Agriculture, Ministry of Attorney General (police services). The *Hospital Act* and Regulations give regional health authorities legislated responsibilities for infection control in health care institutions. In addition, federal acts (e.g., the *Quarantine Act*) enable the federal government to take action or require action to be taken by provinces or territories.

This paper is divided into four sections. The first reviews the evidence for isolation and quarantine; the second examines community-based infection control measures; the third discusses facility-based control measures, and the fourth reviews infection control measures in relation to specific groups of diseases.
2.0 METHODOLOGY

This paper reviews the evidence for public health measures to prevent and control outbreaks in the community and within facilities. The literature search included the following databases: MEDLINE, OLDMEDLINE, EMBASE, and CINAHL. Searches were limited to English-language publications using the following search terms:

Quarantine, isolation, 1918 influenza outbreak, SARS outbreak, school closure, interfacility transfer, cohorting, infections in day care, screening in hospital (diseases were specified e.g., MRSA), facility closure, mass gathering and disease, personal protective equipment, and infection control guidelines (in general and for specific diseases).

Titles and abstracts of citations were reviewed and potentially relevant articles were retrieved. Reference lists in retrieved articles were scanned and additional citations were obtained. The Cochrane Collaboration database and NHS Health Technology Assessment database were also searched for systematic reviews about relevant topics. Websites of Canadian, UK and US government agencies as well as the Canadian Pediatric Society and the American Academy of Pediatrics were searched for infection control guidelines. National and provincial pandemic influenza plans as well as the Campbell Commission’s SARS reports were reviewed for pertinent information.

The National Health Service (NHS) evidence grading system was used to grade the material:

Table 1: Evidence of the Efficacy of an Intervention – Did it Work?

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Type of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1++</td>
<td>High quality meta-analyses, systematic reviews of RCTs (including cluster RCTs), or RCTs with a very low risk of bias.</td>
</tr>
<tr>
<td>1+</td>
<td>Well conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias.</td>
</tr>
<tr>
<td>1-*</td>
<td>Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias.</td>
</tr>
<tr>
<td>2++</td>
<td>High quality systematic reviews of intervention studies (controlled non-randomised trial, controlled before-and-after, interrupted time series), comparative cohort and correlation studies with a very low risk of confounding, bias or chance.</td>
</tr>
<tr>
<td>2+</td>
<td>Well conducted, non-randomised intervention studies (controlled non-randomised trial, controlled before-and-after, interrupted time series). Comparative cohort and correlation studies with a high risk of confounding, bias or chance.</td>
</tr>
<tr>
<td>2-*</td>
<td>Non-randomised intervention studies (controlled non-randomised trial, controlled before-and-after, interrupted time series), comparative cohort and correlation studies with a high risk of confounding, bias or chance.</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytical studies (e.g., case reports, case series).</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion, formal consensus.</td>
</tr>
</tbody>
</table>

* Studies with a level of evidence (-) should not be used as basis for making recommendations.

3.0 ISOLATION AND QUARANTINE

Isolation refers to the separation of known infected or symptomatic people from others, for the period of communicability, to prevent the transmission of infection (Gostin 2003, Day 2006). This person can be isolated at home, a designated facility or if clinically indicated, admitted to a hospital.

Quarantine, on the other hand, is the restriction of activities of asymptomatic persons who have been exposed to a case of communicable disease during its period of communicability (i.e., contacts) to prevent disease transmission during the incubation period if infection should occur. The two main types of quarantine are (Heymann 2004):

- Absolute or complete quarantine: The limitation of freedom of movement of those exposed to a communicable disease for a period of time not longer than the longest usual incubation period of that disease, in such manner as to prevent effective contact with those not so exposed.

- Modified quarantine: A selective, partial limitation of freedom of movement of contacts, commonly on the basis of known or presumed differences in susceptibility and related to the assessed risk of disease transmission. For example, BCCDC recommends that during an influenza outbreak, all non-immunized staff from an outbreak facility must be excluded from working in non-outbreak facilities for 3 days after their last shift in the outbreak facility (BCCDC 2005).
  
  o Modified quarantine includes: personal surveillance, the practice of close medical or other supervision of contacts to permit prompt recognition of infection or illness but without restricting their movements; and segregation, the separation of some part of a group of persons from the others for special consideration, control or observation.

Quarantine can operate at the individual (e.g., exposed contact) or population level (e.g., attendees of a public gathering). Geographic quarantine can involve restrictions on travel to and from designated areas or places (Gostin 2003, Upshur 2003, Inglesby 2006). Closure of community borders around a geographic area is known as a cordon sanitaire.

The word “quarantine” is derived from the Italian words, quarantins and quaranta gironi, which refer to the 40-day period during which ships and their crews were isolated in the Port of Venice (Sattenspiel 2003). Descriptions of quarantine can be found in the Old Testament as well as in Hippocratic teaching in the 5th century B.C. (Gensini 2004). More recent records of quarantine can be found in the 14th century when regulations prevented ships coming from places infected with plague from docking. Readers who are interested in the history of quarantine can refer to articles by Gensini (2004), Jones (2005) and Sattenspiel (2003).

Isolation and quarantine are optimally performed on a voluntary basis, in accordance with the instructions of health officials. However, medical health officers have the legal authority to compel mandatory isolation and quarantine of individuals and groups when necessary to protect the public’s health. Persons who are quarantined should be monitored regularly by a health

Quarantine is a contentious issue and people have argued for and against it for well over a century. During the 19th century, quarantine was at the centre of debate at International Sanitary Conferences (Jones 2005). In the 21st century, some have argued that quarantine played little or no role in controlling SARS (Schabas 2004), while others believed that quarantine helped to quell the outbreak (Diamond 2003).

### 3.1 Effectiveness of Quarantine and Isolation

Most assessments of the effectiveness of community-wide isolation and quarantine stem from evaluations of the 1918-19 influenza pandemic and the 2003 SARS outbreak. Historical records show that in Edmonton during the 1918 influenza pandemic, community-based interventions such as quarantine and isolation, school closure and banning of public gatherings had little impact on the epidemic (McGinnis 1977). Even in cities such as Lomé, British-occupied Togo, where vigorous efforts were used (e.g., isolation of known cases and their contacts, confinement of troops to barracks, closure of schools and churches, ban on public meetings and stoppage of road and rail traffic), influenza continued to spread (Patterson 1983). As early as 1919, Whitelaw tried to evaluate the impact of public health measures in controlling the spread of influenza in Canada but was unable to carry out his evaluation because the measures were poorly implemented (Whitelaw 1919).

Sattenspiel and Herring (2003) created a mathematical model to examine the effects of quarantine in three small Manitoba communities in 1918-19. Estimates of the likely mobility rates during the flu epidemic were derived from daily counts of arrivals and departures recorded in the Hudson Bay Company Post Journals. Results of the simulation showed that at best, quarantine reduced the number of influenza cases by 25% and delayed the epidemic peak.

Paucity of historical data renders such assessments difficult; societal differences between the past and the present also limit the usefulness of the conclusions drawn.

In 2003, cases of severe acute respiratory syndrome (SARS) occurred in approximately 30 countries. In five countries, significant outbreaks were reported – Canada, China (including Hong Kong), Taiwan, Vietnam and Singapore. Because the pathogen was initially unknown and modes of transmission were unclear, quarantine and isolation were widely used to control disease spread (Wang 2007). Ou et al (2003) reported that the number of persons quarantined in China could have been reduced by 66% if efforts were focused only on persons who had contact with a SARS patient. These findings were corroborated by Wang et al (2007) who found the efficiency of SARS quarantine in Taiwan could have been improved by targeting persons with exposure to SARS cases instead of including quarantine for travelers from SARS infected areas.

Researchers have also used different types of mathematical models to assess the effectiveness of quarantine and isolation during the SARS outbreak. Lipsitch (2003) and Riley (2003) measured reproductive rates before and after the introduction of quarantine and early detection of new

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1 Reproduction rate ($R_0$) is the average number of secondary cases generated by a primary case. If $R_0$ is <1, an epidemic cannot be sustained; if $R_0$ is >1, an epidemic occurs.
cases. A compartmental model was used by Zhang (2005), while Hsieh used a discrete time model (2007). Results of mathematical modeling suggest that quarantine was an effective intervention measure during the SARS outbreak in 2003. Findings from these studies are summarized below:

Table 2: Results of Mathematical Models that Examined Public Health Interventions to Control SARS

<table>
<thead>
<tr>
<th>Author</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hsieh 2007</td>
<td>Quarantine of potentially exposed contacts of suspected SARS patients prevented approximately 461 additional SARS cases (81%) and 62 additional deaths (63%) in Taiwan. Quarantine of travelers arriving at borders from SARS affected areas had relatively minor effect, reducing only about 5% of cases and deaths. The combined impact of both types of quarantine had reduced the case numbers and deaths by almost 50%.</td>
</tr>
<tr>
<td>Zhang 2005</td>
<td>Simulation showed that quarantine delay would have resulted in an increased number of SARS cases in China. Simulation also showed that premature lifting of preventive and control measures would have resulted in a larger number of SARS cases and a second epidemic peak.</td>
</tr>
<tr>
<td>Riley 2003</td>
<td>Transmission rate$^2$($\beta$) fell by 67-94% and $R_0^1$ dropped from 2.7 to &lt; 1 when control measures were introduced in Hong Kong. The effects of individual control measures were not examined.</td>
</tr>
<tr>
<td>Lipsitch 2003</td>
<td>Reproduction rate ($R_0^1$) dropped dramatically after institution of control measures. The decline in secondary cases coincided with quarantine of asymptomatic contacts and isolation of SARS cases.</td>
</tr>
<tr>
<td>Chau 2003</td>
<td>Quarantine of close contacts of confirmed SARS cases was insufficient to control SARS in Hong Kong. Quarantine of close contacts of both confirmed and suspected cases was necessary to prevent disease spread in the community.</td>
</tr>
</tbody>
</table>

Level of Evidence: 2-
(i.e., Non-randomized intervention studies using mathematical modeling)

### 3.2 Disease Parameters that Affect Quarantine and Isolation

Fraser et al (2004) used mathematical models of different infectious disease outbreaks to find out which parameters are associated with the successful use of isolation and quarantine. In their model, community mixing is assumed to be homogeneous i.e., all susceptible individuals are equally likely to become infected. They found the amount of transmission which occurs before the onset of symptoms and from asymptomatic individuals ($\theta$) is an important predictor of how well isolation and quarantine would work in reducing disease spread. Models show that for high values of $\theta$, neither isolation nor quarantine would be effective. When $\theta < 1/R_0^1$, isolation can be used alone to be effective. When $\theta > 1/R_0^1$, both isolation and quarantine would need to be used.

Comparing $R_0$ and $\theta$ estimates for SARS, smallpox, pandemic influenza, Fraser et al found SARS to be the easiest infection to control because of low $R_0$ and $\theta$ values. Their analysis found that effective isolation of symptomatic patients would be sufficient to control an outbreak. The

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$^2$ $T(\beta)$: Transmission rate is the number of persons infected per infectious person per day.
second most readily controlled infection is smallpox. In this situation, both isolation and quarantine would be required. Influenza, on the other hand, was found to be very difficult to control because of high levels of pre-symptomatic transmission as well as short incubation periods (approximately 2 days).

The effectiveness of quarantine can be compromised by an inability to trace all infected contacts before they become infectious or by noncompliance with quarantine or by the possibility that some individuals remain infectious after quarantine is lifted. Similarly, the effectiveness of isolation can be limited by the delays with which a sick person is segregated or by failures of infection control while these patients are in isolation (Lipsitch 2003). Despite the difficulties in implementing quarantine and isolation measures to perfection, one needs to bear in mind that as long as the reproductive rate is reduced below 1, the epidemic will be controlled.

### 3.3 Compliance with Quarantine and Isolation

Results of a study of quarantine in Toronto found that civic duty, not fear of legal consequences was the main motivator for those who complied with quarantine during the SARS outbreak (DiGiovanni 2004). In the final report of the SARS Commission, Justice Campbell concluded that “laws are only the last resort…while it is important to strengthen the legal machinery available to public health officials, it is even more important to strengthen the things that encourage public cooperation.” (Campbell 2006).

During the SARS outbreak, 23,103 contacts required quarantine. Of those, only 27 (0.1%) were issued a legally enforceable quarantine order due to noncompliance (Svoboda 2004). Even though Ontario enjoyed high levels of quarantine compliance, DiGiovanni identified the following impediments to observance:

- Fear of loss of income;
- Poor logistical support;
- Psychological stress;
- Spotty monitoring of compliance;
- Inconsistencies in the application of quarantine measures between various jurisdictions; and
- Problems with public communications.

Similar findings were reported by Hawryluck (2004) from his survey of 129 quarantined individuals.
The studies and stories of quarantine during SARS show that the legal power to quarantine comes with a responsibility to ensure that those in quarantine are given adequate support to enable them to comply. Necessary supports include (Campbell 2006):

- Delivery of groceries;
- Refill and delivery of medication;
- Ensuring that children are safely transported to and from day care or school;
- Taking care of children, people with special needs and the elderly whose primary caregivers have been quarantined;
- Special quarantine contingencies for vulnerable populations, such as the homeless;
- Ensuring that those under quarantine have an adequate supply of personal protective equipment.

The Campbell Commission report recommended that “every government emergency plan should provide a basic blueprint for the most predictable types of compensation packages and that they be ready for use, with appropriate tailoring, immediately following any declaration of emergency.”

Level of Evidence: 3 (i.e., case reports)

3.4  The Ethics of Isolation and Quarantine

Isolation and quarantine pose difficult questions about the acceptability of restrictive measures to achieve public health goals (Bensimon 2007). Upshur (2003) and Gostin (2003) have used the public health ethics framework to address this issue. The four principles of the framework are: the harm principle, proportionality, reciprocity, and least restrictive measures.

- First, there should be clear and measurable harm to others should disease go unchecked.
- Second, public health authorities should use least restrictive measures proportional to the goal of achieving disease control. This means that quarantine is voluntary before more restrictive means such as mandatory orders and sanctions are imposed.
- Third, reciprocity requires that society assist individuals who have curtailed their liberty for the good of others. This means providing individuals with adequate food and shelter and psychological support, accommodating their absence from the workplaces and not discriminating against them.
- Finally, there is the transparency principle which requires public health authorities to communicate clearly their justification for their actions. A process of appeal ought to be in place.
3.5 Updated Quarantine Act

The Quarantine Act came into force on December 12, 2006 and replaced a law that had remained largely unchanged since its adoption in 1872 (Tiederman 2007). The intent of this federal public health legislation is to prevent the introduction and spread of a communicable disease arriving in or departing from Canada.

The updated Act enhances the federal government’s authority to deal with suspected cases of communicable diseases at international entry points like airports. Federal officials can deny entry or compel passengers to debark for transfer to quarantine centers. It allows the federal government to close Canadian border points to carriers arriving from a region affected by an outbreak of a serious communicable disease.

It requires the airline and shipping industries to report an illness or death before arrival or departure. Quarantine officers can detain people who refuse medical examination and prevent Canadians from traveling abroad while infectious. Officials can divert a plane or vessel to another location; they can also order the decontamination, or even destruction of conveyances such as airplanes and cargo ships.

The Act does not apply to domestic travel and it does not address issues of interprovincial movement. Provincial surveillance, reporting requirements, information exchange and interprovincial travel limitations are not covered by the Act (Kondro 2007, PHAC 2004).

Further information about the updated Quarantine Act can be found at: http://www.phac-aspc.gc.ca/media/nr-rp/2004/2004_54_e.html.
4.0 COMMUNITY-BASED INFECTION CONTROL MEASURES

When outbreaks occur in the community, public health authorities can turn to community-based containment measures. These interventions are based on the principle of social distancing which refers to measures that serve to reduce contact between people (Inglesby 2006). They can be divided between measures for children and those for adults (CDC 2007):

a. Children and Teenagers
   i. Exclusion of infectious children from school and/or child care programs
   ii. Cancelling of school-based activities
   iii. Cancellation of community-based children’s activities
   iv. Closure of school and/or child care programs

b. Adults
   i. Exclusion of infectious workers
   ii. Modify work place schedules and practices to reduce social contact
   iii. (e.g., staggered shifts, teleconference instead of face-to-face meetings, work from home)
   iv. Cancel or postpone public gatherings (e.g., stadium events, theatre performances, church services, transit system)
   v. Closure of public buildings (e.g., community recreational centres, shopping mall)

Community-based interventions need to be combined with good infection control practices (e.g., good hand hygiene, cough etiquette) and adequate immunization to reduce infections in group settings.

1. Hand washing: www.cdc.gov/cleanhands/
2. Cough etiquette: www.cdc.gov/flu/protect/covercough.htm

4.1 Child Care Facilities in British Columbia

In British Columbia, there are two basic types of child care: licensed and license-not-required. Any caregiver looking after more than two children not related to them must have a license to operate. The Community Care Facilities Branch which is part of the Health Protection Division of the Ministry of Health is responsible for the development and implementation of legislation, policy and guidelines to protect the health and safety of people being cared for in licensed facilities.

Licensed child care programs must meet the requirements of the Community Care and Assisted Living Act and the Child Care Licensing Regulation. The Community Care and Assisted Living Act can be found at: http://www.qp.gov.bc.ca/statreg/stat/C/02075_01.htm. The Child Care Licensing Regulation can be found at: http://www.qp.gov.bc.ca/statreg/reg/C/CommuCareAssisted/319_89.htm.

Community care licensing programs are administered locally by Medical Health Officers and licensing officers who inspect and monitor for the purpose of promoting health and safety.
4.2 Exclusion of Sick Children from Child Care Facilities and Schools

Child care facilities and schools are well known sites of infectious disease transmission (Haskins 1986, Lu 2004). The risk of transmitting infections in a group increases with its size. In a study of 1,100 children between 37 and 54 months, rates of upper respiratory tract illness, gastrointestinal tract illness, and ear infections were higher in children enrolled in child care facilities with more than 6 children (Bradley 2003).

Exclusion is sending home or refusing admission to a child with an illness or health problem. This is intended to prevent transmission of infection among children in group settings. However, few studies have shown its effectiveness. The Canadian Pediatric Society (CPS) (1999) found no data to show that a 5-day exclusion policy that starts once chickenpox is diagnosed slows down the spread of chickenpox within a school or day care centre. Transmission was greatest in the prodrome period before onset of rash. In addition, no transmission was documented after children returned to school less than 5 days from onset of rash. Based on these data, the CPS now recommends a more permissive policy where a child is allowed to return to school or day care as soon as he or she is well enough to participate normally in all activities, regardless of the state of the rash.

A prospective study was conducted in Minneapolis to evaluate the risk of acquiring subsequent infections as a result of attendance at a short term day care facility for mildly ill children. No significant difference was found between rates of infection for respiratory illness, gastrointestinal illness and chickenpox among children who attended the day care facility compared with rates of subsequent infections for children participating in a home-based sick child care program. The authors were not able to demonstrate that children who attended the sick child day care center were at significantly increased risk of developing subsequent infections when compared with a matched group of children who did not attend the center (MacDonald 1990). A review of scientific evidence shows that the evidence of effectiveness for exclusion is weak.

Despite the weak evidence, standards for exclusion of ill children have been published by the American Academy of Pediatrics, American Public Health Association and the National Resource Center for Health and Safety in Child Care (2002). The document acknowledges that short term exclusion of children with many mild infectious diseases is likely to have only a minor impact on the incidence of infection among other children in the group: https://nrc.uchsc.edu/SPINOFF/IE/IncExc.pdf.

The document states that temporary exclusion of a child is indicated if:

- The illness prevents the child from participating comfortably in activities;

- The illness results in a greater need for care than the child care staff can provide without compromising the health and safety of the other children;
• The child has any of the following conditions:
  o Fever
  o Signs and symptoms of severe illness e.g., lethargy, uncontrolled coughing, persistent crying, difficulty breathing, wheezing
  o Diarrhea
  o Blood in the stools (unexplained)
  o Vomiting (> 2 times in 24 hours)
  o Abdominal pain > 2 hours
  o Mouth sores with drooling
  o Rash with fever or behaviour change
  o Purulent conjunctivitis
  o Pediculosis (head lice) from end of the day until after the first treatment
  o Scabies until after treatment has been completed

• The child has any of the following diseases:
  o Tuberculosis
  o Impetigo until 24 hours after treatment
  o Strep throat until 24 hours after initial treatment
  o Chickenpox until all sores have dried and crusted (this differs from CPS statement discussed above)
  o Pertussis
  o Mumps
  o Hepatitis A
  o Measles
  o Rubella
  o Shingles
  o Herpes simplex

Level of Evidence: 4
(Expert Opinion)
4.3 Day Care and School Closure

Influenza epidemics have been found to be amplified in primary school settings (Neuzil 2002). A temporal relationship was noted between school holidays and a decrease in the incidence of influenza diagnoses in France from 1984 to 2000 (Valleron 2004). However, school closures do not always result in a reduction in influenza infections. In 1918, more influenza cases developed among pupils in a Chicago school after a holiday than when schools were in session. It was postulated that school closure might be less effective in some areas because children can more easily meet elsewhere (Jordan 1919). Some have expressed concern that during a pandemic influenza outbreak, closure of schools and day cares could result in children gathering in other settings thus limiting the effect of closures (Ontario Ministry of Health 2006).

A simulation model developed by Ferguson et al (2006) of pandemic influenza transmission in the US and Great Britain showed that school closure can reduce peak attack rates by 40%. However, results by Vynnyky (2007) were less optimistic. Using UK data from the 1957 influenza pandemic to estimate the impact of school/nursery closures in a future pandemic, it was found that closure of schools/nurseries could reduce the epidemic size only by a very small amount (< 10%) if reproductive rate (R0) is high (e.g., 2.5 to 3.5) and modest amounts (e.g., 22%) if R0 is low (e.g., 1.8).

The World Health Organization concluded that data on the effectiveness of school closures are limited (WHO 2006). During a two-week teachers’ strike in Israel which occurred in the midst of an influenza outbreak in 2000, significant decreases were seen in the rates of respiratory infection diagnosed among children 6 to 12 years of age (relative risk 0.58, 95% CI 0.57 – 0.59). When schools reopened, rates of respiratory infections rose again (Heymann 2004).

Day care closures have been used to control shigellosis outbreaks in some settings (Weismann 1975), but not in others (Grenoble 2004). The simultaneous occurrence of shigella clusters in two Seattle day-care centres provided an opportunity to study the effectiveness of two different intervention strategies. One day care closed for 24 working days during which time alternate care arrangements were made for attendees. The second day-care centre remained open and allowed children and staff who were on antimicrobial treatment to return. They were separated from others in the centre and used their own room, bathroom and playground until they had two consecutive negative cultures following treatment. Similar attack rates were found among children, staff and family members at both centres (CDC 1984).

| Level of Evidence: 2- (i.e., Correlation studies) |

4.4 Exclusion of Infected Workers

4.4.1 Blood-borne Infections

There have been two confirmed instances of HIV transmission from health care workers to patients (CDC 1990, Blanchard 1998); at least 46 reports of HCWs transmitting HBV to patients during invasive procedures; and at least three reports of HCV transmission from infected health care providers to patients (Beltami 2000).
Currently available data provide no basis for recommendations to restrict the practice of health care workers (HCWs) infected with HIV, hepatitis B (HBV), or hepatitis C (HCV) who perform procedures not identified as exposure-prone; however, HCWs should not perform exposure-prone procedures unless they have sought counsel from an expert review panel (Beltami 2000).

In British Columbia, the College of Physicians and Surgeons’ Advisory Committee on Blood-Borne Communicable Diseases reviews information pertinent to an affected physician and advises him/her of specific guidelines relevant to his/her practice and, any restrictions on practice that should be implemented to minimize the potential of transmission to patients. Practice guidelines which have been developed by the Advisory Committee are available at: https://www.cpsbc.ca/cps/college_programs/bbcd_panel.

4.4.2 Enteric Diseases

The risk of transmission from infected food handlers has been documented in an international literature review (Guzewich 1999). The authors identified 81 outbreaks involving over 14,700 people between 1975 and 1998. Studies have also documented person-to-person transmission of enteric infections in health care (Carter 1987, McCall 2000) and child care settings (O’Donnell 2002, Galanis 2003, Gouveia 1998).

Under the Health Act Communicable Disease Regulation BC Reg 4/83, the Medical Officer of Health can inform the employer or child care facility that their employee or attendee is infected with a communicable disease that can spread to others and should be excluded from work or attendance until they have met the appropriate criteria.

BCCDC has published guidelines for the exclusion of cases and contacts who work or attend high-risk settings (BCCDC 2007). It is available at: http://www.bccdc.org/content.php?item=192.

Based on severity of illness and evidence that continued presence or work in a high-risk setting leads to transmission of infection, cases and in some instances, contacts of cases with verotoxigenic E. coli, hepatitis A, Salmonella typhi/paratyphi and Shigella infections are excluded from high-risk settings. Microbiological clearance is required before they return. A high-risk setting is defined as one where the case or contact’s activities increases the chance of transmission of enteric infections e.g., food premises, child care facilities, residential and acute health care facilities or other clinical settings.

Level of Evidence: 2-
(i.e., Non-randomized intervention studies)
4.5 Restrictions on Public Gatherings

Restricting public gatherings is one method of social distancing, the goal of which is to reduce the risk of coming in contact with an infected person. This can be a useful control measure for diseases that are transmitted by people who are asymptomatic or mildly ill (Ontario Ministry of Health 2006). However, these measures will have significant impact on the community and workplace. The Ontario Pandemic Influenza Plan suggests that public health authorities use the following criteria to determine whether to restrict public gatherings:

- Will cancellation of the gathering or activity cause significant public disruption?
- Are alternative services in place?
- Will canceling the gathering or activity cause significant public panic?
- Are cancellations feasible?
- Is implementation sustainable?

To date, there are no data about the effectiveness of a ban on public gathering. This intervention has only been studied along with other community-based measures.

| Level of Evidence: 4 (Expert Opinion) |

4.6 Simultaneous Use of Multiple Community-Based Interventions

Hatchett et al (2007) examined the timing of different types of community-based interventions in 17 US cities during the 1918 influenza pandemic. Cities in which multiple interventions (e.g., school closures, bans on public gatherings) were implemented at an early phase of the epidemic had half the peak death rates of cities which did not, and had 20% lower cumulative mortality.

Bootsma and Ferguson (2007) studied the effect of public health measures on the 1918 influenza pandemic. They acquired data on the timing of interventions such as school closures, banning of mass gatherings, mandating mask wearing, case isolation and disinfection measures for 16 US cities. For another 7 cities, they only had data on the start dates of interventions. They used the susceptible-exposed-infected-recovered (SEIR) epidemic model in the analysis. The study showed that variation in control measures explained some of the total excess mortality observed among cities. If controls could have been maintained at the maximum level of effectiveness for each city, mortality could have been reduced by at least 40%.

The study also showed that timing of public health interventions had a profound influence on the pattern of the influenza pandemic. Cities which introduced measures early in their epidemics achieved moderate but significant reductions in overall mortality. In cities that saw a double-

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3 Atlanta, Baltimore, Chicago, Fall River, Indianapolis, Kansas City, Milwaukee, Minneapolis, New York, Newark, Philadelphia, Pittsburgh, San Francisco, Spokane, St Louis and Washington.

4 Boston, Buffalo, Detroit, Rochester, St Paul, Seattle, Toledo.
peaked epidemic, control measures may have been “too effective” stopping transmission so effectively that substantial numbers of susceptible individuals remained in the population when controls were lifted, leading to another epidemic peak. In cities where transmission had been continuing for longer before interventions were introduced, no second epidemic peak was seen, because insufficient susceptible remained to restart transmission once interventions were lifted.

The cities which achieved maximum reduction in mortality were those that implemented both early and effective interventions throughout the first peak, and then were able to reintroduce these when transmission increased again. Bootsma and Ferguson stated that “causality will never be proven, because, unsurprisingly, control measures were nearly always introduced as case incidence was increasing and removed after it had peaked. Thus, the broad correlation observed between the incidence and the timing of control measures was predefined…more work is needed to attempt to disentangle the impact of different control measures”.

Lo et al (2005) reported that influenza and other respiratory infections declined in Hong Kong during the 2003 SARS epidemic, following institution of social distancing interventions such as banning of public gatherings, school closure, case isolation etc. The findings suggest that these measures may have reduced the spread of other respiratory infections other than SARS.

Level of Evidence: 2- (i.e., Correlation studies)
5.0 FACILITY-BASED MEASURES

Transmission of infection within a facility requires three elements: a source of infecting microorganisms, a susceptible host and a means of transmission (Garner 1996). Human sources of the infecting microorganisms may be patients, staff or on occasion, visitors. Other sources of infecting microorganisms can be the patient’s own flora and inanimate environmental objects such as equipment that have become contaminated.

Host factors such as age, underlying disease, certain treatments, immunosuppressive agents, breaks in the first line of defense mechanisms caused by surgical operations, indwelling catheters etc. may render patients more susceptible to infection.

5.1 Disease Transmission in Facilities

Microorganisms are transmitted in facilities by several routes, and the same organism can be transmitted by more than one route. There are five main routes of transmission – contact, droplet, airborne, common vehicle and vector-borne (Brachman 1998).

- Contact transmission includes direct, indirect and droplet transmission. Direct transmission occurs from direct physical contact between an infected (or colonized) individual and a susceptible host. Indirect transmission involves transfer of microorganism via an intermediate object such as contaminated instruments.

- Droplet transmission is a type of contact transmission, but it is considered separately because it requires different precautions. Droplet transmission refers to large droplets >5µm in diameter, generated during coughing or sneezing or during procedures such as bronchoscopy or suctioning. These droplets are propelled < 1m, through the air and deposited on the conjunctiva, nasal or oral mucosa of the susceptible host.

- Airborne transmission refers to dissemination of microorganisms by aerolization. Such microorganisms are widely dispersed by air currents and inhaled by susceptible hosts who may be some distance from the source.

- Common vehicle transmission refers to a single contaminated source such as food, medication, equipment etc. which serves to transmit infection to multiple hosts.

- Vector-borne transmission refers to transmission by insect vectors. Such transmission has not been reported in Canadian hospitals (Health Canada 1999).
A variety of infection control measures are used to decrease the risk of transmission of microorganisms in health care facilities. National infection control guideline are published which reviews routine practices and additional precautions to prevent the transmission of microorganisms in a variety of settings (Health Canada 1999): http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/99pdf/cdr25s4e.pdf.

Routine practices refer to the type of care that should be provided to all patients regardless of their diagnosis or presumed infection status. Additional precautions are necessary for certain pathogens because of their high transmissibility or epidemiological importance. (This document is currently under revision).

National guidelines about handwashing, cleaning, disinfection and sterilization in health care can be found at: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/98pdf/cdr24s8e.pdf.

### 5.2 Personal Protective Equipment

National evidence-based guidelines for preventing health care-associated infections were commissioned by the Department of Health (England). Known as the “epic initiative”, researchers conducted systematic reviews of the literature to formulate their recommendations. The original guidelines were published in 2001 (Pratt 2001) but these were updated in 2007 (Pratt 2007); they are now known as epic2 infection prevention guidelines.

The complete series of evidence tables are posted on the epic website at: http://www.epic.tvu.ac.uk.
The evidence for use of personal protective equipment (PPE) by health care workers in general care settings is presented here. Expert opinion suggests that the primary uses of PPE are to protect staff and reduce opportunities for transmission of microorganisms. The decision to use PPE must be based on an assessment of the level of risk associated with a specific patient care activity or intervention and take account of current health and safety legislation.

5.3 Gloves

Studies have shown that gloves can reduce nosocomial infection rates (Hartstein 1997, Klein 1989). Expert opinion agrees that there are two main indications for the use of gloves:

- To protect hands from contamination with organic matter and microorganisms; and
- To reduce the risk of transmission of microorganisms to both patients and staff.

Gloves must be discarded after each care activity for which they were worn in order to prevent the transmission of microorganisms to other sites in that individual or to other patients.

Systematic reviews have shown that gloves used for clinical practice may leak when apparently undamaged (Pratt 2001). Expert opinion supports the view that the integrity of gloves cannot be taken for granted and hands can become contaminated during the removal of gloves. A study of vancomycin resistant enterococcus (VRE) showed that the organism remained on the hands of health care workers after the removal of gloves (Tenorio 2001).

Table 3: Epic2 Recommendations for Glove Use (2007)

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloves must be worn for invasive procedures, contact with sterile sties, and</td>
<td>Class D³</td>
</tr>
<tr>
<td>non-intact skin or mucous membranes, and all activities that have been assessed</td>
<td></td>
</tr>
<tr>
<td>as carrying a risk of exposure to blood, body fluids, secretions and excretions;</td>
<td></td>
</tr>
<tr>
<td>and when handling sharp or contaminated instruments.</td>
<td></td>
</tr>
<tr>
<td>Gloves must be worn as single use items. They are put on immediately before</td>
<td>Class D³</td>
</tr>
<tr>
<td>an episode of patient contact or treatment and removed as soon as the activity</td>
<td></td>
</tr>
<tr>
<td>is completed. Gloves are changed between caring for different patients, or</td>
<td></td>
</tr>
<tr>
<td>between different patients, or between different care/treatment activities for</td>
<td></td>
</tr>
<tr>
<td>the same patient.</td>
<td></td>
</tr>
<tr>
<td>Gloves must be disposed of as clinical waste and hands decontaminated, ideally</td>
<td>Class D⁵</td>
</tr>
<tr>
<td>by washing with liquid soap and water after the gloves has been removed.</td>
<td></td>
</tr>
<tr>
<td>Neither powdered nor polythene gloves should be used in health care activities.</td>
<td>Class C⁶</td>
</tr>
</tbody>
</table>

Level of Evidence: 4
(Expert Opinion)

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5 Class D: Evidence level 3 (e.g., case series, case reports) or 4 (expert opinion), or extrapolated evidence from studies rated as 2+ (e.g., case control or cohort studies) or formal consensus.

6 Class C: Evidence level 2+ (e.g., case control or cohort studies) or extrapolated evidence from studies rated as 2++(High quality case control or cohort studies or high quality systematic review of case control or cohort studies).
5.4 Gowns

Epic researchers identified four small observational studies that investigated the potential for uniforms to become contaminated during clinical care but none of the studies established an association between contaminated uniforms and health care-associated infections. A Cochrane systematic review of 8 studies which assessed the effects of gowning in newborn nurseries found no evidence to suggest that gowns were effective in reducing mortality, clinical infection or bacterial colonization in infants admitted to newborn nurseries (Webster 2003). One quasi-experimental study suggested the use of gowns and gloves as opposed to gloves alone could reduce the acquisition of VRE in the intensive care unit setting (Puzniak 2002).

International guidelines currently recommend that protective clothing should be worn by all health care workers when close contact with the patient, materials or equipment may lead to contamination of clothing with microorganisms, or when there is a risk of contamination with blood, body fluids, secretions or excretions. (Garner 1996, Health Canada 1999, Clark 2002).

Table 4: Epic2 Recommendations for Gown Use (2007)

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable plastic aprons must be worn when close contact with the patient,</td>
<td>Class D³</td>
</tr>
<tr>
<td>materials or equipment are anticipated and when there is a risk that clothing</td>
<td></td>
</tr>
<tr>
<td>may become contaminated with pathogenic microorganisms or blood, body fluids,</td>
<td></td>
</tr>
<tr>
<td>secretions or excretions, with the exception of perspiration.</td>
<td></td>
</tr>
<tr>
<td>Plastic aprons/gowns should be worn as single-use items, for one procedure,</td>
<td>Class D³</td>
</tr>
<tr>
<td>or episode of patient care, and then discarded and disposed of as clinical</td>
<td></td>
</tr>
<tr>
<td>wasted. Non-disposable protective clothing should be sent for laundering.</td>
<td></td>
</tr>
<tr>
<td>Full-body fluid-repellant gowns must be worn where there is a risk of</td>
<td>Class D³</td>
</tr>
<tr>
<td>extensive splashing of blood, body fluids, secretions or excretions, with the</td>
<td></td>
</tr>
<tr>
<td>exception of perspiration, onto the skin or clothing of health care personnel.</td>
<td></td>
</tr>
</tbody>
</table>

Systematic reviews have found no evidence that gowns are effective in reducing health care related infections.

5.5 Masks, Respiratory Protection and Eye Protection

Expert opinion recommends that face and eye protection reduce the risk of occupational exposure of health care workers to splashes of blood, body fluids, secretions or excretions. Surgical facemasks are used to protect against contact with respiratory droplets and inhalation of airborne respiratory particles (Garner 1996). Facemasks are used in conjunction with eye protection to protect the mucous membranes of the wearer from exposure to blood and/or body fluids. Systematic review shows that different eyewear offered protection against physical splashing of infected substances into the eyes but compliance was poor (Pratt 2001).

Respiratory protective equipment is recommended for the care of patients with certain respiratory diseases such as tuberculosis or SARS (Seto 2003). The filtration efficiency of these
masks protects the wearer from inhaling small respiratory particles but to be effective, they must fit closely to the face to minimize leakage around the mask.

Table 5: Epic Recommendations for Use of Face Masks, Eye and Respiratory Protective Equipment (2007)

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face masks and eye protection must be worn where there is a risk of blood, body fluids, secretions or excretions splashing into the face and eyes.</td>
<td>Class D³</td>
</tr>
<tr>
<td>Respiratory protective equipment i.e., particulate filter mask, must be correctly fitted and used when recommended for the care of patients with respiratory infections transmitted by airborne particles.</td>
<td>Class D³</td>
</tr>
</tbody>
</table>

5.6 Patient and Staff Cohorting

Cohorting of patients is the assignment of patients known to be infected with the same organism to the same room, or grouping of infected and non-infected patients in separate wards. Lior et al (1996) reported successful control of a vancomycin resistant enterococci (VRE) outbreak on a renal ward in Toronto where cohorting of colonized patients was used. Cohorting of staff is the assigning of staff to work in either affected or unaffected areas of a facility but not both. It has been successfully employed to control hospital outbreaks such as Respiratory syncytial virus (Snydman 1988). BCCDC recommends the cohorting of health care workers for control of influenza-like illness outbreaks (2005).

Patient and staff cohorting has been used to interrupt transmission of VRE at a community hospital. Infected or colonized patients were cohorted on a single ward with dedicated nursing staff and patient-care equipment. Following the establishment of the cohort ward, VRE prevalence among all hospitalized patients decreased from 8.1% to 4.7% (p=0.14) and VRE prevalence among patients whose VRE status was unknown before cultures were obtained decreased from 5.9% to 0.8% (p=0.002) (Jochimsen 1999). The BCCDC has recommended nurse cohorting for the control of VRE outbreaks when there is evidence of nosocomial spread (BCCDC 2001).

More recently, both patient and staff cohorting have been used to control methicillin-resistant Staphlococcus aureus (MRSA). A systematic review of isolation policies in the hospital management of MRSA has examined the effect of nurse cohorting (Cooper 2003). Of nine studies which met the inclusion criteria, one study provided positive effect of nurse cohorting. Coello et al (1994) described 1050 cases of MRSA over 3.5 years. A significant drop in MRSA incidence followed institution of nurse cohorting of MRSA patients isolated in single rooms or in cohorts. The remaining studies were found to provide weak evidence for reduction in MRSA infection with nurse cohorting (Cooper 2003).
A second systematic review also examined the effect of nurse cohorting as one of many strategies used to prevent and control MRSA (Loveday 2006). The authors concluded that there was a lack of good quality evidence for the effectiveness of strategies to control MRSA. In a study investigating the effect of a dedicated orthopaedic cohort unit on the control of MRSA, mathematical modelling was used to estimate the effect of the unit (Talon 2003). Modelling demonstrated that in the absence of the cohort unit, the risk of acquiring MRSA would have increased by 160%. The authors concluded that the dedicated cohort facilities helped to control the transmission of MRSA.

Both systematic reviews found the tendency to report the simultaneous implementation of multiple interventions increased the difficulty in drawing clear conclusions about the effect of individual interventions. However, both reviews identified a small number of studies which suggest that nurse cohorting contributes to reductions in MRSA incidence.

<table>
<thead>
<tr>
<th>Level of Evidence: 2-</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Non-randomized intervention studies with a high risk of confounding, bias or chance)</td>
</tr>
</tbody>
</table>

5.7 Screening of Patients and Staff

5.7.1 Patients

Evidence for screening of infectious diseases can be found in the Chapter “Evidence Base for Secondary Prevention of Communicable Diseases.” However, screening for multidrug-resistant organisms is not covered in that chapter so it is discussed below.

One aspect of controlling the spread of multi-drug resistant organisms (MDRO) such as MRSA, VRE, *Acinetobacter baumannii*, has been the screening of colonised or infected patients (Muto 2003, Ostrowsky 2001, Simor 2003, Jernigan 1996). Screening involves taking swabs from one or more body sites (e.g., nose, wounds) where carriage is most likely, and carrying out laboratory tests on these samples. Those found to be culture positive are managed in a way to prevent transmission of infection to others.

An assessment of screening policies and infection control practices in 32 health care facilities in Iowa, Nebraska and South Dakota, showed a decline in point prevalence of VRE in facilities where surveillance cultures and isolation of infected patients were instituted (Ostrowsky 2001). Perencivich et al (2004) used mathematical modelling to evaluate interventions to decrease VRE transmission and found the use of active surveillance cultures (ASC) (versus no cultures) decreased transmission by 39% and that with pre-emptive isolation plus ASC, transmission could be decreased by 65%. Estimated costs of ASC and isolation measures to control a MRSA outbreak were compared with the estimated excess costs of not promptly controlling transmission. Weekly active surveillance cultures and isolation of patients with MRSA halted an outbreak at this hospital, and cost 19- to 27-fold less than the attributable costs of MRSA bacteraemias in another outbreak that was not promptly controlled (Karchmer 2002). Recent UK guidelines for MRSA control which were based on systematic review of the evidence recommends targeted screening of high-risk patients based on medical indications or admission to high-risk units (Coia 2006).
Despite success reported by some studies, others did not reach the same conclusion. At a Geneva hospital, nasal and perianal swabs were taken from patients admitted to medical intensive care unit (ICU) and surgical ICU and tested for MRSA. Even though it resulted in a reduction in medical ICU acquired MRSA infections (relative risk 0.3, 95% confidence interval 0.1–0.7), it had no effect in the surgical ICU (relative risk 1.0, 95% confidence interval 0.6–1.7) (Harbath 2006). In another study, all patients in an ICU had nasal and rectal swabs on admission and weekly thereafter; decolonization with antibiotics was provided to MRSA carriers. During the 6-year follow-up period, MRSA remained poorly controlled throughout the hospital even though rate of extended spectrum beta-lactamase-producing Enterobacteriaceae (ESBL-E) acquisition fell (Troche 2005). The effectiveness of multidrug-resistant enterobacteriaceae (MDRE) screening in the non-outbreak setting was questioned by researchers in Toronto. Patients admitted for new organ transplantation were screened for MDRE colonization. Of the 287 patients, 69 (24%) were colonized, and 6 (9%) of the 69 developed clinical infections. Most colonizing isolates (66/69) were unique and no clinical infections resulted from patient-to-patient transmission. The annual cost of a surveillance program was calculated at Canadian $1,130,184.44. Thus, the routine use of MDRE surveillance and isolation was deemed not warranted in the absence of an outbreak in this population (Gardam 2002).

### Level of Evidence: 2-
(Non-randomized intervention studies with a high risk of confounding, bias or chance)

#### 5.7.2 Staff

a. MRSA: A systematic review of staff screening for MRSA concluded that the evidence for staff screening was poor and it was unclear what role colonized staff played in the transmission of MRSA (Nicholson 1997). Another systematic review published in 2006 came to similar conclusions (Ritchie et al).

### Level of Evidence: 2-
(Non-randomized intervention studies with a high risk of confounding, bias or chance)


The purpose is to:
- Identify HCW with inactive TB and when appropriate, to offer them preventive therapy to decrease their risk of developing active TV;
- Identify HCW with active TB and ensure that they are appropriately treated;
- Document conversion rates;
- Establish HCW’s baseline TB infection status, as a reference for future TB exposure.

### Level of Evidence: 4
c. Influenza: The Centers for Disease Control has the following recommendation for health care worker screening in acute care facilities during influenza season (2007):

*If there is no or only sporadic influenza activity occurring in the surrounding community:* Monitor health-care personnel for influenza-like symptoms and consider removing them from duties that involve direct patient contact, especially those who work in specific patient care areas (e.g., intensive care units (ICUs), nurseries, organ-transplant units). If excluded from duty, they should not provide patient care for 5 days after the onset of symptoms.

*If widespread influenza activity is in the surrounding community:* Evaluate health-care personnel, especially those in high-risk areas (e.g., ICUs, nurseries, and organ transplant units) for symptoms of respiratory infection; perform rapid influenza tests to confirm that the causative agent is influenza and to determine whether they should be removed from duties that involve direct patient contact. If excluded, they should not provide patient care for 5 days following the onset of symptoms.

**Level of Evidence: 4**

5.7.3 Visitors

Influenza: The CDC has the following recommendation for visitors to acute care facilities during influenza season (2007). Through the posting of notices, visitors are asked to self-screen for respiratory symptoms and to take the recommended action.

*If there is no or only sporadic influenza activity occurring in the surrounding community:* Discourage persons with symptoms of a respiratory infection from visiting patients. Post notices to inform the public about visitation restrictions.

*If widespread influenza activity is in the surrounding community:* Notify visitors (e.g., via posted notices) that adults with respiratory symptoms should not visit the facility for 5 days and children with symptoms should not visit for 10 days following the onset of illness.

**Level of Evidence: 4**

5.8 Restriction of Admissions and Transfers

Temporary restriction of admissions during an outbreak is a means of protecting susceptible patients from exposure to infection. The CDC (2007) has recommended curtailment or elimination of elective medical and surgical admissions and restriction of cardiovascular and pulmonary surgery to emergency cases during influenza outbreaks (especially those with high attack rates and severe illness) in the community or acute-care facility.

During the SARS outbreak in Toronto, it was determined that disease spread between hospitals was due in part to interfacility patient transfers (Svoboda 2004, Dwosh 2003, Varia 2003). In order to prevent SARS transmission, a command, control, and tracking system known as the Provincial Transfer Authorization Centre (PTAC) was developed; it used a medical decision
algorithm to determine whether a patient transfer could take place. A subsequent study found the PTAC medical decision algorithm highly sensitive and specific in properly authorizing interfacility patient transfers (MacDonald 2006).

This study examined a decision algorithm used to restrict transfer of potentially infectious patients but it did not study the effectiveness of transfer restriction in curbing disease spread in hospitals. No studies were found which have evaluated transfer restriction as an infection prevention and control measure.

Level of Evidence: 4

5.9 Facility Closure

Nosocomial outbreaks of *Pseudomonas aeruginosa* (Moolenaar 2000, Foca 2000) and MRSA (CBC news, March 9, 2007) have led to the closure of neonatal intensive care units (NICU). During the SARS outbreak in Toronto, entire hospitals were closed when nosocomial transmission was documented within the facility (Svoboda 2004). Hospital closures also occurred in other cities such as Beijing, Hong Kong, and Singapore (Gopalakrishna 2004). Facility closure was one of several interventions which were implemented during the outbreak. While SARS cases dropped sharply following enhanced infection-control measures, it is difficult to know what role facility closure played in curbing disease transmission because multiple interventions were used simultaneously (Svoboda 2004).

Level of Evidence: 3
(Case series)
6.0 INFECTION CONTROL IN RELATION TO DISEASES

6.1 Antibiotic-Resistant Organisms

Multidrug-resistant organisms (MDRO) are microorganisms that are resistant to one or more classes of antimicrobial agents. They include such organisms as MRSA, VRE and certain gram-negative bacilli (MDR-GNB) like *Escherichia coli* and *Klebsiella pneumonia*. In most instances, MDRO infections have clinical manifestations that are similar to infections caused by susceptible pathogens but the options for treating these patients are very limited. Increased lengths of stay, costs and mortality have been associated with MDROs. Once MDROs are introduced into a health care facility, transmission and persistence is determined by the availability of vulnerable patients, selective pressure exerted by antimicrobial use, increased potential for transmission, and the impact of prevention efforts (Siegel 2006).

Most studies reporting successful MDRO control have employed 7 to 8 different interventions concurrently or sequentially. They are summarized in Table 6 and were reviewed in a 2006 CDC document, which is available at (Siegel 2006):


Table 6: Control Measures for MDROs Employed in Studies Performed in Health Care Settings, 1982-2005 (Siegel 2006)

<table>
<thead>
<tr>
<th>Focus of MDRO (No. of Studies)</th>
<th>MDR-GNB (n=30)</th>
<th>MRSA (n=35)</th>
<th>VRE (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education of staff, patients or visitors</td>
<td>19 (63)</td>
<td>11 (31)</td>
<td>20 (53)</td>
</tr>
<tr>
<td>Emphasis on handwashing</td>
<td>16 (53)</td>
<td>21 (60)</td>
<td>9 (23)</td>
</tr>
<tr>
<td>Use of antiseptics for handwashing</td>
<td>8 (30)</td>
<td>12 (36)</td>
<td>16 (41)</td>
</tr>
<tr>
<td>Contact Precautions or glove useα</td>
<td>20 (67)</td>
<td>27 (77)</td>
<td>34 (87)</td>
</tr>
<tr>
<td>Private Rooms</td>
<td>4 (15)</td>
<td>10 (28)</td>
<td>10 (27)</td>
</tr>
<tr>
<td>Segregation of cases</td>
<td>4 (15)</td>
<td>3 (9)</td>
<td>5 (14)</td>
</tr>
<tr>
<td>Cohorting of Patients</td>
<td>11 (37)</td>
<td>12 (34)</td>
<td>14 (36)</td>
</tr>
<tr>
<td>Cohorting of Staff</td>
<td>2 (7)</td>
<td>6 (17)</td>
<td>9 (23)</td>
</tr>
<tr>
<td>Change in Antimicrobial Use</td>
<td>12 (41)</td>
<td>1 (30)</td>
<td>17 (440)</td>
</tr>
<tr>
<td>Surveillance cultures of patients</td>
<td>19 (63)</td>
<td>34 (97)</td>
<td>36 (92)</td>
</tr>
<tr>
<td>Surveillance cultures of staff</td>
<td>9 (31)</td>
<td>8 (23)</td>
<td>7 (19)</td>
</tr>
<tr>
<td>Environmental cultures</td>
<td>15 (50)</td>
<td>14 (42)</td>
<td>15 (38)</td>
</tr>
<tr>
<td>Extra cleaning &amp; disinfection</td>
<td>11 (37)</td>
<td>7 (21)</td>
<td>20 (51)</td>
</tr>
<tr>
<td>Dedicated Equipment</td>
<td>5 (17)</td>
<td>0</td>
<td>12 (32)</td>
</tr>
<tr>
<td>Decolonization</td>
<td>3 (10)</td>
<td>25 (71)</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Ward closure to new admission or to all patients</td>
<td>6 (21)</td>
<td>4 (12)</td>
<td>5 (14)</td>
</tr>
<tr>
<td>Other miscellaneous measures</td>
<td>6 (22)β</td>
<td>9 (27)γ</td>
<td>17 (44)δ</td>
</tr>
</tbody>
</table>

α Contact Precautions mentioned specifically, use of gloves with gowns or aprons mentioned, barrier precautions, strict isolation, all included under this heading.
β includes signage, record flagging, unannounced inspections, selective decontamination, and peer compliance monitoring (1 to 4 studies employing any of these measures).
γ includes requirements for masks, signage, record tracking, alerts, early discharge, and preventive isolation of new admissions pending results of screening cultures (1 to 4 studies employing any of these measures).
δ includes computer flags, signage, requirement for mask, one-to-one nursing, changing type of thermometer used, and change in rounding sequence (1 to 7 studies employing any of these measures).
Two systematic reviews of the evidence for interventions in preventing and controlling MRSA concluded that the quality of study in this field was generally weak (Loveday 2006, Cooper 2003). However, the following interventions can be considered in the prevention and control of the disease in acute care hospitals and long-term-care settings (Loveday 2006):

- Use of active surveillance cultures to identify and subsequently manage high-risk patients with MRSA colonization/infection may have a role in reducing transmission.
- The isolation or cohorting of patients with MRSA colonization/infection may have a role in reducing transmission.
- The long term effectiveness of topical decolonization strategies in eradicating MRSA is unproven, but short-term use in specific patient groups may be of benefit.
- The effectiveness of environmental cleaning is an important factor in strategies to prevent the nosocomial transmission of MRSA.
- Treated combinations of the above measures in high-risk environments may have a role in controlling the nosocomial transmission of MRSA.
- Staff compliance with infection control procedures needs to be improved.

BCCDC’s guidelines for prevention and control of antibiotic-resistant organisms can be found at: [http://www.bccdc.org/content.php?item=194](http://www.bccdc.org/content.php?item=194).


### 6.2 Respiratory Diseases

- BCCDC guidelines for the control of Influenza-like-illness (ILI) outbreaks can be found at: [http://www.bccdc.org/content.php?item=194](http://www.bccdc.org/content.php?item=194).
6.3 Enteric Diseases


- BCCDC guidelines for Exclusion of Enteric Cases and their Contacts can be found at: [http://www.bccdc.org/content.php?item=192](http://www.bccdc.org/content.php?item=192).

- BCCDC’s guidelines about prevention of enteric diseases at petting zoos and open farms can be found at: [http://www.bccdc.org/content.php?item=192](http://www.bccdc.org/content.php?item=192).

6.4 Emerging Communicable and Zoonotic Diseases

Emerging diseases include previously unknown diseases or diseases that have reappeared after a significant decline in incidence. Changes in human demographics, behaviour, land use etc. are contributing to new disease emergence by changing transmission dynamics to bring people into closer and more frequent contact with pathogens.


- National and provincial pandemic influenza guidelines are available at:

- BCCDC’s guidelines about prevention of zoonotic diseases at petting zoos and open farms can be found at: [http://www.bccdc.org/content.php?item=192](http://www.bccdc.org/content.php?item=192).
6.5 **Vector-borne Diseases**

Vector-borne transmission occurs when vectors such as mosquitoes, flies, rats, and other vermin transmit microorganisms; this route of transmission is of less significance in causing outbreaks in North America than in other regions of the world (Garner 1996). Such transmission has not been reported in Canadian hospitals (Health Canada 1999).

6.6 **Blood-borne Diseases (e.g., HIV, Hepatitis B and Hepatitis C)**

- Infection control measures such as education, safety devices, sharps management, personal protective equipment etc. to prevent blood-borne diseases have been reviewed by the Public Health Agency of Canada (PHAC) in its report: Prevention and Control of Occupational Infections in Health Care (2002), Appendix II: [http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/02pdf/28s1e.pdf](http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/02pdf/28s1e.pdf).

- Laboratory testing of source blood following a blood and body fluid exposure is recommended by PHAC. This is voluntary and requires informed consent. In Ontario, legislation is in place to allow certain persons to apply to a medical officer of health for an order requiring a blood sample for testing of hepatitis B, hepatitis C and HIV. The results are then made available to the physician of the exposed individual to assist in his/her management of the patient (Ontario Ministry of Health website).

- Hepatitis B prevention should also include universal immunization of children, pre-exposure immunization of high-risk groups (e.g., those at risk of occupational exposure to blood and body fluids) and post-exposure intervention for those exposed to hepatitis B virus. Further information about hepatitis B vaccination can be found in the Canadian Immunization Guide 2006: [http://www.phac-aspc.gc.ca/publicat/cig-gci/index.html](http://www.phac-aspc.gc.ca/publicat/cig-gci/index.html).

- BCCDC guidelines for blood and body fluid exposure management can be found at: [http://www.bccdc.org/content.php?item=192](http://www.bccdc.org/content.php?item=192).

- Evidence for partner notification and post-exposure prophylaxis following exposure to blood borne infections is reviewed in the chapter “Evidence Base for Secondary Prevention of Communicable Diseases.”

6.7 **Reproductive and Sexual Health**

See Section 6.6 (Blood-borne Diseases).

Evidence for screening and partner notification of sexually transmitted infections is is reviewed in the chapter “Evidence Base for Secondary Prevention of Communicable Diseases.”
6.8 Tuberculosis


- Evidence for screening, contact notification and prophylaxis for tuberculosis is reviewed in the chapter “Evidence Base for Secondary Prevention of Communicable Diseases.”


6.9 Vaccine-Preventable Diseases


- A review of post-exposure prophylaxis following exposure to infections can be found in the chapter “Evidence Base for Secondary Prevention of Communicable Diseases.”
## 7.0 CONCLUSION

<table>
<thead>
<tr>
<th>Public Health Measure</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quarantine and Isolation:</strong></td>
<td></td>
</tr>
<tr>
<td>- Moderate evidence of effectiveness demonstrated during SARS outbreak</td>
<td>2-</td>
</tr>
<tr>
<td>- Weak evidence of effectiveness during 1918 influenza pandemic</td>
<td></td>
</tr>
<tr>
<td><strong>Compliance with quarantine:</strong></td>
<td>3</td>
</tr>
<tr>
<td>- Good evidence of voluntary compliance during SARS outbreak</td>
<td></td>
</tr>
<tr>
<td><strong>Exclusion of Sick Children from Child Care Facilities and Schools:</strong></td>
<td>4</td>
</tr>
<tr>
<td>- Recommendation is based on expert opinion</td>
<td></td>
</tr>
<tr>
<td><strong>Day care and School Closures</strong></td>
<td>2-</td>
</tr>
<tr>
<td>- Weak evidence of effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>Exclusion of Infected Workers:</strong></td>
<td>2-</td>
</tr>
<tr>
<td>- Good evidence of effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>Restrictions on Public Gatherings:</strong></td>
<td>4</td>
</tr>
<tr>
<td>- Weak evidence of effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>Simultaneous Use of Multiple Community-based Interventions</strong></td>
<td>2-</td>
</tr>
<tr>
<td>- Moderate evidence of effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>Personal Protective Equipment</strong></td>
<td></td>
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<tr>
<td>- Good evidence of effectiveness of gloves</td>
<td>4</td>
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<tr>
<td>- Weak evidence of effectiveness of gowns</td>
<td></td>
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<tr>
<td>- Good evidence of effectiveness of eye protection but compliance is poor</td>
<td></td>
</tr>
<tr>
<td><strong>Patient and Staff Cohorting</strong></td>
<td>2-</td>
</tr>
<tr>
<td>- Moderate evidence of effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>Patient screening for multidrug resistant organisms</strong></td>
<td>2-</td>
</tr>
<tr>
<td>- Equivocal evidence – some studies show effectiveness while others do not</td>
<td></td>
</tr>
<tr>
<td><strong>Staff screening for MRSA</strong></td>
<td>2-</td>
</tr>
<tr>
<td>- Weak evidence of effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>Staff screening for TB and influenza</strong></td>
<td>4</td>
</tr>
<tr>
<td>- Recommendation is based on expert opinion</td>
<td></td>
</tr>
<tr>
<td><strong>Visitor screening for influenza</strong></td>
<td>4</td>
</tr>
<tr>
<td>- Recommendation is based on expert opinion</td>
<td></td>
</tr>
<tr>
<td><strong>Restriction of admissions or transfers</strong></td>
<td>4</td>
</tr>
<tr>
<td>- Recommendation is based on expert opinion</td>
<td></td>
</tr>
<tr>
<td><strong>Facility Closure</strong></td>
<td>3</td>
</tr>
<tr>
<td>- Has only been studied as part of multiple intervention strategies during SARS outbreak</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


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http://www.cdc.gov/EID/content/13/2/344.htm


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Yoonchang, S.W., Kim, O.S., et al. (2007). Efficacy of infection control strategies to reduce transmission of vancomycin-resistant enterococci in a tertiary care hospital in Korea: a 4-year follow up study. Infection Control and Hospital Epidemiology, 28(4), 493–495.
