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Pathogens can spread easily in high-traffic facilities. Cleaning and disinfection of equipment (medical, clinical) are important components of preventing the spread of microorganisms that can cause infections; however, such equipment is often composed of many different materials, each of which may respond differently to disinfectants used in healthcare and fitness facilities.³

Pathogens such as Clostridium difficile, vancomycin-resistant enterococci (VRE) or methicillin-resistant Staphylococcus aureus (MRSA) can persist on surfaces and items for prolonged periods of time, sometimes up to several months.⁴

Healthcare providers who come in contact with surfaces in the room of a patient colonized with MRSA or VRE have a 42% to 52% risk of subsequent hand or glove contamination with the same organism; this risk is similar to the risk seen following direct contact with the patient.⁵ ⁶ After contact with a VRE-contaminated surface, healthcare providers transmit VRE to the next clean surface or skin site they come in contact with approximately 10% of the time.⁷

Studies show that up to 85% of wheelchairs in hospitals are contaminated with pathogens such as MRSA.⁸

A newly released Canadian report suggests that antibiotic resistance is expected to have a stark impact over the next three decades, with superbugs estimated to lead to 400,000 deaths, resulting in $12 billion in hospital costs by 2050.⁹

Know your high-risk surfaces.

High-touch surfaces and items require more frequent cleaning and disinfection than low-touch surfaces and items, for example, patient beds and surrounding equipment, light switches, blood pressure and ECG carts, nursing stations, call bells, door handles, washrooms, etc.¹¹

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The holiday season is just around the corner. While everyone is busy decorating, shopping and attending social gatherings, there’s another type of festivity taking place. This is the time of year when respiratory viruses have their own blast and the leading socialite among them is the influenza virus. The influenza virus has been around for hundreds of years and makes its appearance every season during the winter months. Although there are 4 types of seasonal influenza viruses (type A, B, C and D), influenza is caused primarily by the influenza A or B virus. Influenza A viruses are classified into subtypes according to the outer covering of the virus: glycoprotein combinations referred to as the hemagglutinin (HA) and the neuraminidase (NA). The influenza B virus instead is broken down into lineages. According to the World Health Organization the subtypes A(H1N1) and A(H3N2) and the influenza type B viruses belonging to B/Yamagata or B/Victoria lineage are currently circulating.

Influenza symptoms usually appear 1 to 4 days after exposure to the virus and can last up to 10 days. The tricky thing about influenza is that you can be infectious one day before the sudden appearance of symptoms which include headache, chills and cough followed by a fever, loss of appetite, muscle aches, and fatigue. In some cases you may not have any symptoms at all but nonetheless spread influenza to those who are more susceptible such as the very young, the very old and those with weakened immune systems. In this category of patients, influenza can cause very serious complications such as pneumonia or the worsening of underlying health conditions that can lead to hospitalization, antibiotic use, and even death. Health Canada estimates that influenza causes approximately 12,200 hospitalizations and 3,500 deaths each year, predominantly due to influenza A viruses.

December is the season to deck the halls but it’s also the period in the Northern Hemisphere when influenza activity is on the rise and this represents a risk for influenza outbreaks. Influenza is easily transmitted by the droplets of an infected person through coughing or sneezing. It may also be transmitted through direct or indirect contact with infected respiratory secretions. Due to the short incubation period, the ease of transmission and rapid spread in gathered spaces, the virus can cause seasonal outbreaks in healthcare settings. This is especially true in long term care where due to the nature of interactions in a home-like setting, ample opportunities for the spread of influenza exist. In the FluWatch report, Canada’s national influenza surveillance system, 1,038 laboratory-confirmed outbreaks were reported during the 2018-19 influenza season, where slightly over 60% occurred in long-term care and almost entirely were related to influenza A. Outbreaks can have a big impact on a healthcare institution affecting the flow of admissions, increasing costs due to isolation and the increased use of resources, prolonging hospitalization, including ICU transfers and contributing to healthcare provider absenteeism.

When it comes to infection prevention and control measures for influenza, we need to step it up during the holiday season. These measures require a multi-modal approach. The influenza vaccine for healthcare providers and patients is the most effective way to prevent influenza infection or to limit the shedding of virus if one does get ill. Other measures are also necessary. Health Canada recommends the following core strategies for preventing influenza infection: staff education, staff access to adequate hand hygiene products and sufficient personal protective equipment, appropriate management of symptomatic healthcare providers, implementation of respiratory hygiene and cough etiquette, use of spacial separation and droplet and contact precautions for managing symptomatic patients, reinforcement of hand hygiene, and application of appropriate environmental measures. Finally, clear administrative policies and procedures on preventing influenza exposures throughout the duration of a patient’s visit to the healthcare setting should be available to all staff and adhered to.

This holiday season, share the joy with those around you and give the gift of a safe holiday by taking action to prevent the spread of influenza.

Silvana Perna is an infection prevention and control specialist who provides consulting services for Hygie. Hygie is a for-profit company that manufactures products for body fluid management in healthcare settings. No specific products are endorsed in this article.
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‘Tis the season…
‘Tis the season…

Prepared by Silvana Perna, M.Sc.(A), CIC, CNS-IPC

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Membership Services Office
Why infection prevention and control professionals should strive to publish

Devon Metcalf MSc, PhD, CIC, Associate Editor
Victoria Williams MPH, CIC, Editor-in-Chief

For the infection prevention and control professional (ICP), the importance of sharing our work, whether it be original research findings, quality improvement initiatives, or experiences with outbreaks, cannot be overstated. While we may engage in research to inform practice within our own organizations, ICPs should strive for broader dissemination achievable through presentations at conferences and publications in peer-reviewed scientific journals. In the absence of such shared experience, ICPs risk working in isolation and struggling with similar challenges when a common solution may exist. Broad dissemination of research can break down silos and spark important conversations among ICPs as well as with our colleagues working in complimentary disciplines such as public health, epidemiology, nursing, microbiology and infectious diseases. It gives ICPs the opportunity to make a contribution to the field and influence practice. The development of evidence-based guidance for decision-making and to inform policies and programs is critically important to the field of infection prevention and control (IPAC), and is dependent on the dissemination of research findings.

In the IPAC Canada 2018 Mega Survey, only 29% of respondents reported having submitted their work for publication in a scientific journal [1]. Barriers to publishing our work may include a lack of time, resources and support from our organizations, inexperience in research and writing, and perhaps limited confidence in our abilities and the suitability of our work for publication. Despite these challenges, ICPs should strive to develop the skills to propose, conduct, analyze and describe their own research to help answer IPAC questions and to advance the knowledge base of the field. For those with less experience in preparing their work for presentation and publication, IPAC Canada has resources available to support the process. The 2019 IPAC Canada and International Federation of Infection Control Conjoint Conference featured a presentation by Kathryn Suh entitled Manuscript Preparation: How to Get Your Paper Published [2]. With the slide deck available on the IPAC Canada website, anyone considering publishing their work can refer to the slides for consideration about the importance of publishing, how to structure a manuscript and practices to avoid. An IPAC Canada webinar entitled Tricks and Tips for Abstract Writing presented by Gwyneth Meyers is also available on the IPAC Canada website [3]. This webinar can support ICPs by providing guidance for writing a compelling abstract for multiple purposes including conference presentations, grant proposals and as part of a manuscript for publication.

Other strategies to address the barriers that ICPs face could include collaborating with or seeking mentorship from a more experienced colleague who may have previously navigated the publication process. Alternatively, experienced researchers could seek out mentorship opportunities to support novice researchers in designing, conducting and writing up their research projects. Starting small, with a simple research project, provides the opportunity to develop the skills needed for more complicated projects. Also, it is important to remember that not all work worthy of publication adheres to the format of formal, original research. There is great value in sharing the lessons learned from an outbreak investigation or a description of a quality improvement initiative. Refer to the Guidelines for Authors for a description of all publication categories accepted by CJIC.

Those in leadership positions should encourage and support ICPs in their publication endeavours to promote staff engagement, and as a means of professional development through the extension of professional knowledge and skills development. Involvement in research activities is recognized by various professional organizations as an important component of the role of an ICP. The IPAC Canada Core Competencies for Infection Control Professionals (2016) describes the required knowledge, skills and attitudes of a competent ICP [4]. The ability to develop research proposals, collect and analyze data and disseminate research findings are classified as foundational core competencies. The Association for Professionals in Infection Control and Epidemiology (APIC) also lists conducting and participating in routine investigational and epidemiological research as a professional and practice standard [5]. Starting in 2020, the Certification Board of Infection Control and Epidemiology, Inc. (CBIC) is offering a new option for recertification. In addition to the current examination option, ICPs will be able to recertify by continuing education. Referred to by CBIC as infection prevention units (IPUs), continuing education includes ‘Publications’ as a category and authors of IPAC-related, peer-reviewed journal articles will receive five IPUs per publication (towards the 40 IPUs minimum required to recertify) [6].

The recognition of the importance of publications in professional development...
by these organizations further highlights the dual benefit to both the ICP and to the broader field of IPAC.

ICPs should evaluate the work we do and the changes we would like to implement to identify what could benefit other ICPs if disseminated broadly. Considering the heavy workload and resource limitation ICPs often face, prioritization of research activities can be a significant obstacle. Engaging leadership with a clear message about the benefits of researching and publishing within our organizations could potentially garner the support and resources necessary for the fundamental work of sharing evidence. If ICPs do not prioritize contributions to our own field and the ongoing maintenance of high-quality IPAC practice, who will?

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POSITION STATEMENT: VRE screening and contact precautions

This position statement was developed by the Standards and Guidelines Committee.
Chair: Madeleine Ashcroft
Principal Authors: Standards and Guidelines Committee

Publication Date
Original: 2012 November
Revised: 2019 November

BACKGROUND
Vancomycin resistant enterococci (VRE) are present in many healthcare facilities across Canada to varying degrees, usually as rectal colonization [1]. VRE bacteraemia is associated with greater hospital mortality and length of stay than vancomycin-sensitive enterococcal (VSE) bacteraemia [2]. In recent years, some Canadian healthcare facilities have decided to reduce or stop screening as well as the use of contact precautions as a VRE control strategy. Others continue to support current guideline recommendations for VRE surveillance and the use of additional precautions [3].

POSITION STATEMENT
IPAC Canada recognizes that while there are various bodies of expert opinion on VRE control, recent Ontario studies [3-7] support ongoing screening and contact precautions. Decisions regarding screening and contact precautions should be based on local epidemiology, and guided by regional and provincial recommendations and requirements [4-9]. Further, any changes to practice should be implemented to improve patient care and not be used as a cost-cutting measure. These changes should only be considered in the context of an infection prevention and control program already meeting or exceeding best practices (including hand hygiene, environmental cleaning, routine practices and additional precautions).

For those healthcare facilities that are considering or have implemented a reduction in VRE control strategies, IPAC Canada recommends an approach that considers the following:

• Epidemiologic investigation and risk assessment for VRE infections;
• Consultation with staff and client groups, including high-risk wards/clinics;
• Consultation with institutional stakeholders;
• Discussion with other internal and external stakeholders, including the health region; and

Further, IPAC Canada recommends that any savings incurred from decreased screening and contact precautions is reinvested in the following activities (as determined by the risk assessment above):
• Education on Routine Practices
• Environmental cleaning;
• Hand hygiene;
• Antimicrobial stewardship;
• Monitoring of healthcare-acquired infections (HAIs); and
• Other activities deemed important for infection control and prevention.

Decreased surveillance of VRE results in a paucity of information regarding colonization. Any reduction in screening and contact precautions should be accompanied by close monitoring of all VRE culture-positive HAIs to ensure that undue harm is not incurred as a result. In the event that harm is found, institutions should be prepared to return to previous policies. It is also highly recommended that those institutions that choose to change their strategy communicate their experiences to other members of the infection control community for future policy making.

STAKEHOLDERS
Infection Prevention and Control Professionals, healthcare workers, and their clients (the Canadian public).

REFERENCES


Investigation of an outbreak of group A Streptococcus in a Regina retirement residence and personal care home, 2018

Trecker M A, Danielson C, Koutsoulis G, Lloyd K, Benz Tramer C, Diener T, Hennink M
Population and Public Health Services, Saskatchewan Health Authority, Regina, SK.

Corresponding author:
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ABSTRACT
Streptococcus pyogenes (group A Streptococcus) is a common bacterium that causes infections ranging from minor illnesses, like strep throat, to life-threatening invasive disease. The elderly are particularly at risk of invasive infection, with this risk compounded by living in communal settings, including long-term care facilities or personal-care homes. Following the identification of five invasive group A streptococcal infections in residents of a Regina retirement residence and personal care home over a period of five months, an outbreak was declared on May 8, 2018. Over the 10 weeks the outbreak lasted, 10 cases were diagnosed, attributable to nine individuals: six residents and three staff. Five of the 10 cases (50%) were invasive, all of which required hospitalization. The predominant emm type was 92 – a type not common in Canada. Interventions, including onsite inspections, weekly surveillance, hand hygiene and environmental cleaning improvements, as well as mass screening for carriage of group A Streptococcus were carried out in collaboration with the personal-care home. Mitigating outbreak risks in private retirement residences and personal care homes requires that facilities establish robust infection control programs, including hand hygiene and effective environmental cleaning, and work collaboratively with Public Health officials to address outbreaks.

KEYWORDS
Group A Streptococcus; Streptococcus pyogenes; iGAS; GAS; personal care home

Group A streptococcal (GAS) infections are caused by a common bacterium, Streptococcus pyogenes. Infections are often mild, manifesting as illnesses like strep throat, and typically respond well to treatment. Invasive disease (iGAS) can occur, however, causing life-threatening conditions such as necrotizing fasciitis or streptococcal toxic shock syndrome. The elderly are particularly vulnerable to iGAS infection [1], and have the highest case-fatality rates [2]. A number of medical conditions have also been found to be associated with increased risk of iGAS, including dermatologic conditions (such as bullous pemphigoid), diabetes, heart disease, and cancer – conditions more common among this demographic. Further, the risk of acquiring GAS is compounded by living in crowded settings, such as long-term care facilities (LTCFs) or personal care homes (PCHs) [3], and there is a substantial amount of evidence related to the risks specific to residents of these facilities [4-6].

Although the related burden of disease and number of deaths is lower in developed countries such as Canada, iGAS is a nationally notifiable disease [7]. In Saskatchewan, an average of 87 iGAS cases was reported annually between 2004 and 2017. Cases occurred at the same rate among males and females, and 21% of cases were 65 years of age and over. The most prominent emm types were emm81, emm1, and emm41.11. The majority of cases presented as bacteremia, with a very small proportion being necrotizing fasciitis (Saskatchewan Ministry of Health, personal communication).

Located in south-central Saskatchewan, Regina is the capital city, with a population of 214,631 individuals, 13.8% of whom are 65 years of age or older [8]. We report here on an outbreak of GAS, which occurred in a dual private retirement residence and PCH in Regina in the late winter till the spring of 2018. The classifications of LTCFs and PCHs differ from one another in that in Saskatchewan, LTCFs are part of the publicly funded healthcare system, and tend to serve residents with more substantial care needs, while PCHs are privately operated facilities, licensed by the Ministry of Health.

This outbreak occurred in a facility that serves as both a private retirement residence and PCH, housing 199 residents, with 50 staff. The multi-story building includes both independent living suites and a PCH. Services provided by the PCH include

ACKNOWLEDGEMENTS
We would like to acknowledge the collaboration of the facility during this outbreak.

CONFLICTS OF INTEREST
None.

1 emm sequence typing is a system used to characterize the degree of genetic diversity among circulating strains of S. pyogenes; emm types are numerical, and, where applicable, the subtype is indicated by a number following the decimal point.
assistance with all activities of daily living, and basic nursing care is provided by Licensed Practical Nurses. Residents, including those that live in the PCH, are able to move about the building via two elevators – one in the south wing and one in the north wing. In February 2018, a new male resident moved into the PCH upon discharge from hospital, where he had been treated for iGAS disease (bacteremia) since December 2017. He would ultimately prove to be the index case of the outbreak.

For the purposes of describing this outbreak, the following case definitions were used. Cases were defined as those with laboratory-confirmed GAS from any site, with or without symptoms. iGAS was defined as isolation of GAS (S. pyogenes) from a normally sterile site, such as blood [9]. Persistently positive cases were those who remained positive for GAS despite appropriate antibiotic therapy. A case was considered to be a repeat infection when an individual was treated for GAS, confirmed to be negative for GAS from all sites post-treatment, and subsequently developed another symptomatic infection with GAS isolation.

On February 2, 2018, the index case of the outbreak was discharged from hospital, where he had been treated for iGAS (blood). He moved into the North wing of the PCH located on the 2nd floor. On March 9, a second case of iGAS (blood) was identified in a resident on a different floor. A third case (blood) followed two days later, on March 11, in a resident living in the same PCH as the index case. At this time, a four-week period of surveillance for GAS was initiated. No new cases were identified among residents and staff during the four-week period, and surveillance was ended on April 10. Between May 3 and 8, however, two new iGAS (blood) cases were identified among residents of the building, including one living in the PCH. At the same time, the index case was re-hospitalized for a cutaneous GAS infection. In light of these new cases, an outbreak was declared on May 8.

All invasive GAS isolates are submitted to the National Microbiology Laboratory for typing and results are available within approximately one month. *emm* typing from the index case identified in December 2017, and the two cases identified in March 2018, revealed the same type (*emm*92), suggesting they could potentially represent the same strain. Unfortunately, however, this cannot be confirmed because strain typing information was unavailable. Screening of staff and residents was carried out to identify any new cases. In total, all 50 staff, and 25 residents living in the north wing PCH, were swabbed (nose, throat, and any open wounds). Three staff members were found to have asymptomatic carriage of GAS in their throats, and one resident had a GAS-positive wound. The three staff were started on Cephalexin 500mg QID for 10 days by their family physicians, per the Guidelines for the Prevention and Control of Invasive Group A Streptococcal Disease [9], and excluded from work until 48 hours after starting the antibiotics. The resident with the positive wound swab was also treated with antibiotics, and was maintained on contact and droplet precautions for 48 hours after treatment initiation. Each case found during mass screening and/or surveillance was re-screened at 14 and 28 days after treatment began.

The initial on-site environmental inspection was carried out by the communicable disease control team made up of Public Health nurses and a Public Health inspector. It included a tour of the facility, assessment of hand hygiene practices, personal protective equipment (PPE) use, and environmental cleaning processes. The inspection revealed a lack of access to hand-washing sinks and alcohol-based hand rub (ABHR), insufficient use of PPE and related isolation procedures, and that environmental cleaning products were not being applied per manufacturers’ recommendations. Links to resources from Public Health Ontario, Public Health Agency of Canada (PHAC), and the Patient Safety Institute were provided to assist the management of the PCH to establish infection control procedures, including PPE use and appropriate isolation measures for their facility.

The primary focus of the response was to improve access to ABHR, reinforce the need for hand hygiene among staff, and address deficiencies in environmental cleaning practices. In total, eight on-site visits were made over the course of the outbreak to support and encourage the adoption of the advised practices, and to assess progress in this area. Public Health staff provided a ‘train the trainer’ session to facilitate a review with all staff of how and when they should be cleaning their hands, utilizing resources from the local health region and the Hand Hygiene Practices in Healthcare Settings document from PHAC [10].

Addressing the lack of access to hand-washing sinks and ABHR was a priority to help curb the spread. Installation of wall-mounted ABHR dispensers and provision of staff with small bottles of ABHR to carry with them was recommended. The PCH management voiced concerns, however, that mounting ABHR dispensers would diminish the ‘home-like’ feeling that they had strived to create, and the unexpected cost delayed the installation of these until the end of the outbreak. Staff were provided with personal-sized bottles of ABHR and facility management initiated a process for auditing whether staff were carrying and using these. When the public health team interviewed staff about their hand hygiene practices, staff reported that they were ‘scared’ because of the outbreak and cleaning their hands more often; however, none of the staff interviewed were carrying the personal size bottles of ABHR at the time.

Steps to address deficiencies in environmental cleaning involved working with the facility cleaning staff and management to ensure the cleaning products were being applied at the right concentration for disinfecting, and that the recommended wet contact time was observed. Increased attention was paid to disinfection of high-touch surfaces in the common areas and in the GAS-positive resident rooms. Public Health worked with management of the PCH to create checklists of the high-touch surfaces, which were to be cleaned on day and night shifts. The use of chemical test strips and a recording log was advised to test and track that the cleaning products were being dispensed at the correct concentration, but this was not done consistently. Testing by Public Health staff during site visits, however, found that the correct concentration of chemical was present on the housekeeping carts in use on the unit. Environmental sampling was not done.

From December 2017, when the index case was in hospital, through June 2018, 10 cases of GAS were diagnosed with links
to the facility (attack rate = 3.0% among residents). In addition
to the index case, there were two cases in March, six in May,
and one in June (Figure 1). The 10 cases were attributable
to nine individuals – six residents and three staff. Of the six
residents and three staff involved in the outbreak, five (55.6%) were female and four (44.4%) were male. The mean age was
91.5 years among residents, and all were over 80 years of age.

The index case was found to be persistently positive with GAS
despite appropriate antibiotic treatments, and another resident
was positive for GAS on two separate occasions (repeat infection).

Five of the 10 cases (50.0%), all among residents, were
invasive, requiring hospitalization. Three of the five non-invasive
cases (60.0%) were among asymptomatic staff, identified upon
screening. Eight of the 10 cases (80.0%) were type emm92; the
remaining two cases (20.0%) – both among asymptomatic staff –
were emm1.0 and emm1.41. (Table 1)

Site visits and interviews revealed that the six resident
cases (all emm92) lived in the north wing of the building.
Cases occurred on all floors of the building, with a significant
clustering of four residents in the PCH. The four rooms in the
PCH were located in close proximity to one another, and to the
north elevator (figure 2). Indirect contact between the index
case and others occurred on various occasions while riding in
the north elevator at the same time. The one staff case with
emm92 had an office in the north wing. This staff member
reported indirect contact with the index case and direct contact
with two of the iGAS cases. Direct contact occurred after onset
of symptoms in the two cases when she was called to assist
when each became ill, requiring transfer to hospital, where each
was diagnosed with iGAS bacteremia.

All but two cases were negative on repeat screens at 14 and
28 days after treatment initiation. The index case was persistently
positive on four different occasions, and one other resident had
positive wounds on two occasions (repeat infection).

This was the first GAS outbreak to occur in a private PCH
in the Regina area. Because PCHs are privately owned and
operated, there are varying degrees of formal infection control
programs, and a collaborative approach to identification of and
response to the outbreak was required. We found the primary
challenges to outbreak control were lack of compliance with

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**TABLE 1: Characteristics of 10 cases of GAS among nine individuals at the Regina PCH (includes one repeat infection).**

<table>
<thead>
<tr>
<th>Case number</th>
<th>ID</th>
<th>New or repeat</th>
<th>Invasive (bacteremia)</th>
<th>Hospitalized</th>
<th>emm type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 R</td>
<td>New</td>
<td>Y</td>
<td>Y</td>
<td>92</td>
</tr>
<tr>
<td>2</td>
<td>2 R</td>
<td>New</td>
<td>Y</td>
<td>Y</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>3 R</td>
<td>New</td>
<td>Y</td>
<td>Y</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>4 R</td>
<td>New</td>
<td>Y</td>
<td>Y</td>
<td>92</td>
</tr>
<tr>
<td>5</td>
<td>5 R</td>
<td>New</td>
<td>Y</td>
<td>Y</td>
<td>92</td>
</tr>
<tr>
<td>6</td>
<td>6 R</td>
<td>New</td>
<td>N</td>
<td>N</td>
<td>92</td>
</tr>
<tr>
<td>7</td>
<td>7 S</td>
<td>New</td>
<td>N</td>
<td>N</td>
<td>1.0</td>
</tr>
<tr>
<td>8</td>
<td>8 S</td>
<td>New</td>
<td>N</td>
<td>N</td>
<td>92</td>
</tr>
<tr>
<td>9</td>
<td>9 S</td>
<td>New</td>
<td>N</td>
<td>N</td>
<td>1.41</td>
</tr>
<tr>
<td>10</td>
<td>5 R</td>
<td>Repeat</td>
<td>N</td>
<td>N</td>
<td>92</td>
</tr>
</tbody>
</table>

**FIGURE 1: Timeline of GAS outbreak at a Regina Personal Care Home, December 2017 to June 2018. (R=resident, S=staff)**

**FIGURE 2: Diagram illustrating the proximity of cases’ rooms (yellow) in the North Wing.**

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proper hand hygiene, and lack of proper implementation of PPE, isolation procedures, and environmental cleaning. The lack of adherence to routine practices, like hand hygiene and/or environmental cleaning, likely contributed to GAS transmission. The spatial clustering of seven individuals (comprising eight cases of infection) with emm92 either living or working in the north wing of the building also supports the possibility of person-to-person transmission, given the common environment and opportunities for contact. Such spatial clustering of cases within a facility has been previously reported [11]. Unfortunately, since strain typing information was not available, we cannot definitively say that these cases shared the same strain. Propagation of infection by staff within such facilities, along with poor infection control measures, has also been documented as potentially contributing to outbreaks [5]. In this scenario, the outbreak was eventually brought under control when access to hand hygiene materials, appropriate environmental cleaning processes, and use of proper PPE were fully established, further supporting the hand hygiene/environmental contamination hypothesis.

An additional element that likely contributed to this outbreak is the fact that the index case had an underlying dermatological condition that predisposed him to remain colonised with GAS in spite of treatment. Because patients such as this are unlikely to be able to be decolonised, strict infection control processes are needed. Such strict controls were not in place in the PCH at the time the index case became a resident, which likely led to environmental contamination and person-to-person spread, most likely by staff at the facility.

Another interesting element of this outbreak was the prevalence of the emm92 type. emm92 is uncommon both nationally and in the province. In Canada, emm1 has generally been the most prevalent emm type [12]. Types emm81 (17%), emm1 (11%), and emm41.11 (8%) are the most common in Saskatchewan (Saskatchewan Ministry of Health, personal communication). In the five-year period from 2013-2018, emm92 was identified in the Regina area only four times previous to this outbreak – twice in 2016 and twice in 2017. No epi-link was identified for the index case, and the source of his initial infection with emm92 remains unknown.

Facilities where elderly residents live together, such as retirement residences or PCHs, with many vulnerable persons living in close proximity, provide an ideal environment for disease transmission. Mitigating this risk requires that facilities establish robust infection control programs, including hand hygiene and effective environmental cleaning. The implication of poor hand hygiene and limited infection control procedures as factors contributing to this outbreak highlight important areas of focus for such facilities. Unlike publicly funded LTCFs, PCHs are privately owned, and operate with no mandatory standards for infection control. Because of this, a collaborative approach between Public Health and PCHs is necessary to ensure the well-being of residents of such private facilities when outbreaks occur.

REFERENCES
The effect of timing of oseltamivir chemoprophylaxis in controlling influenza B outbreaks in long-term care facilities in Manitoba, Canada, 2017-2018: A retrospective cohort study

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ABSTRACT
A retrospective cohort study (n=8) was used to examine the effect of the timing of administration of oseltamivir chemoprophylaxis for the control of influenza B outbreaks among residents in long-term care facilities in Manitoba, Canada during the 2017-2018 influenza season. Delay of oseltamivir chemoprophylaxis was associated with increased odds of influenza-like illness in both univariate and multivariable analyses with an adjusted odds ratio of 1.34 (95% CI: 1.12-1.60) per day for influenza B.

KEYWORDS
Influenza; Outbreak; Long-term care; Oseltamivir; Prophylaxis; Public Health

BACKGROUND
In long-term care (LTC) influenza outbreaks in Manitoba, symptomatic residents receive five days of oral oseltamivir at the therapeutic dose, and all other residents receive 10 days of oseltamivir chemoprophylaxis at the prophylactic dose [1]. This approach is described in many studies, used in other countries, and is similar to the recommendations of the Infectious Diseases Society of America [1-5].

Delayed oseltamivir chemoprophylaxis is associated with increased odds of resident infection during influenza A H3N2 outbreaks in LTC facilities [6], but this has not been studied for influenza B outbreaks. Since oseltamivir is not as effective at treating influenza B as it is for influenza A, the effect of timing of oseltamivir chemoprophylaxis may be different [7]. This study examines the effect of the timing of administration of oseltamivir chemoprophylaxis for the control of influenza B outbreaks among residents in LTC facilities in Manitoba, Canada, controlling for other institutional factors.

METHODS
The main independent variable was the number of days between the true start of the outbreak (the date the second person became ill) and commencement of oseltamivir chemoprophylaxis. The dependent variable was cases of influenza-like illness (ILI) (yes or no). The control variables, measured at the outbreak beginning, were:
1. number of days between declaring an outbreak and starting oseltamivir chemoprophylaxis,
2. number of days between the first and second cases,
3. prevalence of symptomatic infection among residents,
4. prevalence of symptomatic infection among staff,
5. number of at-risk residents,
6. percentage of residents vaccinated,
7. percentage of staff vaccinated,
8. rural (yes or no),
9. publicly operated facility (yes or no), and
10. percent compliance during hand-hygiene audit.

Acknowledgements: The authors would like to thank all of the Regional Health Authority Ethics Review Boards and Infection Prevention and Control Coordinators from the Winnipeg Regional Health Authority (WRHA), Interlake-Eastern Regional Health Authority (IERHA), Northern Regional Health Authority (NRHA), Prairie Mountain Health (PMH), and Southern Health – Santé Sud (SH) for being so helpful in accessing the necessary data and being collaborative partners.

Authorship and Manuscript Preparation: No drug manufacturers had any involvement, direct or indirect, with any portion of the planning or production of this manuscript.

Conflicts of Interest: None.

Funding: None.
Outbreaks were included for analysis if:
1. they occurred between October 2017 and May 2018, and;
2. influenza type was determined.

Outbreaks were excluded if the dependent variable or the main independent variable could not be determined, or if another virus, in addition to influenza B, was detected among residents with ILI at the time of the outbreak.

The data were analyzed using a multilevel logistic regression model. All analyses were two-tailed and conducted at an alpha level (α) of 0.05.

Additional details about methods were previously published when examining influenza A H3N2 outbreaks [6].

RESULTS
There were 20 influenza B outbreaks in LTC facilities during the 2017-2018 influenza season. Twelve outbreaks were excluded: five contained the co-detection of respiratory syncytial virus or human coronavirus, three did not report when oseltamivir was started; and four started oseltamivir on different days in different sections of the institution. The characteristics of the eight remaining influenza outbreaks can be seen in Table 1.

Using a univariate analysis, four independent variables were statistically significant (Table 2): the number of days from the second case to starting oseltamivir (t=2.93, df=6, p=0.026), the number of days from declaring an outbreak to starting oseltamivir (t=3.48, df=6, p=0.013), the number of residents at risk (t=3.60, df=6, p=0.011), and rural location (t=2.59, df=6, p=0.041).

Using a stepwise forward-modelling strategy, one variable was found to be statistically significant (Table 2): the number of days from the second case to starting oseltamivir (t=4.18, df=5, p=0.0087). The number of days from the first case to the second case (t=2.08, df=5, p=0.092), and the number of residents at risk (t=2.31, df=5, p=0.068) both trended towards significance in a two-variable model, but the number of days between the first two cases explained more variation in the sample and was included in the final model. The main effects model was assessed for co-linearity and statistically significant interactions; none were found.

The odds ratio of developing ILI for the number of days from the second case to the start of oseltamivir in the final model is 1.34 (95% CI: 1.12 – 1.60). This means that for every day that passes from the second case to the initiation of oseltamivir, the odds of a resident at risk of infection in the facility developing ILI increases by 34%.

DISCUSSION
These data indicate that the sooner oseltamivir chemoprophylaxis is initiated, the lower the odds of secondary infection with influenza during influenza B outbreaks in LTC facilities in Manitoba. This is the first study to provide evidence supporting the rapid detection of influenza B outbreaks, and the rapid administration of oseltamivir chemoprophylaxis in an LTC resident population. Delays in this process can occur at many key points including: early recognition of illness, collection of nasopharyngeal specimens, transport of specimens to the

<table>
<thead>
<tr>
<th>TABLE 1: Influenza B outbreak characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Resid</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>148</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>299</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>

Note: Resid = residents; OB = outbreak; Prev = prevalence; Vacc = vaccinated; N/A = not available; ILI = Influenza-like-illness; ILI is characterized as acute onset of respiratory illness with fever and cough and with one or more of the following: sore throat, arthralgia, myalgia, or prostration that could be due to influenza[1].
1 Primary cases are defined as cases of ILI occurring on or before the day that the second case occurred.
2 Number of days from second case to start of oseltamivir.
3 Number of days between case one and case two of the primary cases.
4 Number of days from second case to declaration of an outbreak.
5 At the start of the outbreak.
6 Hand hygiene score in the facility during the 2017-2018 influenza season.
7 Rural = a population less than 10,000 in the 2016 Health Canada Census (1=Yes, 0=No)
8 Facilities not directly operated by the Regional Health Authority (1=Yes, 0=No)
laboratory, identification of viruses present, communication of results, making the decision to administer oseltamivir chemoprophylaxis, and the actual administration of oseltamivir. Rural LTC facilities experienced longer delays to initiation of oseltamivir, explaining why this variable was statistically significant with univariate analysis, but no longer significant after controlling for the time to initiation of chemoprophylaxis (Table 2). This delay could be caused by increased time to transport samples to the laboratory, and transport oseltamivir from the drug warehouse to the LTC facility in rural Manitoba. Each point of possible delay is an opportunity for a quality improvement analysis to determine if times can be reduced.

**Strengths:** First, Manitoba employs a common provincial approach to oseltamivir prophylaxis. Second, this study examines secondary attack rate, a more accurate approach than total attack rate. Third, oseltamivir resistance is likely not a confounder since none of the 60 influenza B samples tested in Manitoba for oseltamivir resistance were positive [8]. As well, only one of the 706 influenza B samples tested in Canada for oseltamivir resistance was positive [8]. Fourth, a multilevel model was used, accounting for both the number of outbreaks and the size of the facilities involved.

**Limitations:** First, the final sample size was small, increasing the likelihood that type 2 errors could be made. This also limits the generalizability of the findings since the facilities included in the analysis may not accurately represent the wider population of LTC facilities. Second, not all cases of ILI received a nasopharyngeal swab. Therefore, some cases of ILI that developed during the outbreaks may have been caused by other respiratory viruses. However, this lack of specificity

**TABLE 2:** Univariate and final model predictor Odds Ratios for Influenza-like-illness

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Model Predictions for Influenza Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted OR (95% CI)</td>
</tr>
<tr>
<td># Days from 2nd Case of ILI to chemoprophylaxis (n=8)</td>
<td>1.29 (1.04 – 1.59)</td>
</tr>
<tr>
<td># Days between 1st and 2nd Cases (n=8)</td>
<td>1.07 (0.52 – 2.18)</td>
</tr>
<tr>
<td># Days from Declaring Outbreak to Chemoprophylaxis (n=8)</td>
<td>1.46 (1.12 – 1.90)</td>
</tr>
<tr>
<td>Prevalence of ILI among Residents² (n=8)</td>
<td>1.08 (0.82 – 1.44)</td>
</tr>
<tr>
<td># Residents at Risk² (n=8)</td>
<td>0.99 (0.98 – 0.99)</td>
</tr>
<tr>
<td>Prevalence of ILI among Staff² (n=5)</td>
<td>1.48 (0.51 – 4.28)</td>
</tr>
<tr>
<td>% Staff Vaccinated² (n=4)</td>
<td>0.95 (0.90 – 1.01)</td>
</tr>
<tr>
<td>% Residents Vaccinated² (n=8)</td>
<td>1.08 (0.89 – 1.31)</td>
</tr>
<tr>
<td>Rural³ (Yes or No) (n=8)</td>
<td>5.58 (1.10 – 28.30)</td>
</tr>
<tr>
<td>Hand Hygiene Compliance⁴ (n=5)</td>
<td>1.03 (0.95 – 1.11)</td>
</tr>
<tr>
<td>Privately Run⁵ (Yes or No) (n=8)</td>
<td>0.13 (0.005 – 3.13)</td>
</tr>
</tbody>
</table>

**Note:** OR = odds ratio; ILI = Influenza-like-illness; ILI is characterized as acute onset of respiratory illness with fever and cough and with one or more of the following: sore throat, arthralgia, myalgia, or prostration that could be due to influenza[1].

¹ (-) indicates that this variable was not included in the final model
² At the start of the outbreak
³ Rural = a population less than 10,000 in the 2016 Health Canada census (1=Yes, 0=No)
⁴ Hand hygiene score in the facility during the 2017-2018 influenza season. If more than one audit occurred during this time, scores were averaged
⁵ Facilities not directly operated by the Regional Health Authority (1=Yes, 0=No)

Statistical test: multilevel logistic regression
likely affected all institutions equally at random so only the magnitude of the result should be affected, not the presence of an effect. Third, though this study attempts to control for some of the discrepancy between how various facilities operate, some of these differences may not be accounted for by the control variables and may confound the results in an unpredictable way. Fourth, the analysis does not control for individual factors, such as age, co-morbidities, smoking status, or mobility, among the various LTC facility residents. Therefore, differences such as the number and types of co-morbidities and other demographic differences could be present and affect the results. Fifth, this study does not examine hospitalization or mortality. However, these variables are less sensitive measures of effectiveness.

REFERENCES
Trends in health care-associated infections in acute care hospitals in Canada: an analysis of repeated point-prevalence surveys

Robyn Mitchell MHSc, Geoffrey Taylor MD, Wallis Rudnick PhD, Stephanie Alexandre BSc, Kathryn Bush MSc, Leslie Forrester MSc, Charles Frenette MD, Bonny Granfield BScN, Denise Gravel-Tropper MSc, Jennifer Happe MSc, Michael John MD, Christian Lavallee MD, Allison McGeer MD, Dominik Mertz MD, Linda Pelude MSc, Michelle Science MD, Andrew Simor MD, Stephanie Smith MD, Kathryn N. Suh MD, Joseph Vayalumkal MD, Alice Wong MD, Kanchana Amaratunga MD; for the Canadian Nosocomial Infection Surveillance Program


ABSTRACT

BACKGROUND: Health care-associated infections are a common cause of patient morbidity and mortality. We sought to describe the trends in these infections in acute care hospitals, using data from three national point-prevalence surveys.

METHODS: The Canadian Nosocomial Infection Surveillance Program (CNISP) conducted descriptive point-prevalence surveys to assess the burden of health care-associated infections on a single day in February of 2002, 2009 and 2017. Surveyed infections included urinary tract infection, pneumonia, Clostridioides difficile infection, infection at surgical sites and bloodstream infections. We compared the prevalence of infection across the survey years and considered the contribution of antimicrobial-resistant organisms as a cause of these infections.

RESULTS: We surveyed 28 of 33 (response rate 84.8%) CNISP hospitals (6,747 patients) in 2002, 39 of 55 (response rate 71.0%) hospitals (8,902 patients) in 2009 and 47 of 66 (response rate 71.2%) hospitals (9,929 patients) in 2017. The prevalence of patients with at least one health care-associated infection increased from 9.9% in 2002 (95% confidence interval [CI] 8.4%-11.5%) to 11.3% in 2009 (95% CI 9.4%-13.5%), and then declined to 7.9% in 2017 (95% CI 6.8%-9.0%). In 2017, device-associated infections accounted for 35.6% of all health care-associated infections. Methicillin-resistant Staphylococcus aureus (MRSA) accounted for 3.9% of all organisms identified from 2002 to 2017; other antibiotic-resistant organisms were uncommon causes of infection for all survey years.

INTERPRETATION: In CNISP hospitals, there was a decline in the prevalence of health care-associated infection in 2017 compared with previous surveys. However, strategies to prevent infections associated with medical devices should be developed. Apart from MRSA, few infections were caused by antibiotic-resistant organisms.

Health care-associated infections represent substantial burden on health care systems in highly developed countries, including Canada [1–3]. In 2002, health care-associated infection developed in an estimated 5% of patients admitted to hospital in the United States, resulting in 1.7 million infections and 98,000 deaths [1]. A study using 2015 data from the European Antimicrobial Resistance Surveillance Network (EARS-Net) from 30 countries estimated 426,277 infections with antibiotic-resistant bacteria were associated with health care, with an attributable mortality of 33,110 [2]. A point-prevalence study conducted in 2015 estimated that there were 687,200 health care-associated infections in US hospitals [3].

Timely data on the occurrence of health care-associated infections and antimicrobial-resistant organisms in Canadian hospitals are essential to the response to an evolving epidemiologic situation. Internationally, prevalence surveys are widely used to estimate the incidence and burden of disease from these infections [3–10].

The Canadian Nosocomial Infection Surveillance Program (CNISP) provides data on the incidence of selected health care-associated infections and antimicrobial-resistant organisms [11–15] and conducted point-prevalence surveys in 2002 and 2009 [16, 17]. In 2017, we replicated a point-prevalence survey in CNISP hospitals, to provide an up-to-date estimate of the burden of health care-associated infections and antimicrobial-resistant organisms causing these infections in Canadian hospitals, and to describe the trends observed over time in the three surveys.

METHODS

Sources of data and study population

The Canadian Nosocomial Infection Surveillance Program is a collaboration of the Public Health Agency of Canada (PHAC) and sentinel hospitals across Canada that participate as members of the Canadian Hospital Epidemiology Committee, a subcommittee of the Association of Medical Microbiology and Infectious Disease Canada (Appendix 1, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.190361/-/DC1). Canadian Nosocomial Infection
Surveillance Program hospitals from nine provinces participated in the 2002 and 2009 descriptive point-prevalence surveys, and hospitals from all 10 provinces participated in 2017. Patients of any age who were admitted to a participating CNISP hospital for 48 hours or longer were eligible for inclusion. Patients who had been admitted for less than 48 hours but were admitted within the last month to the survey hospital were also included. We excluded patients admitted to long-term care, maternity, mental health, day surgery or rehabilitation units.

Case definitions
We defined health care-associated infections using the Centers for Disease Control and Prevention (CDC) National Health care Safety Network standard definitions [18], except for central line-associated bloodstream infections for which we used the CNISP definition [19]. We considered an infection to be present if the patient was symptomatic of, or was receiving antimicrobial therapy to treat, a health care-associated infection on the day of the survey. We collected data on the following: pneumonia, urinary tract infection (UTI), primary and secondary bloodstream infection, infection at surgical sites and infection caused by Clostridioides difficile.

Data collection
We identified eligible patients by hospital census on a specified day in February of each survey year. The 2002 survey was conducted in February owing to the timing of budget allocation. To limit the influence of seasonal variation in health care-associated infections and to permit comparison among surveys, the 2009 and 2017 surveys were also conducted in February.

Experienced and trained staff reviewed the medical records of eligible patients for demographic data (age, sex, date of admission and type of ward where the patient was located on the day of the survey) and information on health care-associated infection (infection type, specimen collection date and microbiological etiology when available). In 2017, we collected data on ventilator-associated pneumonia, surgical site infections associated with a prosthetic implant, catheter-associated UTI and central line-associated bloodstream infections. We collected data on methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci and extended-spectrum β-lactamase-producing organisms for all three surveys. Carbapenemase-producing organisms emerged as a concern in Canada in 2010 and were surveyed in 2017 only [14].

Hospital staff who were experienced in collection of surveillance data, use of National Health care Safety Network case definitions and trained in the use of the prevalence survey protocol (infection control professionals) collected data on a standardized form and submitted these forms to the PHAC for data entry, validation and analysis.

We performed double-entry verification, and any inconsistencies in the data were compared with the submitted form and verified by the hospital if required. The Canadian Nosocomial Infection Surveillance Program collects hospital-level data (e.g., bed size, specialized services provided and type of hospital) annually using a standardized hospital profile form. We extracted hospital profile data for CNISP hospitals that participated in the three surveys and included this data in the analysis.

Statistical analysis
We analyzed the data using SAS software (version 9.3). We compared the characteristics of participating hospitals and patients who were surveyed, the prevalence of health care-associated infections and organisms causing infection using standard differences, [20] χ² tests, Fisher-Freeman-Halton exact tests for categorical variables or Kruskal-Wallis tests for continuous variables. We considered a two-sided p value of 0.05 or less as significant.

We calculated the prevalence of health care-associated infection as the percentage of the number of patients with at least one infection over the total number of patients surveyed. We used Poisson regression with the survey year as the exposure variable to calculate the differences in prevalence of infection. We used generalized estimating equations to account for clustering by hospital, and to calculate p values and robust standard errors.

Ethics approval
These surveys were either considered exempt as quality assurance projects or approved by the research ethics boards at participating hospitals if required by institution-specific policies.

RESULTS
Twenty-eight of 33 CNISP acute care hospitals (6,747 patients) participated in the 2002 point-prevalence survey (response rate 84.8%), 39 of 55 hospitals (8,902 patients) in 2009 (response rate 71.0%) and 47 of 66 hospitals (9,929 patients) in 2017 (71.2% response rate). Table 1 provides the characteristics of the participating hospitals. Over the three surveys, the hospitals remained similar with respect to geographic distribution, bed size, hospital type and specialized services provided.

Table 2 provides the characteristics of the patients who were surveyed. Although there were differences in the age distribution and there was an increased proportion of patients located in the intensive care unit (ICU) in 2017, the size of the effect was small (< 0.2) for all characteristics.

For all three surveys combined, a total of 2,647 health care-associated infections were reported in 2,447 patients with infection (1.08 health care-associated infections per infected patient). The prevalence of patients with at least one health care-associated infection increased from 9.9% in 2002 (95% confidence interval [CI] 8.4%-11.5%) to 11.3% in 2009 (95% CI 9.4%-13.5%) followed by a significant decline to 7.9% in 2017 (95% CI 6.8%-9.0%). For all three surveys combined, prevalence of health care-associated infection was higher in patients admitted to ICU, where 16.2% of these patients had at least one health care-associated infection compared with 8.7% of patients in all other units combined (p < 0.001). We observed a major decline in the prevalence of infection in patients in the ICU, decreasing from 20.1% in 2002 (95% CI 15.8%-25.5%) to 17.8% in 2009.
In an analysis restricted to the 18 hospitals that participated in all three surveys, we found that the prevalence of patients with a health care-associated infection was 9.8% in 2002 (95% CI 7.8%-12.2%) to 10.4% in 2009 (95% CI 7.9%-13.7%) and 8.0% in 2017 (95% CI 6.4%-10.1%). Similarly, the prevalence of health care-associated infections in patients in the ICU in these 18 hospitals also declined from 20.2% in 2002 (95% CI 14.9%-27.4%) to 14.3% in 2009 (95% CI 9.9%-20.5%) to 13.9% in 2017 (95% CI 10.8%-17.8%).

Over the three surveys, UTIs (31.9%) were the most common infection type, followed by pneumonia (23.4%), surgical site infection (20.2%), bloodstream infection (15.2%) and C. difficile infection (9.3%). The prevalence of patients with a UTI, surgical site infection and C. difficile infection declined over time, although not significantly. However, the prevalence of patients with pneumonia and bloodstream infection did significantly decrease from 2.9% in 2002 (95% CI 2.4%-3.6%) to 2.7% in 2009 (95% CI 2.1%-3.5%) to 1.8% in 2017 (95% CI 1.5%-2.3%) for pneumonia, and from 1.8% in 2002 (95% CI 1.4%-2.4%) and 2009 (95% CI 1.4%-2.3%) to 1.2% in 2017 (95% CI 0.9%-1.5%) for bloodstream infection (Figure 1).

In 2017, device-associated infections (i.e., ventilator-associated pneumonia, catheter-associated UTI, surgical site infections associated with a prosthetic implant and central line-associated bloodstream infection) accounted for 35.6% of all health care-associated infections (278 of 780 infections). Of the device-associated infections, catheter-associated UTI accounted for 37.1%, ventilator-associated pneumonia for 22.3%, central line-associated bloodstream infection for 21.2% and surgical site infections associated with a prosthetic implant for 19.4%.

Table 3 presents some selected antimicrobial resistant organisms that cause health care-associated infection. Overall, antimicrobial-resistant organisms remained an uncommon cause of health care-associated infection across all survey years. The most common resistant organism was MRSA, which was present in 6.2% of pneumonia infections, 5.6% of bloodstream infections, 5.0% of surgical site infections and 1.1% of UTIs. Of organisms associated with a bloodstream infection, the prevalence of MRSA more than doubled from 3.8% in 2009 to 8.5% in 2017 (p = 0.1). Vancomycin-resistant enterococci infrequently caused infection at any site (1.0%, 0.5% and 0.8% of organisms associated with UTIs, surgical site infection and bloodstream infection, respectively). Carbapenemase-producing organisms were identified in only three infections (two Escherichia coli and one Enterobacter species) in the 2017 survey. Infections associated with extended-spectrum β-lactamases significantly increased in frequency between 2002 (0.4%) and 2017 (2.8%) (p = 0.01), and were most common in patients with UTIs.

Among all health care-associated infections, the percentage of S. aureus isolates that were methicillin resistant remained consistent from 31.4% (2002) to 28.3% (2009) to 31.4% (2017). Conversely, the percentage of Enterococcus species isolates that were vancomycin-resistant increased from 1.9% (2002) to 5.0% (2009) to 8.2% (2017) (p = 0.12).

**TABLE 1: Selected characteristics of participating hospitals for the point-prevalence surveys (2002, 2009 and 2017).**

<table>
<thead>
<tr>
<th>Variable</th>
<th>2002 n = 28</th>
<th>2009 n = 39</th>
<th>2017 n = 47</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participating provinces</td>
<td>BC, AB, SK, MB, ON, QC, NL, NS, PEI</td>
<td>BC, AB, SK, MB, ON, QC, NL, NS, PEI</td>
<td>BC, AB, SK, MB, ON, QC, NL, NS, PEI</td>
<td>0.2</td>
</tr>
<tr>
<td>Region</td>
<td>Eastern Canada</td>
<td>6 (21.4)</td>
<td>8 (20.5)</td>
<td>12 (27.1)</td>
</tr>
<tr>
<td></td>
<td>Central Canada</td>
<td>10 (35.7)</td>
<td>13 (33.8)</td>
<td>13 (28.9)</td>
</tr>
<tr>
<td></td>
<td>Western Canada</td>
<td>12 (42.9)</td>
<td>16 (41.0)</td>
<td>12 (26.3)</td>
</tr>
<tr>
<td>Hospital size</td>
<td>Mean ± SD</td>
<td>441 (246-620)</td>
<td>342 (165-487)</td>
<td>290 (203-436)</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>445 (245-284)</td>
<td>354 (213-422)</td>
<td>343 (222-444)</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>13 (46.4)</td>
<td>20 (51.3)</td>
<td>17 (36.2)</td>
</tr>
<tr>
<td></td>
<td>Mixed</td>
<td>9 (32.1)</td>
<td>15 (38.0)</td>
<td>17 (36.2)</td>
</tr>
<tr>
<td></td>
<td>Pediatric</td>
<td>6 (21.4)</td>
<td>7 (18.4)</td>
<td>11 (23.4)</td>
</tr>
<tr>
<td></td>
<td>Specialized services</td>
<td>ICU</td>
<td>28 (100)</td>
<td>37 (94.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hematology-oncology</td>
<td>26 (93.1)</td>
<td>38 (100)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dialysis</td>
<td>24 (85.7)</td>
<td>35 (92.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burn unit</td>
<td>21 (75.0)</td>
<td>27 (69.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solid organ transplant</td>
<td>15 (53.6)</td>
<td>20 (51.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching hospital</td>
<td>Yes</td>
<td>28 (100)</td>
</tr>
</tbody>
</table>

**Note:** ICU = intensive care unit, IQR = interquartile range, SD = standard deviation.

*Unless specified otherwise.

*Eastern Canada includes Nova Scotia (NS), New Brunswick (NB), Prince Edward Island (PEI) and Newfoundland and Labrador (NL).

*Central Canada includes Ontario (ON) and Quebec (QC).

*Western Canada includes Manitoba (MB), Saskatchewan (SK), Alberta (AB) and British Columbia (BC).
TABLE 2: Selected characteristics of patients who were surveyed in 2002, 2009 and 2017.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>2002</th>
<th>2009</th>
<th>2017</th>
<th>Standardized difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, male</td>
<td>3485 (51.7)</td>
<td>4569 (51.5)</td>
<td>5217 (52.8)</td>
<td>0.03</td>
</tr>
<tr>
<td>Age, mean ± SD; yr</td>
<td>56.1 ± 7.0</td>
<td>57.8 ± 7.9</td>
<td>58.3 ± 7.9</td>
<td>0.08</td>
</tr>
<tr>
<td>Age group, yr</td>
<td>8869</td>
<td>8869</td>
<td>8986</td>
<td>0.08</td>
</tr>
<tr>
<td>Infants (+1)</td>
<td>493 (7.3)</td>
<td>672 (7.6)</td>
<td>837 (8.5)</td>
<td>0.04</td>
</tr>
<tr>
<td>Children (1-17)</td>
<td>481 (7.1)</td>
<td>619 (7.0)</td>
<td>554 (5.6)</td>
<td>0.06</td>
</tr>
<tr>
<td>Adults (18-64)</td>
<td>2444 (36.2)</td>
<td>3052 (34.4)</td>
<td>3235 (32.7)</td>
<td>0.07</td>
</tr>
<tr>
<td>≥ 65</td>
<td>3329 (49.3)</td>
<td>4526 (51.0)</td>
<td>5270 (53.3)</td>
<td>0.08</td>
</tr>
<tr>
<td>Location of patient in hospital on survey day</td>
<td>n = 6736</td>
<td>n = 8864</td>
<td>n = 9012</td>
<td>0.17</td>
</tr>
<tr>
<td>Medical/surgical</td>
<td>4882 (72.4)</td>
<td>5934 (66.7)</td>
<td>5664 (57.1)</td>
<td>0.07</td>
</tr>
<tr>
<td>ICU</td>
<td>713 (10.6)</td>
<td>1027 (11.5)</td>
<td>1227 (12.4)</td>
<td>0.06</td>
</tr>
<tr>
<td>Adult</td>
<td>296 (4.4)</td>
<td>497 (5.6)</td>
<td>583 (5.9)</td>
<td>0.06</td>
</tr>
<tr>
<td>Neonatal</td>
<td>355 (5.3)</td>
<td>475 (5.4)</td>
<td>534 (5.4)</td>
<td>0.06</td>
</tr>
<tr>
<td>Pediatric</td>
<td>62 (0.9)</td>
<td>55 (0.6)</td>
<td>110 (1.1)</td>
<td>0.05</td>
</tr>
<tr>
<td>Hematology/oncology/bone marrow transplant</td>
<td>295 (4.4)</td>
<td>446 (5.0)</td>
<td>526 (5.3)</td>
<td>0.04</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>336 (5.0)</td>
<td>376 (4.2)</td>
<td>404 (4.1)</td>
<td>0.04</td>
</tr>
<tr>
<td>Critical/coronary care (not ICU)</td>
<td>169 (2.5)</td>
<td>209 (2.4)</td>
<td>348 (3.5)</td>
<td>0.07</td>
</tr>
<tr>
<td>Gynecology/obstetrics</td>
<td>123 (1.8)</td>
<td>155 (1.7)</td>
<td>207 (2.1)</td>
<td>0.03</td>
</tr>
<tr>
<td>Trauma/burn</td>
<td>104 (1.5)</td>
<td>92 (1.0)</td>
<td>115 (1.2)</td>
<td>0.05</td>
</tr>
<tr>
<td>Solid organ transplant</td>
<td>104 (1.5)</td>
<td>104 (1.5)</td>
<td>94 (1.0)</td>
<td>0.05</td>
</tr>
<tr>
<td>Other</td>
<td>10 (0.2)</td>
<td>16 (0.2)</td>
<td>174 (1.8)</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Note: ICU = Intensive care unit, IQR = Interquartile range, SD = Standard deviation. *Univariate OR with 95% CI. **Absolute standardized difference.
An important finding of our study is that antimicrobial-resistant organisms other than MRSA remain an uncommon cause of health care-associated infection in the Canadian hospitals that were surveyed; however, their prevalence has increased. Methicillin-resistant *S. aureus* is now widely prevalent as a cause of infection across types, increasingly as a cause of bloodstream infection, reaching 8.5% in 2017. This is a cause for great concern because MRSA associated bloodstream infection is associated with a mortality rate of greater than 20% in patients admitted to hospital [25].

The prevalence of infection associated with extended-spectrum β-lactamases, while remaining low, was highest in 2017. We collected data on carbapenemase-producing organisms in the 2017 survey and found only three infections. The proportion of MRSA (31.4%) and very low frequency of carbapenemase resistance seen in 2017 compares to the prevalence of 45% for MRSA and 5% for carbapenemase-producing organisms in a study of infections in a sample of US hospitals in 2015 [3]. However, the rising MRSA bacteremia data and emerging signs of resistant gram-negative infections in 2017 indicates a need for vigilance and preventive actions to avoid a worsening antibiotic-resistance problem among infections in CNISP hospitals.

The prevalence of health care-associated infections in our surveys (11.3% in 2009 and 7.9% in 2017) are higher than those reported by the CDC (4.0% in 2011 and 3.2% in 2015) [3]. This is likely because our surveys represent data from large, tertiary care hospitals that typically serve patient populations at higher risk for infection compared with general hospitals that were included in the CDC surveys. The distribution and trends in infection in our surveys differed from those found by CDC: in their surveys, pneumonia and *C. difficile* infection were predominant; only surgical site infection and UTI fell in prevalence. The prevalence of health care-associated infections in our 2017 survey (7.9%) was comparable to results reported by a 2016/2017 prevalence survey by the European Centre for Disease Control and Prevention (7.1%) among tertiary care hospitals; [5] however, by excluding low- to very low-risk units such as mental health and maternity, our prevalence could be expected to be slightly higher. Differences in frequency and trends in health care-associated infections among jurisdictions highlights the importance of collecting Canadian data to direct prevention strategies.

**Limitations**

Our surveys have several limitations. First, our findings may not be representative of the general inpatient population in Canada because the populations examined in these surveys were mainly in large, tertiary acute care hospitals. However, our results provide a robust estimate of health care-associated infections in hospitals of this type in Canada. The Public Health Agency of Canada is
conducted additional prevalence surveys in hospital settings that were not included or underrepresented in these surveys. Second, results were not disaggregated by province; this was to protect the confidentiality of individual hospitals because some provinces have few reporting hospitals. Third, slight changes to the National Health Care Safety Network surveillance definitions occurred between the 2009 and 2017 surveys. For example, both the UTI and pneumonia definitions were more specific in 2017 than in 2009. In 2017, a reduction in follow-up period defining surgical site infections occurred, which could reduce the hospital prevalence of these infections [26]. Fourth, laboratory practices have changed over time: for example, laboratories now use more sensitive assays to detect C. difficile infection, which could result in an increase in prevalence [27]. Nevertheless, by adopting the same methods, timing, similar definitions, hospital type and case mix, we have attempted to minimize the potential for protocol variation. Fifth, there is a risk of inconsistent adjudication considering turnover of hospital staff reviewing the medical charts. However, we provided standardized training to data collectors to reduce inconsistencies in data collection. Sixth, although patients in maternity wards are susceptible to health care-associated infections, they were excluded as most infections among this population present after the patient’s brief hospital stay. For consistency, and to permit comparison among surveys, the decision to exclude maternity patients in the 2002 survey was maintained in 2009 and 2017.

CONCLUSION

Using three sequential point-prevalence studies in a sentinel group of Canadian hospitals between 2002 and 2017, we found a reduction in the prevalence of health care-associated infections overall and that infections caused by antimicrobial-resistant organisms remain uncommon. However, continued efforts in infection prevention and control are required to reduce the burden of health care-associated infections further.

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Contributors: Robyn Mitchell and Wallis Rudnick performed the data analysis. Robyn Mitchell and Geoffrey Taylor interpreted the data and drafted the initial manuscript. All of the authors contributed to conception and design of the work, and data acquisition; revised the manuscript critically for important intellectual content, gave final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Data sharing: Study protocols are available. Data-sharing requests will be considered and reviewed by the Public Health Agency of Canada and individual site investigators.

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- Reduces risk of HAI by reducing C.Diff, VRE & other pathogens.
- Automated 5 minute disinfection cycle following each bathroom use.

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For more information or to schedule a presentation, please contact:

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Neutral pH PCS 250 Oxidizing Disinfectant/Disinfectant Cleaner DIN 02314843

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<th>Description</th>
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<tr>
<td>#5908NPH-6</td>
<td>946 mL</td>
<td>6/cs</td>
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<td>#6048-6</td>
<td>70 container wipes 7” x 12” 500 mL container PCS 250 Oxidizing Disinfectant/Disinfectant Cleaner</td>
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PCS Friction Natural Organic Multi-Purpose Cleaner

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<th>Code</th>
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<td>#6079-6</td>
<td>70 container wipes 7” x 12” 500 mL container PCS Friction</td>
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