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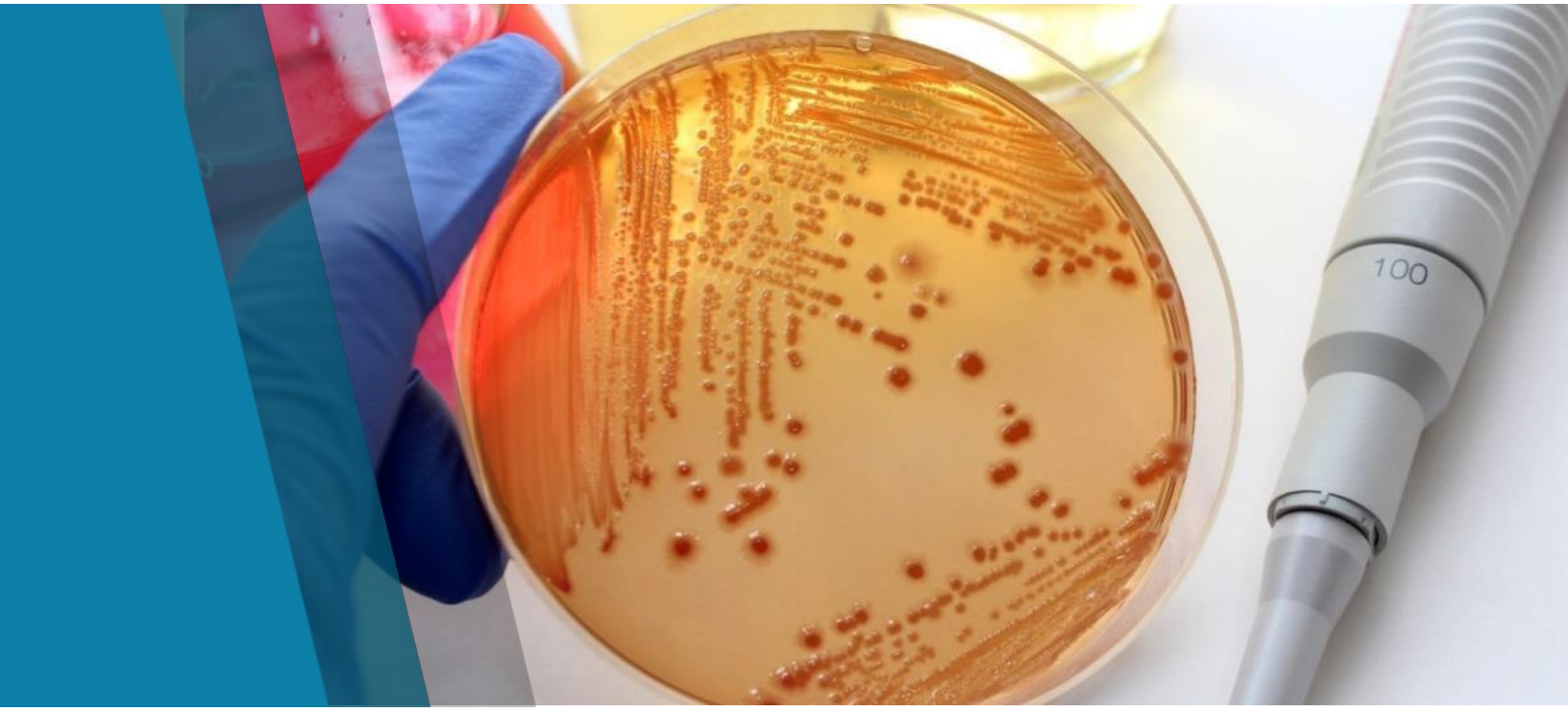
Institute for Quality Management in Healthcare

Antimicrobial Resistance in Common Hospital Pathogens in Ontario

Annual Laboratory and Hospital Survey Report 2016



Annual Report

August 2018

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- emergency preparedness
- health promotion, chronic disease and injury prevention
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Institute for Quality Management in Healthcare

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Authors

Emily Shing, MPH
Epidemiologist
Infection Prevention and Control
Public Health Ontario

Michelle E. Policarpio, MSc
Epidemiologist
Infection Prevention and Control
Public Health Ontario

Elaine Kerr, ART, BA
Consultant Technologist
Institute for Quality Management in Healthcare

Samir N. Patel, PhD, FCCM
Deputy Chief Microbiology
Public Health Ontario Laboratory
Public Health Ontario

Jennifer Robertson, PhD
Manager
Infection Prevention and Control
Public Health Ontario

Jennie Johnstone, MD, PhD, FRCPC
IPAC Physician and Scientist
Infection Prevention and Control
Public Health Ontario

Eva Truong, BA
Research Assistant
Infection Prevention and Control
Public Health Ontario

Gary Garber, MD, FRCPC, FACP, FIDSA
Chief
Infection Prevention and Control
Public Health Ontario

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We also acknowledge Dr. Donald Low who initially developed the concept of this reporting system in 1995, and Allison McGeer and Christine Fleming who oversaw data collection and compilation of data over the following years.

Contents

Executive Summary

Objective: The objective of this report is to provide findings of surveys on the burden of antimicrobial-resistant organisms (ARO) and infection control practices in Ontario.

Methods: In 2017, the Institute for Quality Management in Healthcare (IQMH) sent a survey assessing the number of antimicrobial-resistant organisms (AROs) isolated in 2016 to all licensed laboratories that perform bacteriological testing in Ontario. Similarly, Public Health Ontario (PHO) sent a survey to infection prevention and control teams of all hospitals that provide inpatient care assessing infection control practices related to AROs in 2016.

Results: A total of 76 of 79 laboratories providing service for 202 hospitals in Ontario responded to the IQMH survey.

Based on data provided by laboratories, there was an overall 18.9% decrease in patients colonized or infected with methicillin-resistant *Staphylococcus aureus* (MRSA) in 2016 compared to 2015. South East LHIN and Central West LHIN experienced the greatest decrease in the rate of MRSA patients from 2015. Six LHINs experienced an increase in the rate of MRSA patients reported in 2016 compared to 2015.

Laboratories across the province reported 637 incident patients with a clinical (i.e., non-screening) isolate of VRE in 2016, a 15.7% decrease compared to 756 patients with clinical VRE isolates in 2015. The change in rates of VRE from clinical isolates varied by LHIN region, with Central West and North West LHINs reporting significantly lower rates in 2016 compared to 2015. The proportion of VRE-infected patients with bacteremia has increased noticeably since 2013 – from 84 (5.0%) of 1,683 VRE infections in 2013, 61 (8.1%) of 756 VRE infections in 2015, to 148 (23.1%) of 637 VRE infections in 2016, comparable to what was described in the PHO Memorandum from June 23, 2017.[1]

Laboratories reported consistent proportions of resistance among third-generation cephalosporins and ciprofloxacin in *Escherichia coli* and *Klebsiella* spp. isolates in 2016 compared to 2015. Approximately, 12.7% of *P. aeruginosa* isolates were resistant to ciprofloxacin in 2016, similar to 13.6% resistant isolates in 2015. Among *Acinetobacter* spp. isolates, ciprofloxacin resistance was 5.6% in 2016, comparable to 7% resistance in 2015.

In 2016, 144 patients were identified as colonized or infected with carbapenemase-producing organisms (CPO) by laboratories in Ontario. Among these patients, 70 (48.6%) were E. coli, 55 (38.2%) were *Klebsiella* spp. positive for carbapenemase. Similar to 2015, New-Delhi metallo-beta-lactamase (NDM) mediated resistant *Enterobacteriaceae* were the most commonly isolated CPO in 2016.

Of all laboratories, 61 (80.3%) reported screening for *C. difficile* toxin in-house, and 15 (19.7%) laboratories sent stool samples directly to Public Health Ontario Laboratory (PHOL) or to another laboratory for testing in 2016. The 7 laboratories in Toronto Central LHIN reported the greatest number of specimens tested for *C. difficile* toxin – a total of 34,130 specimens tested, with 4,321 (12.7%) positive specimens identified. Overall, 54 (88.5%) of 57 laboratories with in-house *C. difficile* testing laboratories reported a turnaround time (TAT) of <24 hours from when the specimen is received to when the test result is reported.

112 (53.6%) of 209 hospitals responded to the hospital-based infection control survey. Among the hospital respondents, 23 (20.5%) acute teaching hospitals, 36 (32.1%) large community hospitals, 36 (32.1%) small community hospitals, and 17 (15.2%) other hospital types (e.g., complex continuing care, mental health hospitals, rehabilitation). Similar to 2015, nearly all responding hospitals reported having a MRSA screening program (111 (99.1%) of 112 hospitals). The majority of hospitals screened patients who were directly admitted from other health care institutions and nursing homes or were roommates of patients with MRSA.

The proportion of hospitals that reported having no VRE screening program increased from 18 (9.3%) of 194 hospitals in 2013, to 27 (20.9%) of 129 hospitals in 2015, to 31 (29.5%) of 105 hospitals in 2016. Of the 74 hospitals with a VRE screening program, common practices included screening roommates of VRE colonized or infected patients or those who were directly admitted from another health care institution or nursing home.

In 2016, 36 (32.1%) of 112 hospitals screened patients for extended spectrum beta-lactamase (ESBL) organisms. Hospitals in Ontario have varying practices in applying additional precautions for those patients who are colonized or infected with ESBL-producing organisms; 57 (54.8%) of 104 responding hospitals reported using additional precautions for all identified colonized or infected patients, whereas 29 (27.9%) hospitals reported they did not use additional precautions.

A total of 98 hospitals provided information on CPE screening practices; 50 (51.0%) reported having a screening program to identify patients with CPE. Of these hospitals, 37 (74.0%) screened patients admitted directly from hospitals abroad or with a history of hospital admission in another country, and 14 (28.0%) screened patients with a travel history abroad.

Among 111 respondents on *Clostridium difficile* infections (CDI) infection control practices, 86 (77.5%) reported using additional precautions on all identified colonized or infected patients with CDI, and 24 (21.6%) reported using additional precautions on some patients (e.g., symptomatic with diarrhea or infected patients only). Combination cleaning practices for patients with CDI were common and in 80 (71.4%) hospitals, cleaning twice daily and disinfection of resident bathrooms using a sporicidal agent was combined with notifying environmental services staff of additional cleaning requirements for residents on additional precautions.

Conclusions: AROs contribute substantial health and economic burden to the health care system in Ontario and pose a serious threat to public health as the effectiveness of antimicrobials declines. Our surveys enable PHO and IQMH to monitor the burden of AROs across the province, as well as infection control practices related to AROs in Ontario over time. Supporting consistent infection control practices between health care facilities in Ontario, as well as continued surveillance and monitoring of AROs plays a crucial role in informing policies and practices aimed to prevent the spread of resistant organisms in health care settings and in our communities.

Abbreviations

ARO	Antimicrobial-resistant organism
CDI	*Clostridium difficile* infection
C & S	Culture and sensitivity
CPE	Carbapenemase-producing *Enterobacteriaceae*
CPO	Carbapenemase-producing organism
ESBL	Extended spectrum beta-lactamases
HAI	Health care-associated infection
IQMH	Institute for Quality Management in Healthcare
MRSA	Methicillin-resistant *Staphylococcus aureus*
PHO	Public Health Ontario
PHOL	Public Health Ontario Laboratory

Postal code regions:

K - Eastern

L - Southcentral

M - Toronto

N - Southwestern

P - Northern

QMP-LS	Quality Management Program–Laboratory
VRE	Vancomycin-resistant enterococci

Background

Antimicrobial resistance is a global public health problem. The World Health Organization (WHO) reports that there were high proportions of antimicrobial-resistant bacteria that cause common infections in all regions of the world.[2] In the United States, the Centers for Disease Control and Prevention (CDC) estimates that at least 2 million illnesses and 23,000 deaths annually were caused by antimicrobial resistance.[3] In Canada, it has been estimated that the incidence of health care-associated infections (HAIs) is over 220,000 per year, resulting in more than 8,000 deaths.[4] Control of antimicrobial-resistant organisms (AROs) requires coordinated efforts from various sectors. Collection, analysis, and dissemination of data are the first step in understanding the breadth of the issue and identifying potential solutions.

From 1996 to 2014, the Institute for Quality Management in Healthcare (IQMH), formerly Quality Management Program – Laboratory Services (QMP-LS), administered an annual survey on antimicrobial resistance in common hospital pathogens to all licensed Ontario bacteriology laboratories. Data collected from this annual survey was summarized in a report, shared with all laboratories and posted on the IQMH website for public access. This survey was consistently administered for years, providing a reliable annual update of information on AROs and trends over time. Due to the close working relationship between QMP-LS and laboratories for accreditation and proficiency programs, Ontario laboratories responded to the survey with nearly 100% completion rate. This unique collaboration allowed all laboratories in the jurisdiction to gather information of laboratory and infection control practices related to the control of AROs.

In 2016, Public Health Ontario (PHO) and IQMH established a partnership to conduct annual surveillance of AROs in laboratories and hospitals. As part of this collaboration, IQMH resumed laboratory survey administration in 2016, while PHO administered the hospital survey to infection control practitioners. In 2017, both surveys underwent review and editing, applying feedback received in the previous survey cycle. Questions have evolved to capture changing trends in AROs in Ontario. In 2017, data collected included the prevalence of carbapenemase-producing organisms (CPO), including both *Enterobacteriaceae* and non-*Enterobacteriaceae* organisms. Analyses for both datasets were completed at PHO, and coordination between IQMH and PHO was ensured during the development and promotion of the final report.

Report Objectives and Scope

The objective of this report is to provide information and share findings of the surveys on antimicrobial resistance of common hospital pathogens among laboratories and hospitals in Ontario in 2016. Information on the burden of AROs, laboratory information, and screening practices, as well as infection control practices related to methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), antibiotic-resistant gram-negative bacilli, carbapenemase-producing organisms (CPO), and Clostridium difficile infection (CDI).

Methods

Two separate surveys were conducted in 2017 by IQMH and PHO to assess the number of ARO isolates and infection control practices related to ARO. In February 2017, IQMH conducted the laboratory-based survey. This survey asked questions on laboratory type, number of new patients identified and other laboratory practices, and experiences in 2016 related to MRSA, VRE, antibiotic-resistant gram-negative bacilli, CPO, and CDI. It was administered to all 79 currently licensed bacteriology laboratories in Ontario using IQMH's pre-existing questionnaire interface.

In March 2017, PHO conducted a hospital-based survey among hospitals in Ontario using FluidSurveys. All 209 hospitals providing inpatient care in 2016 were invited to participate in the survey. The hospital survey asked questions about hospital type, details on their screening programs for MRSA, VRE, extended spectrum beta-lactamase (ESBL)-producing organisms, CPE and CDI, screening practices upon patient admission, and infection control practices.

The survey items in both questionnaires were similar to the 2015 IQMH comprehensive survey questionnaire. Each survey ran for approximately one month. Data from both surveys were extracted from their current interface and cleaned by a PHO epidemiologist in collaboration with an IQMH consultant technologist. In most cases, no attempt was made to verify the submitted data and inaccuracies may be present. This survey is dependent on complete and accurate responses in order to provide useful information on AROs that may benefit laboratories practicing bacteriology. Data were analyzed using SAS Enterprise Guide and Microsoft Excel.

Results

A total of 76 (96.2%) of the 79 currently licensed bacteriology laboratories responded to the laboratory based survey – 54 (71.1%) hospital-based, 11 (14.5%) community-based, and 11 (14.5%) public health laboratories. These 76 laboratories provided service for 202 hospitals in Ontario in 2016.

112 of the 209 hospitals (53.6%) that provided inpatient care in 2016 responded to the hospital-based survey – 23 (20.5%) acute teaching hospitals, 36 (32.1%) large community hospitals, 36 (32.1%) small community hospitals, and 17 (15.2%) 'other' hospital types (e.g., complex continuing care and rehabilitation, mental health hospitals).

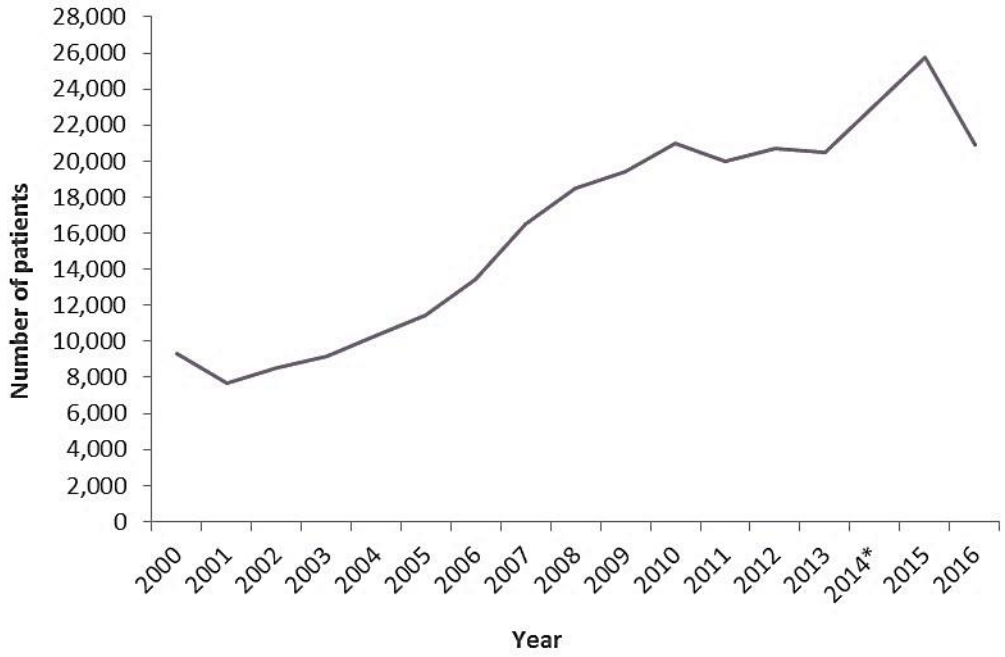
Nearly all (23/26, 88%) of acute teaching hospitals surveyed responded to the survey. The majority (61%) of small community hospitals responded, followed by 44% of 'other' hospital types, and 40% of large community hospitals.

Methicillin-Resistant *Staphylococcus aureus* (MRSA)

Laboratory Data

In total, 59 laboratories reported 20,900 patients colonized or infected with MRSA (median: 189 patients, range: 1–2,620 patients). This represents an 18.9% decrease from 2015 when 25,767 MRSA patients were reported (Figure 1).

FIGURE 1. NUMBER OF PATIENTS COLONIZED OR INFECTED WITH MRSA IN ONTARIO, 2000 TO 2016.



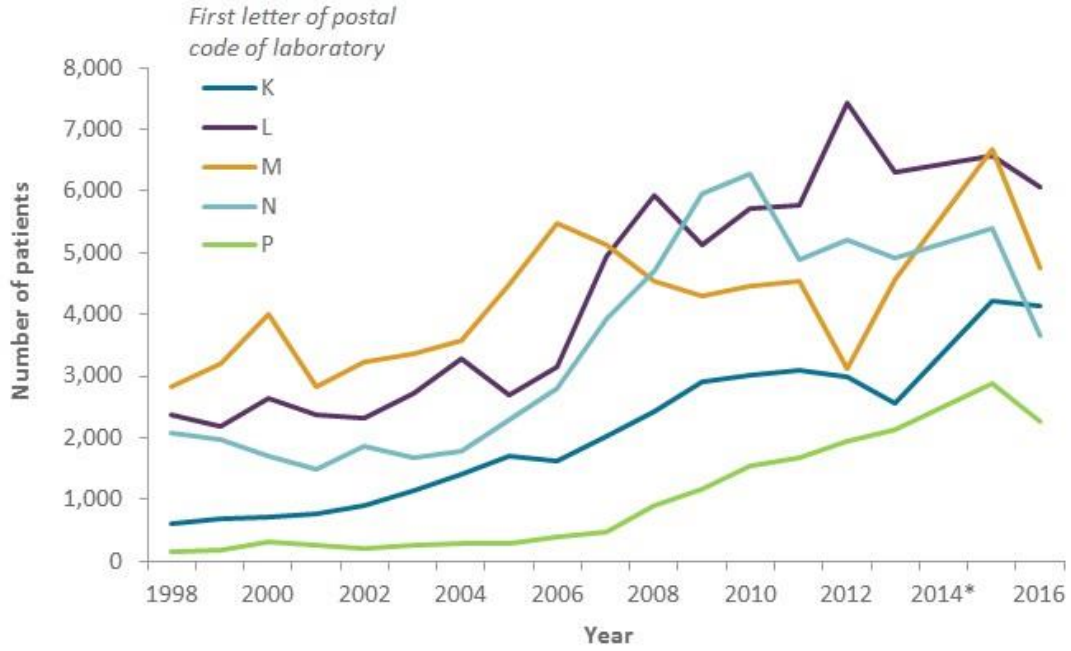
*Survey not conducted in 2014

The number of MRSA cases decreased across Ontario in all regions between 2015 and 2016 (Figure 2). Southwestern Ontario (postal code N) experienced the largest change with a 32.4% decrease from 2015. Toronto area laboratories (postal code M) reported 28.6% fewer MRSA patients in 2016 (4,762 patients in 2016, compared to 6,672 patients in 2015).

Six LHINs experienced an increase in the rate of MRSA patients reported in 2016 compared to 2015 (Figure 3). Most notably, Mississauga Halton LHIN reported an increase of 1.0 to 4.8 patients with MRSA per 1,000 days of patient care. Central LHIN reported 1,286 MRSA patients in 2016, compared to 365 patients in 2015 (rate increased from 0.5 to 1.7 patients with MRSA per 1,000 days of care).

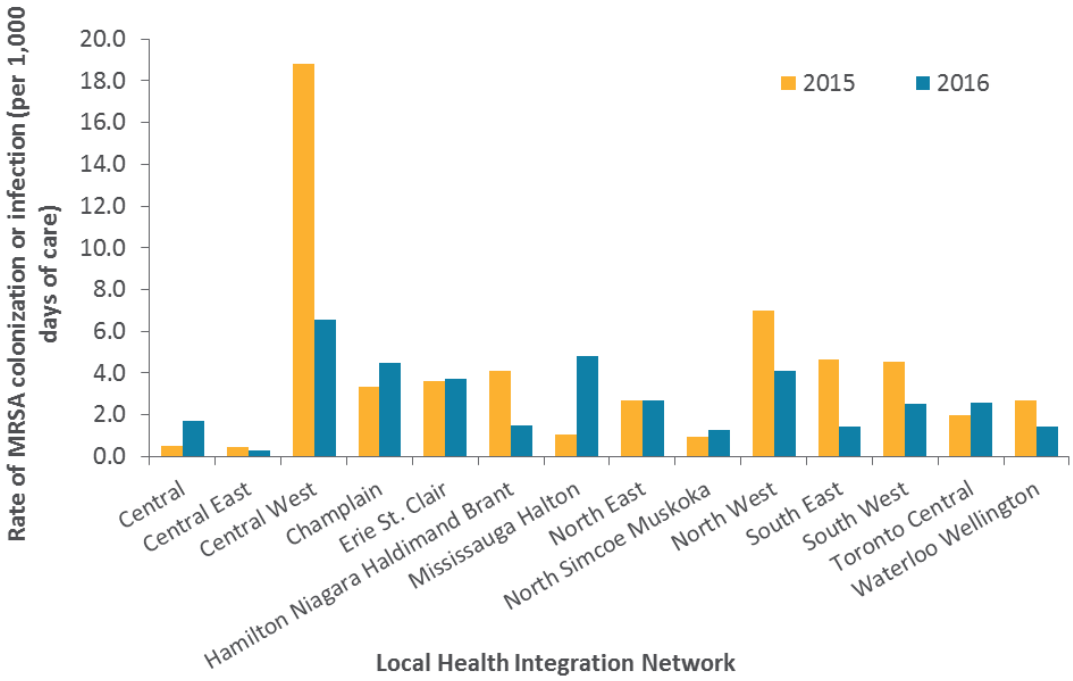
In contrast, South East LHIN and Central West LHIN were among 7 LHINs that reported lower rates of MRSA in 2016 compared to 2015. In South East LHIN, 455 patients with MRSA were reported in 2016 compared to 1,442 patients reported in 2015 (rate of 4.6 to 1.4 patients per 1,000 days of care in 2016). In Central West LHIN, the rate of patients with MRSA decreased from 18.3 to 6.5 per 1,000 days of care in 2016 (Figure 3).

FIGURE 2. NUMBER OF PATIENTS COLONIZED OR INFECTED WITH MRSA, STRATIFIED BY GEOGRAPHIC REGION, 1998 TO 2016.



*Survey not conducted in 2014

FIGURE 3. RATE OF MRSA COLONIZATION OR INFECTION PER 1,000 DAYS OF CARE*, STRATIFIED BY LHIN, 2015 AND 2016.



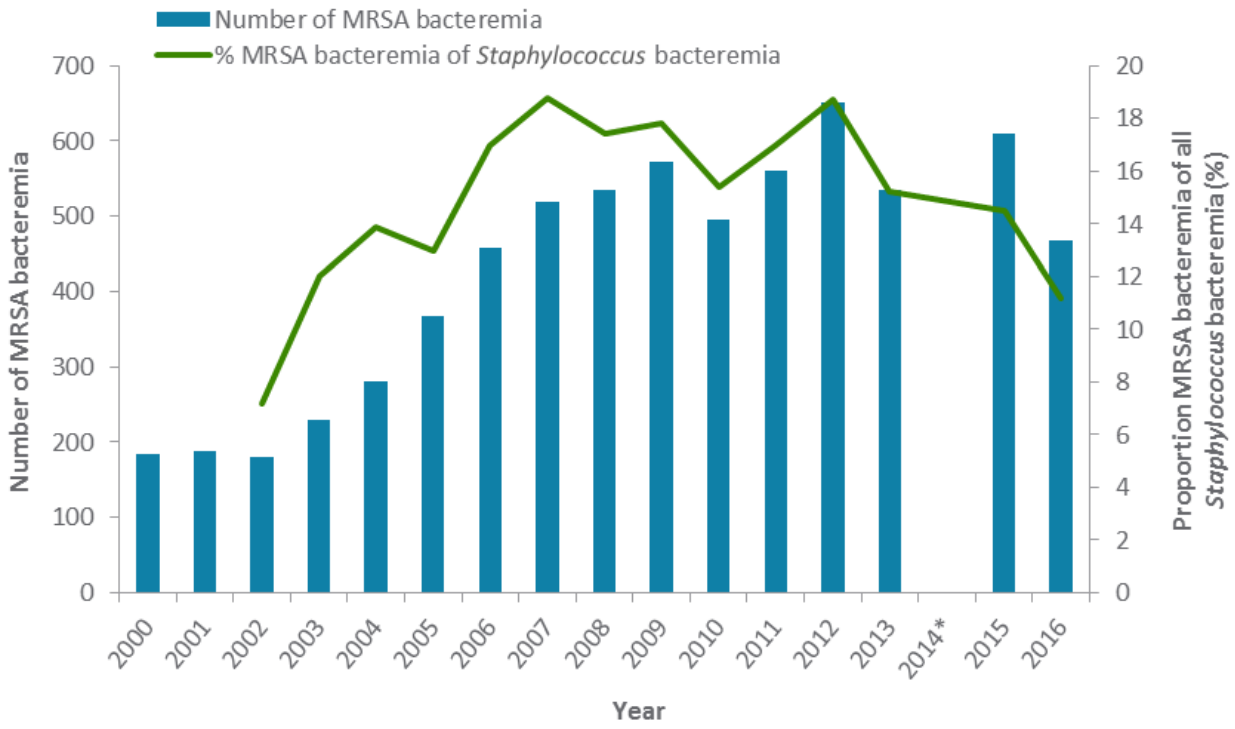
*Days of Care 2015, 2016, IntelliHEALTH ONTARIO, Ontario Ministry of Health and Long-Term Care, Date Extracted: March 19, 2018.

Laboratories were able to provide the MRSA-positive patient setting of 12,287 (58.8%) of 20,900 patients. Of these, 5,916 (48.1%) MRSA-positive patients were identified in acute care inpatient settings, 2,173 (17.7%) in emergency and ambulatory outpatient settings, 189 (1.5%) in rehabilitation institutions, 256 (2.1%) in complex and continuing care settings, 303 (2.5%) in long-term care facilities, 736 (6.0%) in community settings, 1,144 (9.3%) from referred specimens, and 1,570 (12.8%) from health care settings other than those listed.

Among 53 laboratories that distinguished between patients with colonized MRSA vs. MRSA infection, 4,877 (33.9%) of 14,373 patients had an MRSA infection in 2016, whereas in 2015, 8,171 (38.4%) of 21,254 patients had an MRSA infection. See note in Appendix A about MRSA data assumptions.

The proportion of MRSA bacteremia decreased by 3.3%, from 609 (14.5%) of 4,191 total blood cultures in 2015, to 467 (11.2%) of 4,176 total blood cultures in 2016 (Figure 4). The greatest number of bacteremia were reported from laboratories in Toronto Central LHIN (81 (17.3%) bacteremia cases in 2016).

FIGURE 4. MRSA BACTEREMIA REPORTED BY LABORATORIES IN ONTARIO, 2000 TO 2016.



*Survey not conducted in 2014

A total of 54 laboratories (11 community, 43 hospital laboratories) servicing 182 hospitals reported screening for vancomycin-intermediate resistance (VISA) and/or heterogenous VISA (hVISA); 12 laboratories did not respond.

There were 10 (18.5%) laboratories that reported using brain heart infusion (BHI) 6 mg/L agar plates to screen for VISA/hVISA and 18 (33.3%) laboratories that used automated systems. 21 (38.9%) laboratories used both plates or automated systems to screen for VISA/hVISA. A total of 44 (81.5%)

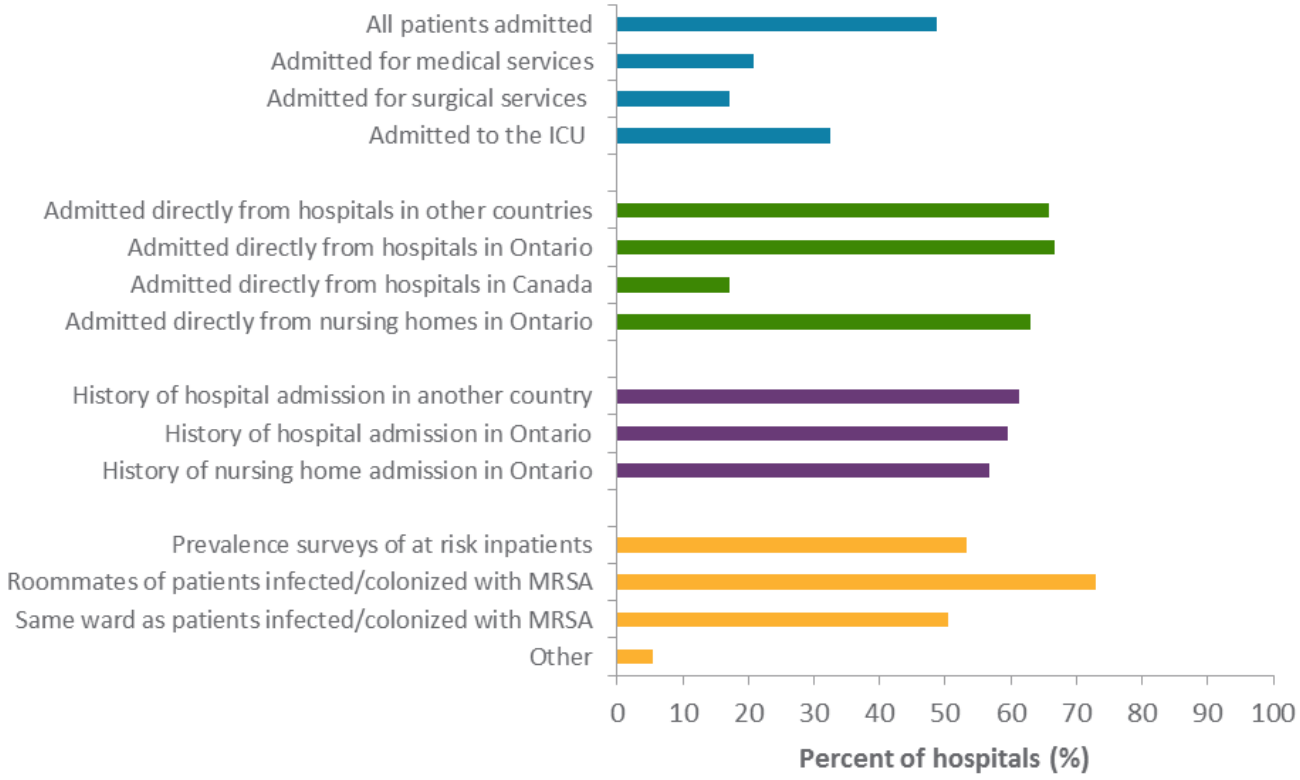
laboratories sent isolates to public health or reference laboratories to confirm VISA/hVISA after screening. Two hospital-based laboratories (Champlain, South West) each reported one patient with VISA in 2016, compared to 7 patients reported with VISA in 2015.

Hospital Data

Among all 112 hospital respondents, 111 (99.1%) hospitals reported having a screening program for MRSA in 2016. Of the 111 hospitals, 54 (48.6%) hospitals screened all patients who were admitted for MRSA, and 72 (34.3%) hospitals screened patients if they had been admitted to another hospital within the past 12 months.

In addition, 73 (65.8%) hospitals screened patients directly admitted from hospitals abroad, 74 (66.7%) screened patients directly admitted from other Ontario hospitals, 81 (73.0%) screened roommates of patients identified as colonized or infected with MRSA, and 70 (63.1%) screened patients directly admitted from nursing homes in Ontario as part of their screening program (Figure 5).

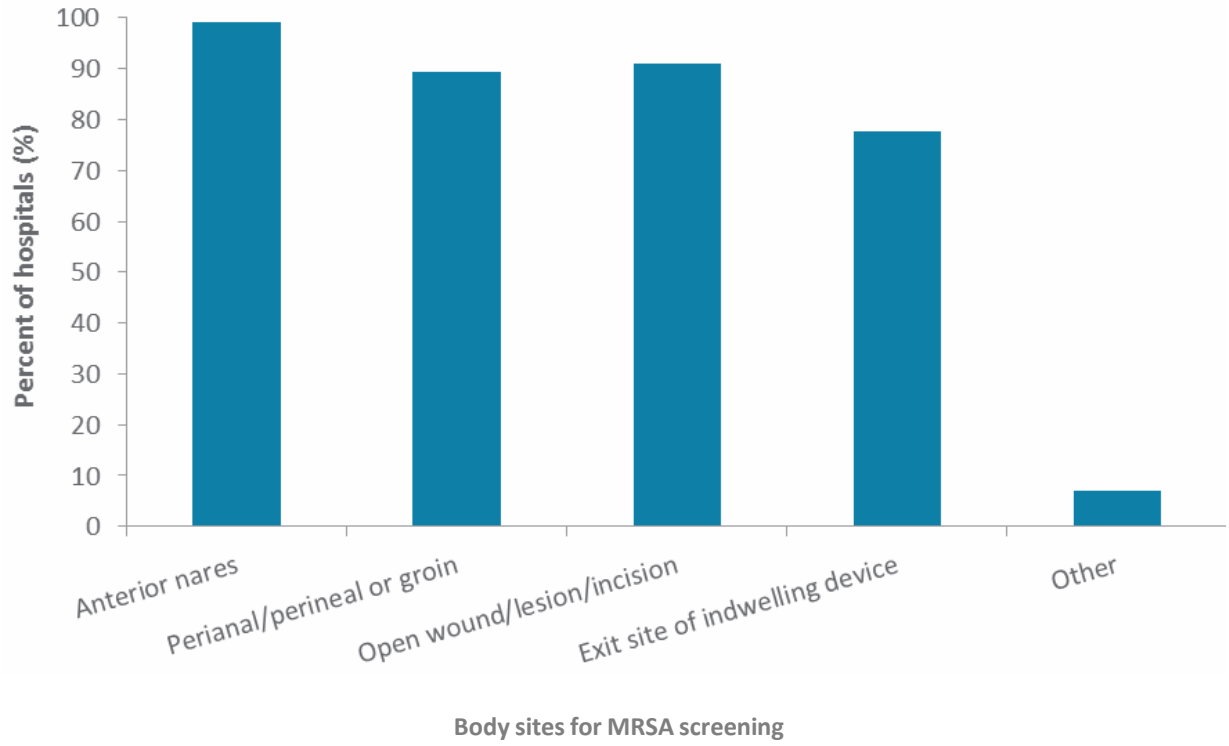
FIGURE 5. CRITERIA FOR PATIENT SCREENING AMONG ALL HOSPITALS WITH A MRSA SCREENING PROGRAM, 2016 (N=111).



All 111 hospitals reported obtaining swabs for MRSA screening from anterior nares, 102 (91.9%) hospitals obtain specimens from wounds, lesions, or incisions, and 100 (90.1%) hospitals obtain specimens from perianal, perineal, or groin specimens (Figure 6). The majority of hospitals reported obtaining specimens for MRSA screening from a combination of sites – 102 (91.9%) hospitals obtain

specimens from anterior nares and open wounds, and 84 (75.7%) hospitals obtain specimens from the anterior nares, perianal/perineal region, open wounds, and exit sites of indwelling devices to screen for MRSA. A total of 29 (26.1%) hospitals reported decolonizing patients with MRSA; the remaining 82 hospitals do not currently have a decolonization protocol in place.

FIGURE 6. BODY SITES USED FOR MRSA SCREENING (N=111).



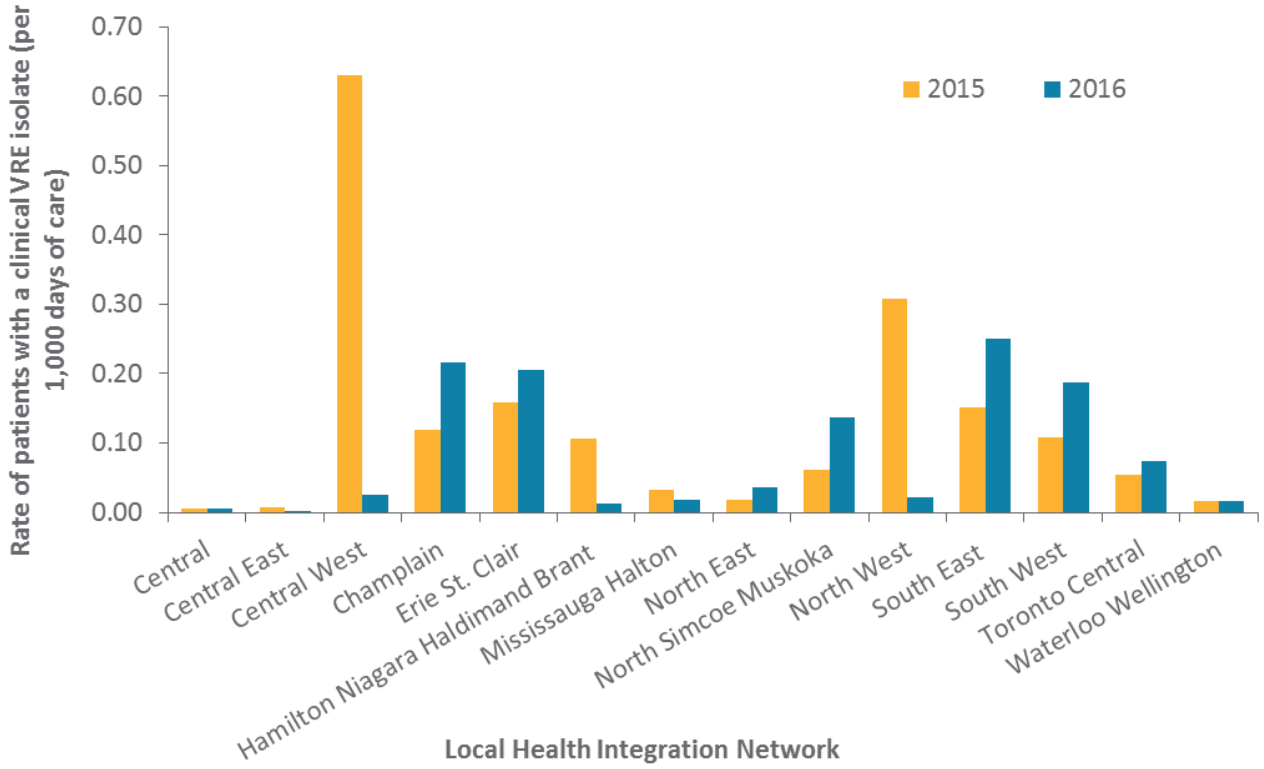
Vancomycin-Resistant Enterococci (VRE)

Laboratory Data

A total of 60 laboratories accepted and processed screening specimens for testing VRE in 2016; 48 (80.0%) were hospital-based and 12 (20.0%) were community-based laboratories. Among the 60 laboratories, 58 (96.7%) reported testing all isolates or all clinically significant isolates for enterococci vancomycin susceptibility; 2 laboratories reported testing from sterile sites. This was in contrast to 65 (90.3%) of 72 laboratories that reported testing all isolates/all clinically significant isolates for enterococci vancomycin susceptibility in 2015.

637 incident patients with a clinical isolate of VRE were identified in 2016. Of these patients, 605 (95.0%) had vancomycin-resistant *E. faecium*, 17 (2.7%) had *E. faecalis,* and 15 (2.4%) patients had unknown *Enterococcus* species. North Simcoe Muskoka, North East, and Champlain LHINs reported the greatest increases in the rate of patients with VRE isolated from clinical specimens from 2015 to 2016. In contrast, Central West, North West, and Hamilton Niagara Haldimand Brant LHIN reported dramatically lower rates of patients with VRE isolated clinical specimens from 2015 to 2016 (Figure 7).

FIGURE 7. RATE OF PATIENTS WITH VRE ISOLATED FROM A CLINICAL SPECIMEN PER 1,000 DAYS OF CARE*, STRATIFIED BY LHIN, 2015 AND 2016.

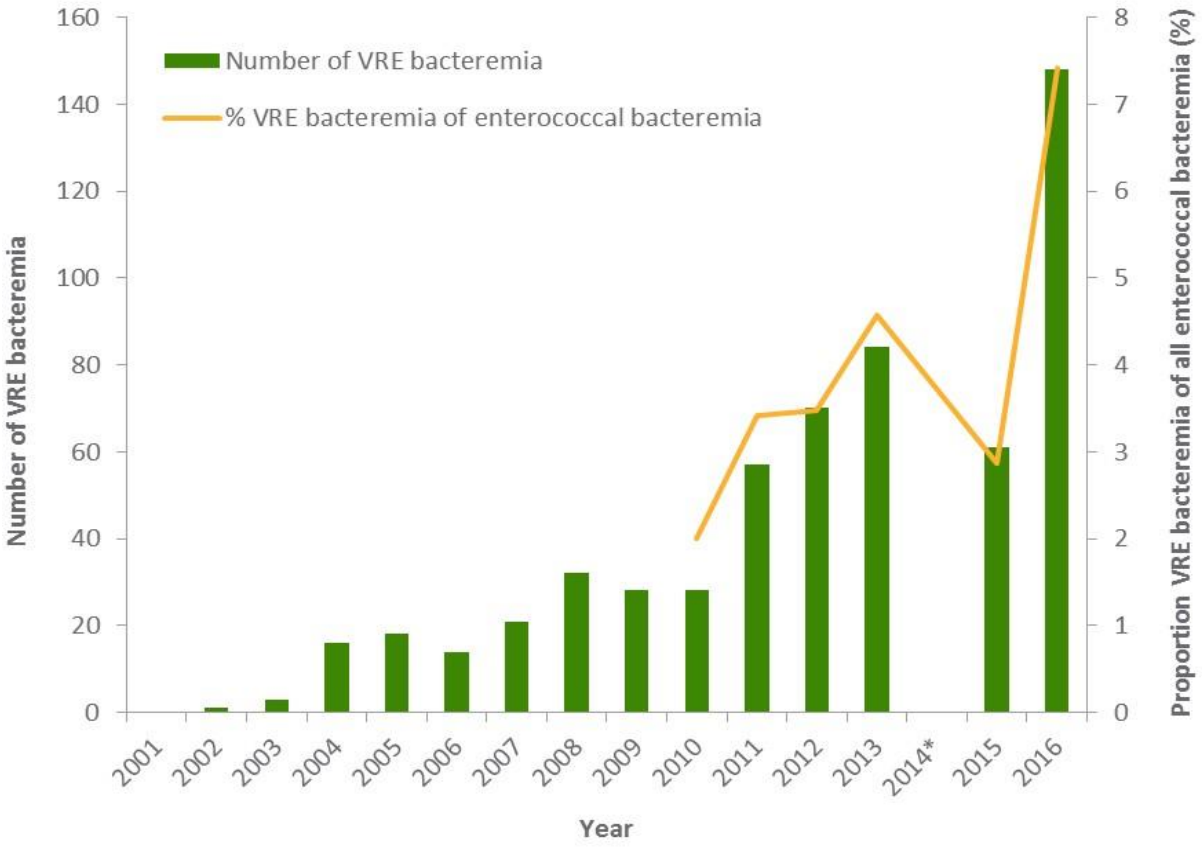


*Days of care 2015, 2016, IntelliHEALTH ONTARIO, Ontario Ministry of Health and Long-Term Care, Date Extracted: March 19, 2018

In 2016, only 4 (6.9%) hospital-based laboratories differentiated between *vanA* and *vanB* isolates, of which, 2 laboratories used PCR testing, 1 used antimicrobial susceptibility testing, and 1 used both methods. These 4 laboratories provided service for 35 hospitals; isolates from 613 patients were tested. Of these patients, 580 (94.6%) patient isolates contained *vanA* and 33 (5.4%) contained *vanB*.

The number of patients with VRE bacteremia increased from 61 (2.9%) of 2,122 total enterococcal bacteremia in 2015 to 148 (7.4%) of 1,997 enterococcal bacteremia in 2016 (Figure 8). Of these, 65 (43.9%) patients with VRE bacteremia were from eastern Ontario, 39 (11.0%) were southwestern Ontario, and 33 (4.8%) were from the Toronto region (Figure 9). In addition, the proportion of VRE-infected patients with bacteremia has increased from 61 (8.1%) of 756 VRE infections in 2015 to 148 (23.1%) of 637 VRE infections in 2016.

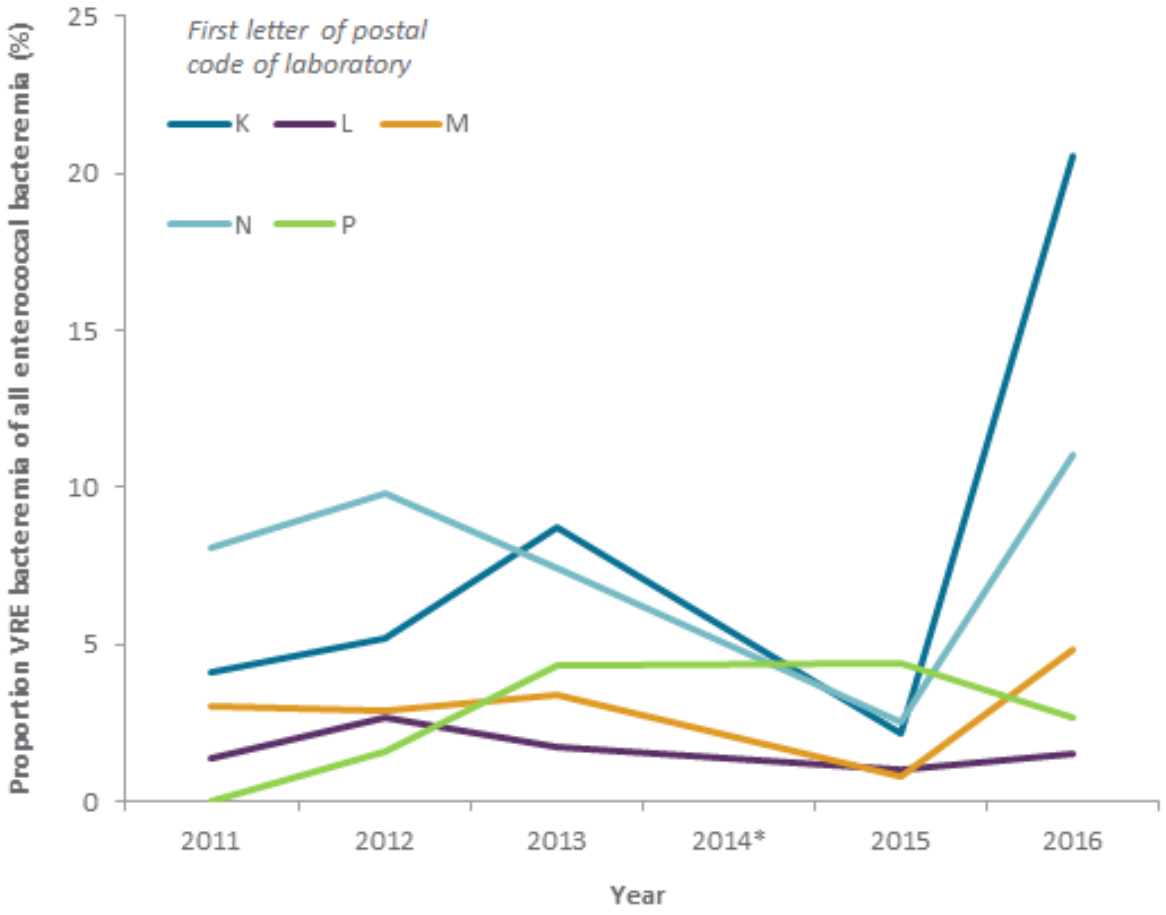
FIGURE 8. NUMBER OF VRE BACTEREMIA REPORTED BY LABORATORIES IN ONTARIO, 2001 TO 2016.



*Survey not conducted in 2014

There were 8 (13.8%) laboratories (3 in Toronto, 3 in Northern Ontario, 1 in southcentral, and 1 in southwestern Ontario) that used PCR to identify a total of 16 patients who were colonized or infected with an enterococcal isolate containing the *vanA* gene, but were susceptible to vancomycin by *in vitro* testing.

FIGURE 9. PROPORTION OF VRE BACTEREMIA AMONG ALL ENTEROCOCCAL BACTEREMIA, STRATIFIED BY GEOGRAPHIC REGION, 2011 TO 2016.



*Survey not conducted in 2014

Hospital Data

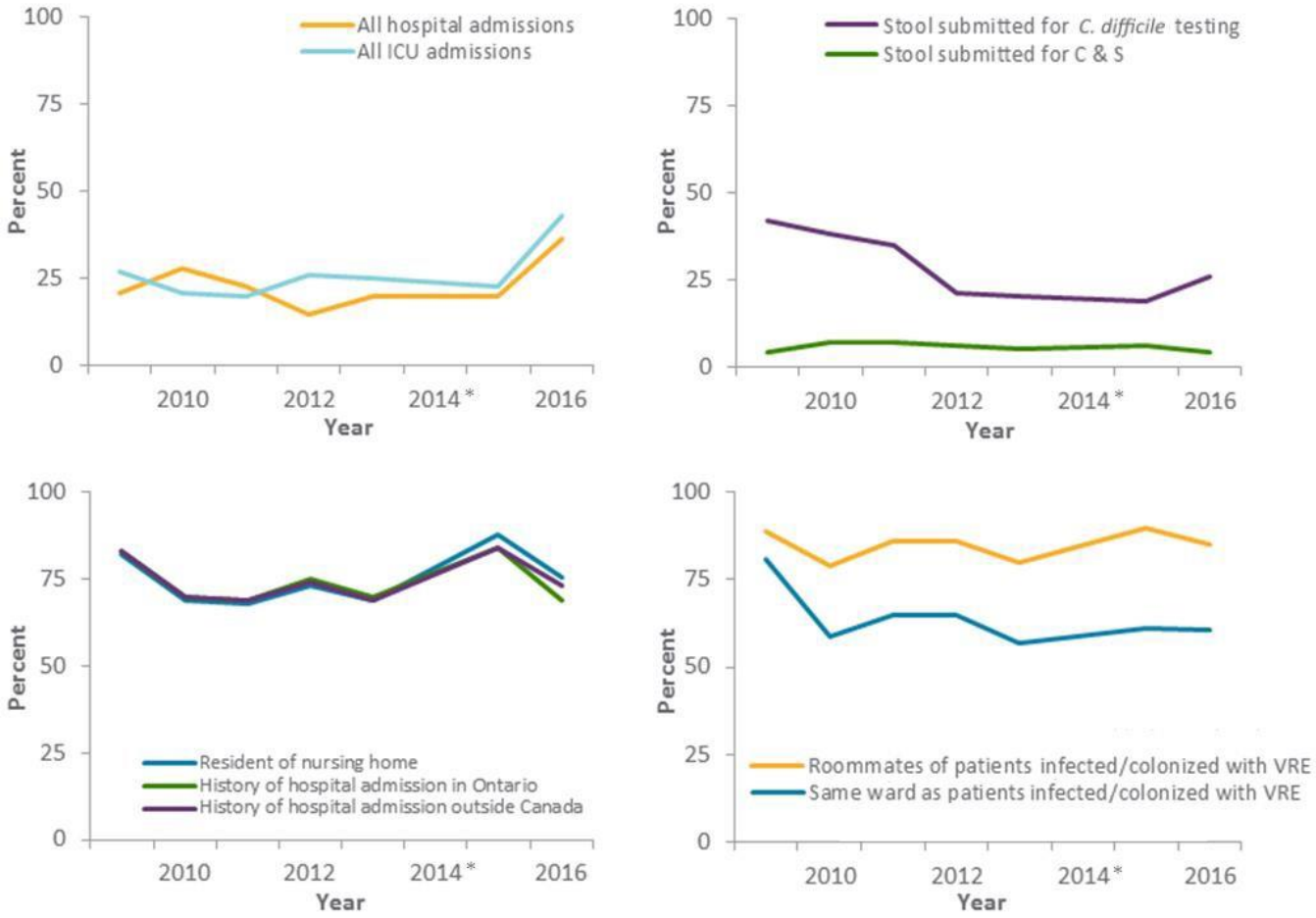
Among 105 hospitals that provided information on their VRE screening practices, 74 (70.5%) hospitals reported having a VRE screening program in 2016, compared to 102 (79.1%) of 129 hospitals that reported having a screening program for VRE in 2015. Of the 74 screening hospitals, 28 (37.8%) were large community hospitals, 25 (33.8%) were small community hospitals, 9 (12.2%) were acute teaching hospitals and 12 (16.2%) were other hospital types (e.g., complex continuing care, rehabilitation).

Fifty-eight (78.4%) hospitals reported screening all patients who were admitted directly from hospitals abroad and all patients admitted from other Ontario hospitals in Ontario, 63 (85.1%) reported screening roommates of patients identified as colonized or infected with VRE, and 56 (75.7%) reported screening patients directly admitted from a nursing home in Ontario as part of their screening program (Figure 10).

For VRE screening sites, 56 (75.7%) hospitals reported obtaining swabs from the perianal, perineal, or groin, 28 (37.8%) hospitals obtained rectal swabs or stool specimens (e.g., stool from ostomy), and 19 (25.7%) obtained specimens from open wounds, lesions, or incisions.

In addition, all 74 hospitals that screened for VRE reported using additional precautions for patients infected or colonized with VRE. 68 (91.9%) hospitals provided a single room with dedicated toileting to patients with VRE, and 30 (40.5%) reported cohorting patients with VRE and providing dedicated toileting.

FIGURE 10. CRITERIA FOR PATIENT SCREENING AMONG ALL HOSPITALS WITH A VRE SCREENING PROGRAM, 2009 TO 2016.



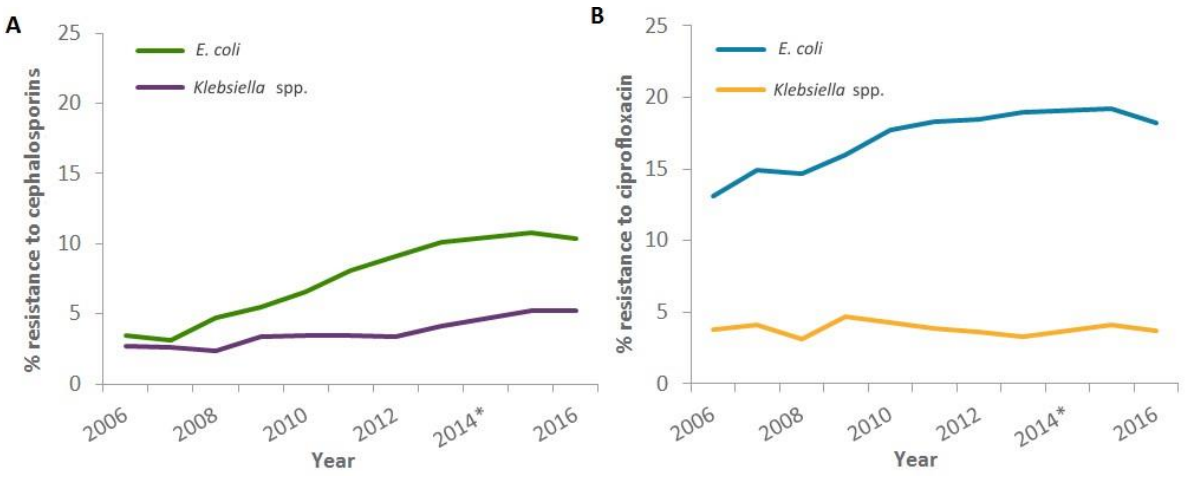
*Survey not conducted in 2014

Antibiotic-Resistant Gram-Negative Bacilli

Laboratory Data

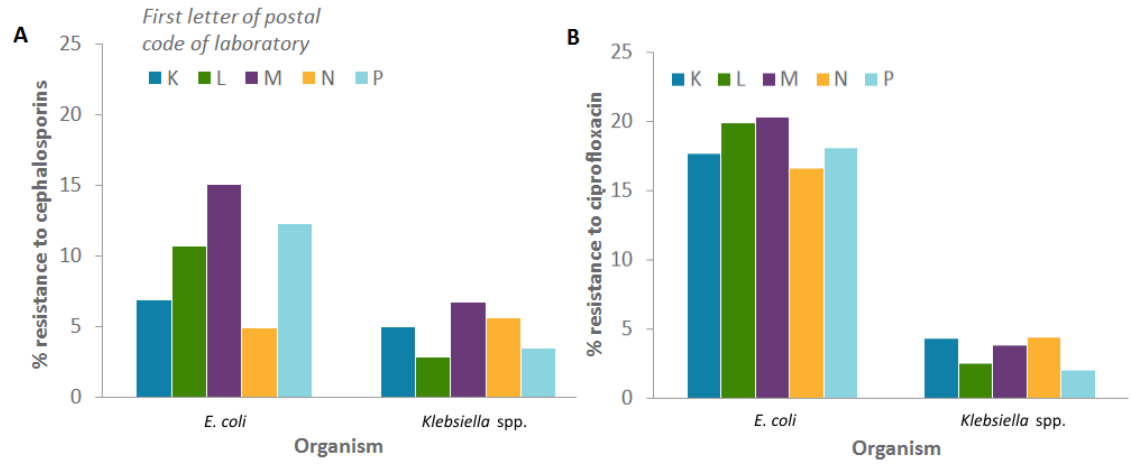
In 2016, 473,849 clinical isolates of *Escherichia coli*, 82,005 clinical isolates of *Klebsiella* spp., 41,430 clinical isolates of *Pseudomonas aeruginosa*, and 2,973 clinical isolates of *Acinetobacter* spp. were reported by laboratories. Percent resistance to third-generation cephalosporins and ciprofloxacin was relatively consistent in *E. coli* and *Klebsiella* spp. clinical isolates between 2015 and 2016 (Figure 11).

FIGURE 11. PERCENT RESISTANCE OF E. COLI AND KLEBSIELLA SPP. ISOLATES TO THIRD-GENERATION CEPHALOSPORINS (A) AND CIPROFLOXACIN (B) IN ONTARIO, 2006 TO 2016.



*Survey not conducted in 2014

FIGURE 12. PERCENT RESISTANCE OF E. COLI AND KLEBSIELLA SPP. ISOLATES TO THIRD-GENERATION CEPHALOSPORINS (A) AND CIPROFLOXACIN (B), STRATIFIED BY GEOGRAPHIC REGION, 2016.



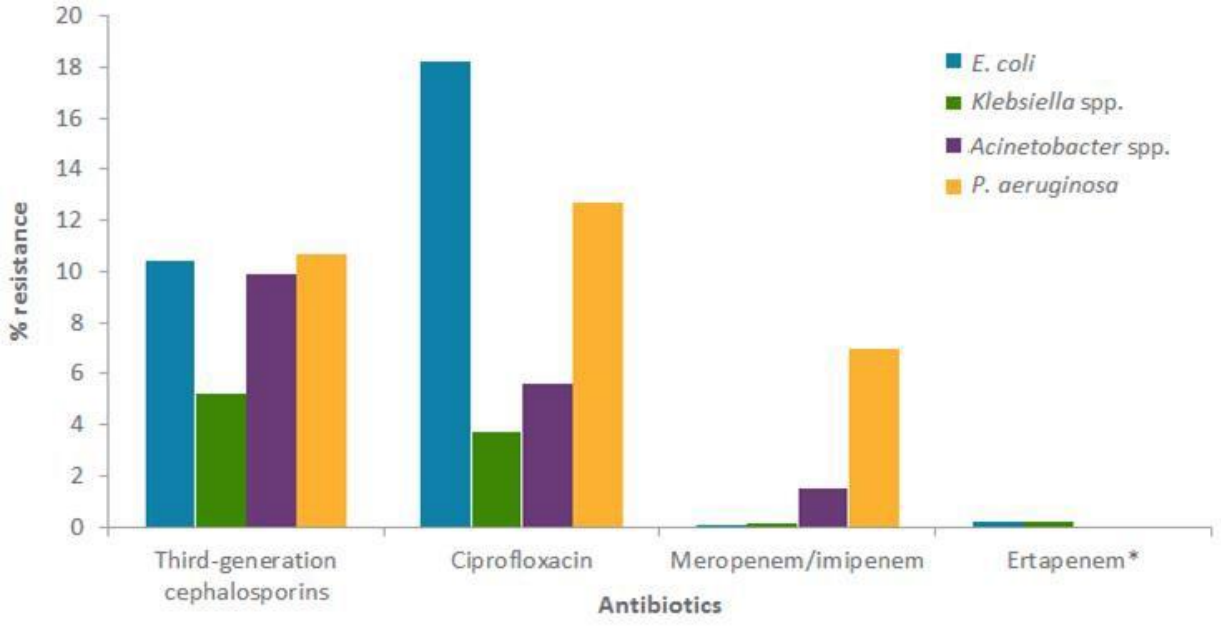
Cephalosporin- and ciprofloxacin-resistant isolates were reported from all areas of the province, with the highest prevalence of resistant *E. coli* reported by laboratories in Toronto (postal code M). Toronto area labs also reported the highest prevalence of cephalosporin-resistant *Klebsiella* spp. (6.7% resistance in Toronto, compared to 2.8% resistance in southcentral Ontario). Ciprofloxacin-resistant *Klebsiella* spp. were most common in southwestern Ontario (4.4% resistance in southwestern Ontario, compared to 2.0% resistance in northern Ontario) (Figure 12).

Laboratories providing data on resistance in *P. aeruginosa* identified 5,131 (12.7%) of 38,417 isolates resistant to ciprofloxacin, compared to 13.6% resistant isolates in 2015. In addition, there were 164 (5.6%) of 2,919 ciprofloxacin-resistant *Acinetobacter* spp. isolates, and 257 (9.9%) of 2,601 *Acinetobacter* spp. isolates resistant to third-generation cephalosporins in 2016 (Figure 13).

Resistance to carbapenems among gram-negative bacilli remained relatively low in Ontario (Figure 13). An exception was noted as 282 (7.0%) of 40,515 *P. aeruginosa* isolates were resistant to meropenem/imipenem. Laboratories reported that 152 (0.04%) of 373,342 *E. coli* isolates were resistant to meropenem/imipenem, and 694 (0.20%) of 347,857 were resistant to ertapenem. Among *Klebsiella* spp. isolates, 105 (0.15%) of 71,519 were resistant to meropenem/imipenem and 141 (0.21%) of 66,018 isolates were resistant to ertapenem.

Fifty-one (0.16%) of 32,760 isolates of *P. aeruginosa* were resistant to all antimicrobial agents tested. These *P. aeruginosa* isolates tested originated from all LHINs – 11,922 (36.4%) from Toronto Central, 6,138 (18.7%) from Mississauga Halton, and 3,121 (9.5%) from Hamilton Niagara Haldimand Brant LHIN.

FIGURE 13. RESISTANCE OF E. COLI, KLEBSIELLA SPP., P. AERUGINOSA, AND ACINETOBACTER SPP. ISOLATES TO THIRD-GENERATION CEPHALOSPORINS, CIPROFLOXACIN, AND CARBAPENEMS, 2016.



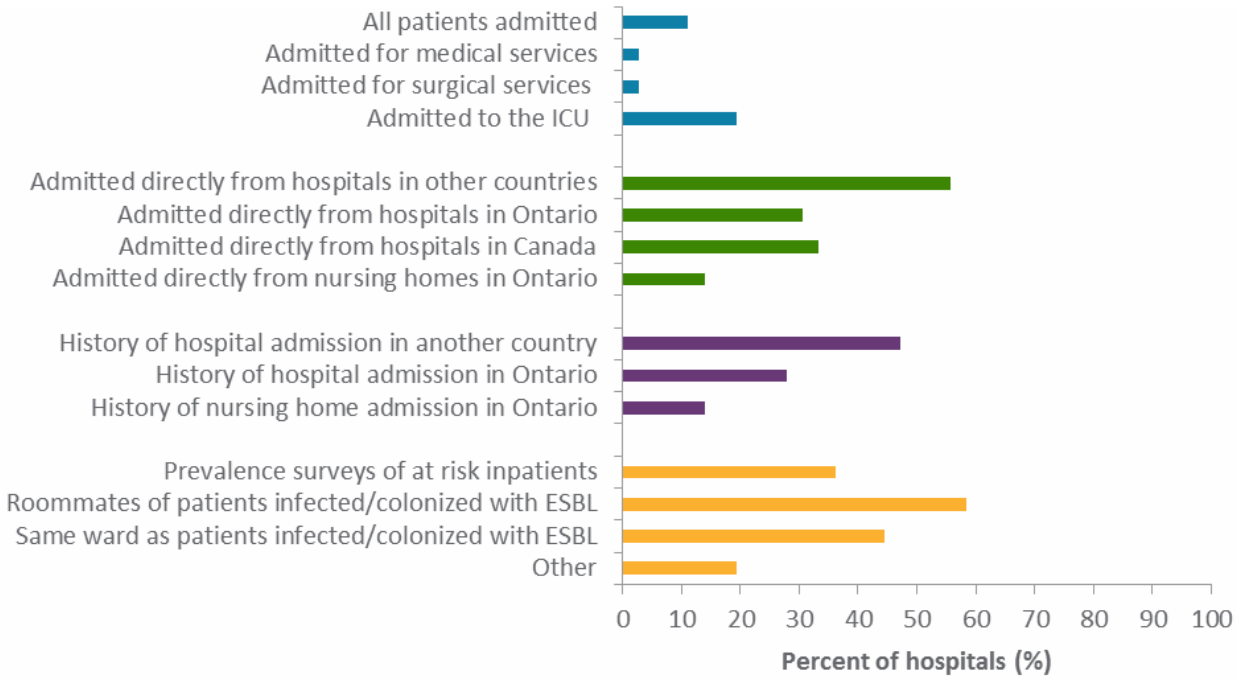
*Data on resistance to ertapenem in *Acinetobacter* spp. and *P. aeruginosa* isolates was not collected.

Hospital Data

Among all 112 hospital respondents, 36 (32.1%) hospitals reported having a screening program to identify patients with extended spectrum beta-lactamase (ESBL) -producing *E. coli* or *Klebsiella* spp. in 2016; 8 (22.2%) were acute teaching hospitals, 13 (36.1%) were large community hospitals, 13 (36.1%) were small community hospitals, and 2 (5.6%) were other hospital types.

As part of their screening program for ESBL, 20 (55.6%) hospitals screened patients who had a history of hospital admission abroad, 21 (58.3%) hospitals screened roommates of colonized/infected patients, and 16 (44.4%) screened patients on the same ward as colonized/infected patients (Figure 14).

FIGURE 14. CRITERIA FOR PATIENT SCREENING AMONG ALL HOSPITALS WITH AN ESBL SCREENING PROGRAM, 2016 (N=36).



Of all 36 hospitals, 22 (61.1%) reported obtaining swabs from perianal, perineal, or groin site for ESBL screening; 11 (30.6%) hospitals reported using rectal swab or stool sample for ESBL specimen testing.

When facing infected or colonized patients with ESBL-producing *E. coli* or *Klebsiella* spp., 57 (54.8%) of 104 responding hospitals reported using additional precautions for all identified colonized or infected patients, whereas 29 (27.9%) hospitals reported they did not use additional IPAC precautions. The remaining 16 (15.4%) hospitals used precautions suited to the patient's hospital setting and characteristics, including contact precautions and isolation for critical care or patients with incontinency.

Carbapenemase-Producing Organisms (CPO)

Laboratory Data

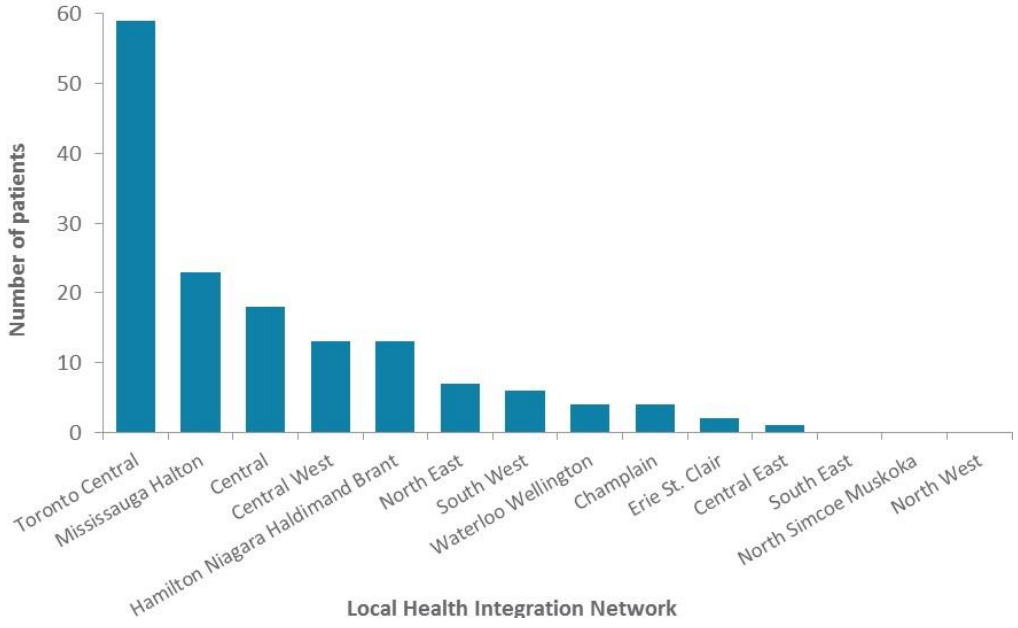
Among all 76 laboratories, 64 laboratories provided information on whether they screened for carbapenemase-producing organisms (CPO) in 2016. Fifty-six (87.5%) laboratories reported screening for CPO – 41 (73.2%) of these laboratories screened from both clinical or screening sites, 14 (25.0%) laboratories screened only from clinical sites, and 1 (1.8%) laboratory screened only from screening sites.

There were 35 (62.5%) laboratories that reported screening for all *Enterobacteriaceae* from screening sites and 49 (87.5%) that reported screening for all *Enterobacteriaceae* from clinical sites. Four (7.1%) and 6 (10.7%) laboratories screen for carbapenemases from *Acinetobacter* and *Pseudomonas*, respectively. Twenty (35.7%) laboratories follow the CLSI MIC interpretive guidelines to screen for CPO; 32 (57.1%) follow Consensus Practice Recommendations developed by IQMH.[5] The remaining 4 (7.1%) laboratories did not indicate which MIC interpretive guidelines are followed.

Thirty-seven (66.1%) laboratories did not perform further testing in-house on suspected CPO and sent isolates to PHOL for further testing; 20 (35.7%) laboratories use phenotypic testing (ROSCO KPC-MBL kit), and 3 (5.3%) laboratories perform the modified Hodge test on suspect CPO isolates. Fifty-three (94.6%) laboratories reported that no further PCR testing was performed in-house to confirm suspected CPO these isolates were all sent to PHOL.

Of the total 144 patients identified with CPO, 59 (40.7%) were reported by laboratories in Toronto Central LHIN, followed by 23 (16.0%) from Mississauga Halton. Laboratories in South East, North Simcoe Muskoka, and North West LHIN did not report any patients with CPO in 2016 (Figure 15).

FIGURE 15. NUMBER OF PATIENTS POSITIVE FOR CARBAPENEMASE-PRODUCING ORGANISMS, BY LHIN, 2016.



A total of 16 (28.6%) CPO-screening laboratories reported a total of 70 patients positive for carbapenemase-producing *E. coli* (compared to 29 (51.8%) laboratories that reported 140 patients in 2015). Among these 70 patients, carbapenemase-producing genes were specified for 57 (81.4%) patients – 32 (45.7%) NDM, 11 (19.3%) KPC, 12 (21.1%) OXA48, 1 (1.8%) VIM, and 1 (1.8%) with other genes unspecified.

Additionally, 18 (32.1%) laboratories reported 55 patients with carbapenemase-producing *Klebsiella* spp. Carbapenemase-producing genes specified in *Klebsiella* spp. were 14 (25.5%) NDM, 16 (29.1%) KPC, 21 (38.2%) OXA48, 1 (1.8%) VIM, and 3 (5.5%) NDM/OXA48.

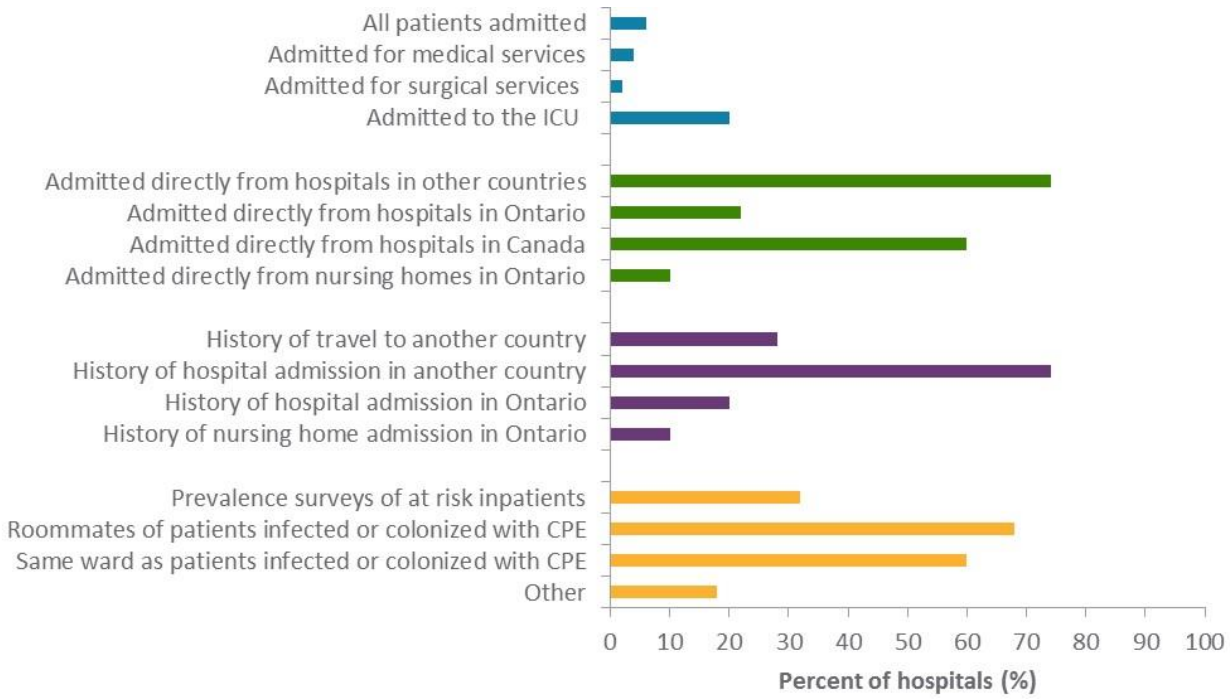
Laboratories also identified 25 patients with at least one isolate of a non-*E. coli*, non-*Klebsiella* spp. *Enterobacteriaceae* that was confirmed to be a carbapenemase producer and 23 patients with at least one isolate of a non-*Enterobacteriaceae* confirmed to be a carbapenemase producer.

In 2016, data on non-*Enterobacteriaceae* isolates was collected for the first time. There were 24 isolates from patients reported; 10 (41.7%) *P. aeruginosa* (1 NDM, 2 VIM/IMP, 7 unknown genotypes) isolates and 14 (58.3%) *Acinetobacter* spp. (2 OXA24/51, 1 OXA51/23, 8 OXA 51/235, 2 OXA23, 1 unknown genotype) reported by 7 labs.

Hospital Data

Among 98 hospital respondents providing data on carbapenemase-producing *Enterobacteriaceae (CPE)* screening practices, 50 (51.0%) hospitals reported having a screening program for CPE in 2016. Of these 50 hospitals, 37 (74.0%) screened patients admitted directly from hospitals abroad, 14 (28.0%) screened patients with a travel history abroad, 34 (68.0%) screened roommates of patients colonized or infected with CPE, and 30 (60.0%) screened for patients on the same ward as other patients colonized or infected with CPE as part of their screening program (Figure 16). Ten (20.0%) hospitals reported screening patients admitted to the ICU, however unless patients had a history of admission in another hospital or were exposed to another infected patient, very few hospitals screened patients on admission as part of their screening program (3 (6.0%) hospitals reported screening all patients admitted for CPE).

FIGURE 16. CRITERIA FOR PATIENT SCREENING AMONG ALL HOSPITALS WITH A CPE SCREENING PROGRAM, 2016 (N=50).



Of the 98 hospitals that reported information on precautions used for patients with CPE, providing a private room and toilet was most common, practiced by 81 (82.7%) hospitals, followed by 12 (12.2%) hospitals that reported cohorting CPE patients with other positive patients to use shared toileting. Less common accommodations included cohorting positive patients and providing dedicated toileting reported by 9 (9.2%) hospitals, and multi-patient rooms with dedicated toileting reported by 8 (8.2%) hospitals. All hospitals reported using some type of special accommodations for patients with CPE.
It is recommended that hospitals follow the current CPE guidelines developed by the Provincial Infectious Disease Advisory Committee on Infection Prevention and Control (PIDAC-IPC). In 2016, among the 48 hospitals that reported having no screening program for CPE, 38 (79.2%) hospitals identified the population served by their facility was not at risk for CPE. Other barriers to implementing a CPE screening program included lack of laboratory testing capacity in 9 (18.8%) hospitals, lack of resources reported by 16 (33.3%) hospitals, and/or lack of senior management approval reported by 7 (14.6%) hospitals.

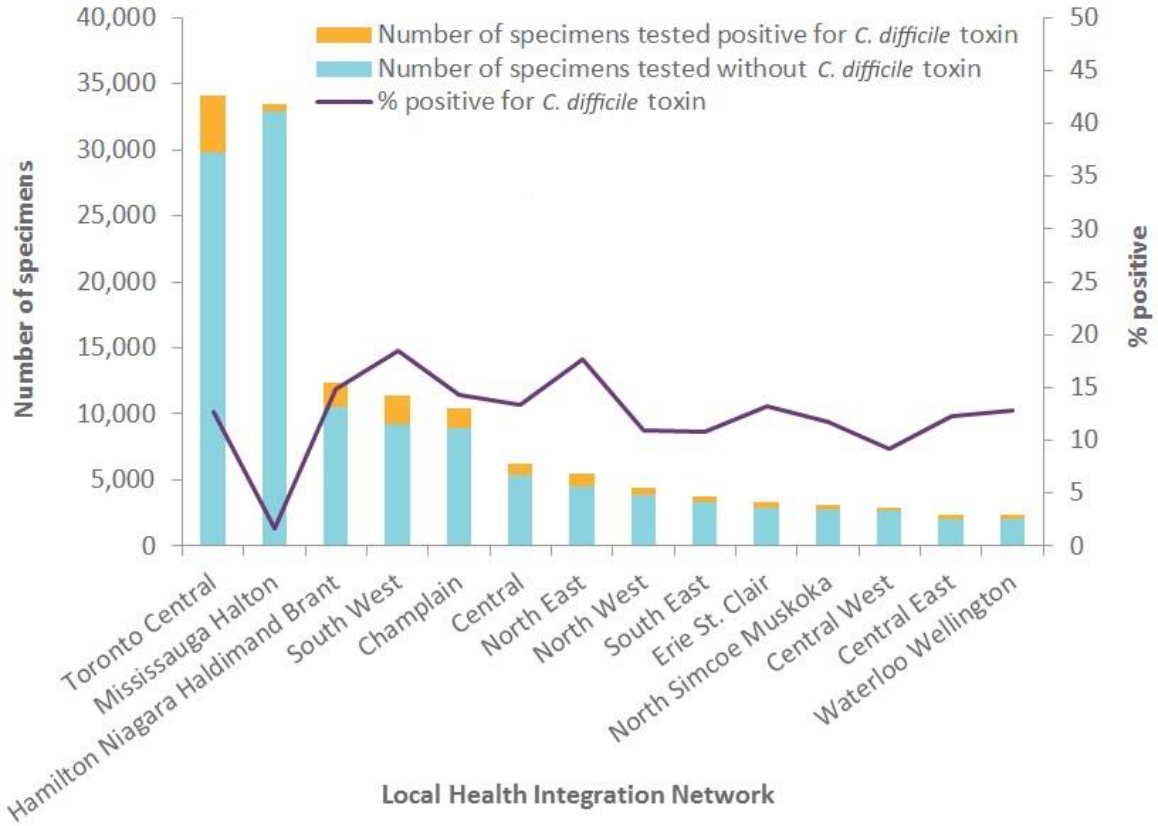
Clostridium difficile

Laboratory Data

In 2016, 61 (80.3%) laboratories reported screening for *C. difficile* toxin in-house, and 15 (19.7%) laboratories sent stool samples directly to PHOL or to another laboratory for testing. The 7 laboratories in Toronto Central LHIN reported the greatest number of specimens tested for *C. difficile* toxin – a total of 34,130 specimens tested in 2016; 4,321 (12.7%) were positive. Laboratories in North East LHIN (n=10) reported the greatest proportion of positive *C. difficile* specimens, with 977 (17.7%) of 5,514 specimens testing positive for *C. difficile* toxin in 2016 (Figure 17).

Overall, 54 (88.5%) of 57 laboratories with in-house *C. difficile* testing laboratories reported a turnaround time (TAT) of <24 hours from when the specimen is received to when the test result is reported; 22 (38.6%) had TATs <12 hours, and 32 (56.1%) reported TATs between 12 and 24 hours.

FIGURE 17. SPECIMENS TESTED FOR C. DIFFICILE TOXIN IN ONTARIO, BY LHIN, 2016.



Hospital Data

Among 111 hospital respondents, 86 (77.5.2%) reported using additional precautions on all identified colonized or infected patients with CDI, and 24 (21.6%) reported using additional precautions on some patients (e.g., those with diarrhea or infected patients only).

A total of 81 (72.3%) of 112 hospitals accommodated patients with CDI by providing a single room with dedicated toileting; 9 (8.0%) cohorted CDI patients and provided dedicated toileting.

Combination cleaning practices for patients with CDI were common. In 80 (71.4%) hospitals, cleaning twice daily and disinfection of resident bathrooms using a sporicidal agent was combined with notifying environmental services staff of additional cleaning requirements for residents on additional precautions.

Fifty-eight (52.3%) of 111 hospital respondents considered discontinuing additional precautions for patients with CDI after the patient has been asymptomatic for 48 hours, 55 (49.5%) consulted IPAC before discontinuing additional precautions, and 35 (31.5%) had the room/bedspace and bathroom terminally cleaned/ followed discharge CDI cleaning with sporicide before additional precautions were discontinued. The majority of hospitals indicated a combination of these 3 practices were performed prior to discontinuing additional precautions for CDI; 5 (4.5%) required patients to be asymptomatic for 72 hours to consider discontinuing additional precautions.

Limitations

Although the strength of these surveys includes summarizing and providing annual updates of data on laboratory screening and infection control practices related to AROs, several limitations merit consideration.

For the laboratory survey, the number of "new" patients was assumed not to be duplicated by another testing laboratory though most likely there will be a number of patients who may have been identified and reported by multiple laboratories due to different hospital visits or admissions within that year. This would overestimate the burden of ARO in Ontario. The number of patients attributed to sources such as another hospital or nursing home, or community may also not be as accurate as some patients may visit several facilities within a short period of time, making it difficult to determine a source.

The response rate of the hospital survey was lower than in 2015, declining from 130 (58.6%) of 222 hospitals to 112 (53.6%) to 209 hospitals. To administer this voluntary survey, PHO leveraged regional IPAC staff and existing hospital contact lists; however, we faced challenges determining appropriate infection control contacts in some hospitals. This may have impacted response rates, and opportunities for strengthening networks between PHO and hospitals in the future will be discussed for the coming survey cycle.

For both the laboratory and hospital surveys, several assumptions were made during the data cleaning process (Appendix A provides a detailed list of these assumptions). Further, results of this report may not be comparable to other surveillance systems due to different methods employed in collecting data and level of reporting implemented in each of the surveillance systems (i.e., provincial, national level).

Conclusions

AROs contribute to significant morbidity and mortality among hospitalized patients. Increased prevalence of AROs poses a serious threat to patient safety and public health as there are limited antimicrobial options available to treat infections caused by resistant organisms.[2,3] These surveys enable PHO and IQMH to monitor the burden of AROs across the province, as well as infection control practices related to AROs in Ontario over time.

In 2016, the proportion of VRE bacteremia has increased dramatically, though 8.6% fewer hospitals reported having a VRE screening program in 2016, compared to 2015. In addition, a greater breadth of resistant organisms was detected in 2016, especially reflecting emerging organisms with distinct carbapenemase-producing genotypes. The percent of hospitals that reported having a screening program for CPO has remained around 50% over the last two years (51% in 2016, 56% in 2015), however with greater travel and migration and increased incidence of CPO in Ontario, we anticipate that more hospitals may implement screening programs for CPO in the coming years.

Supporting consistent infection control practices between health care facilities in Ontario, as well as continued surveillance and monitoring of AROs plays a crucial role in informing policies and practices aimed to prevent the spread of resistant organisms in health care settings and in our communities.

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Appendix A: Assumptions and Data Cleaning Procedures

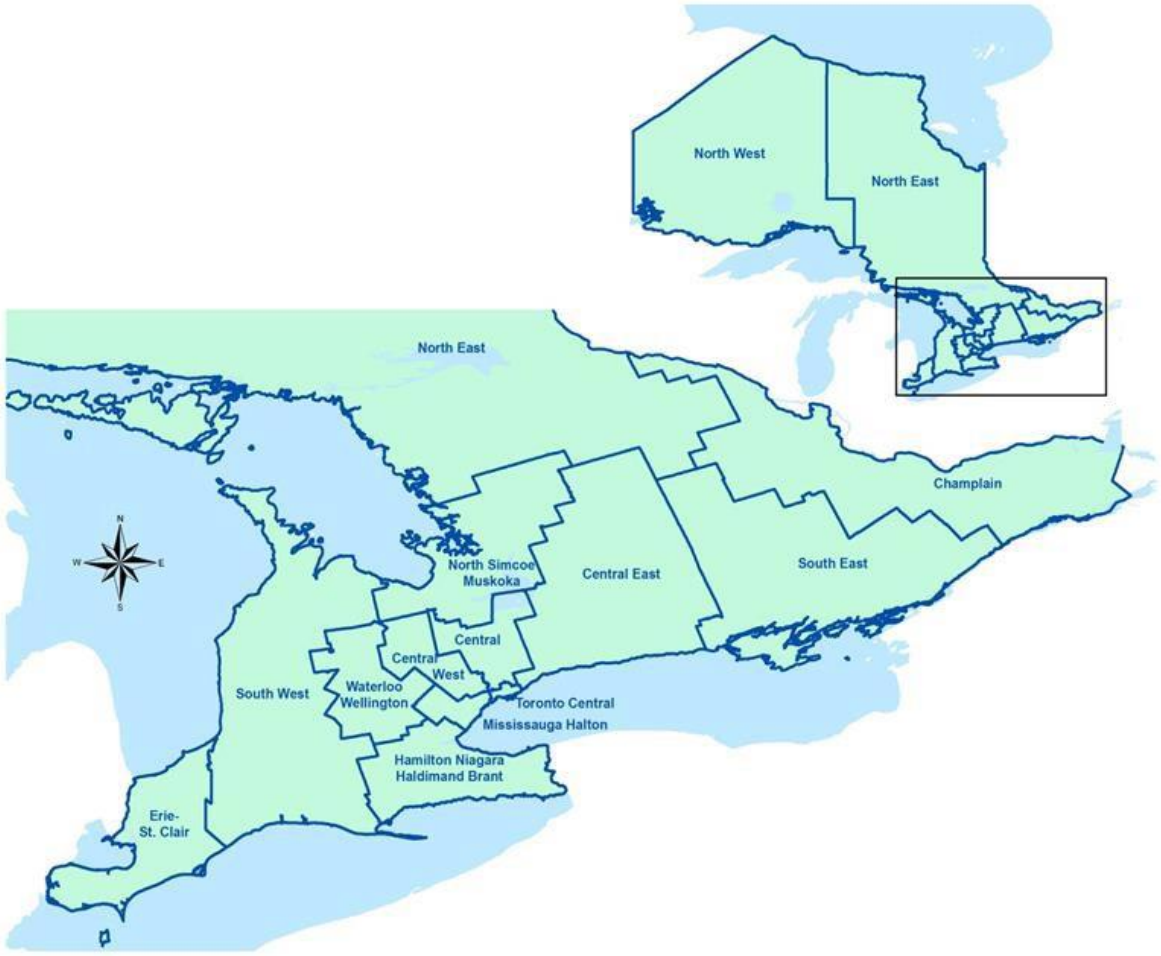
Laboratory Data

1. The numbers provided in the survey were assumed to be accurate.
2. To avoid duplicate entries, supplementary questionnaires received from laboratories which send specimens to a centralized laboratory were deleted from the dataset if data from their laboratories were already captured by the centralized laboratory. Information that was in the supplementary questionnaire that was not in the centralized laboratory questionnaire was manually added to the latter.
3. Character values in numeric variables were changed to numeric values where possible. Responses such as “NA”, “not available”, “unable to determine” were changed to blanks.
4. For duplicated laboratories grouped with other laboratories, the numbers were assumed to be coming from different laboratories since separating the counts were not feasible.
5. Where the subtotals did not match the total number of isolates, the total number of isolates was used.
6. If the screening question was not completed but practices were specified in follow-up responses, the laboratory was assumed to conduct screening related to the ARO in question.
7. Interpretation of questions may vary between laboratories, especially when different laboratory personnel respond to the survey year to year. Every effort was made to use unambiguous wording in the survey.
8. *Q5:* respondents were asked to enter the number of new patients with MRSA in 2016, including all colonized and infected patients.
   Q6: respondents were asked to enter the number of patients identified with an MRSA infection only. The wording in question 5 and 6 led some respondents to enter a greater number of patients in question 6, than in question 5. In this situation, we assumed the value entered in question 6 encompassed all of the patients with MRSA (i.e., both colonized and infected) and used as the estimate of the total number of patients identified by the laboratory. If the laboratory entered 0 patients in question 5, but entered a value in question 6, this value was assumed to be the total number of patients with MRSA identified by the laboratory in 2016 (i.e., colonized or infected). For the remaining laboratories that entered in a greater value in question 5 than question 6 as intended by the survey question, the total number of patients with MRSA identified by the laboratory in 2016 was assumed to be the value entered in question 5.

Hospital Data

1. If the screening program question was not completed but follow-up responses were indicative of a positive response, the hospital was assumed to have a screening program in place.
2. Infection control practices submitted by the corporation were assumed to apply across all institutions under the corporation.

Appendix B: Map of Local Health Integration Networks (LHINs) in Ontario



Public Health Ontario
480 University Avenue, Suite 300
Toronto, Ontario
M5G 1V2

647.260.7100
communications@oahpp.ca
www.publichealthontario.ca