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Institute for Quality Management in Healthcare

# Antimicrobial Resistance in Common Hospital Pathogens in Ontario: Annual Laboratory and Hospital Survey Report 2022


Annual Report

February 2024

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## Disclaimer

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# Background

Antimicrobial resistance poses a serious threat to patient safety and global public health, as current antimicrobials become less effective at treating resistant organisms. Health care-associated infections contribute to increased length of hospitalization, mortality and use of health care resources. In Canada, it is estimated that antimicrobial resistance causes 5,400 deaths and cost the health care system $1.4 billion in 2018.[1] Recent evidence suggests the SARS-COV-19 pandemic may have accelerated the emergence and transmission of AMR.[2,3] Patients colonized with antimicrobial resistant organisms (AROs) are a major reservoir for health care-associated pathogens; screening and surveillance programs further our understanding of the burden of AROs and the impact of infection control programs in health care settings.

For nearly 20 years, 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 and summarized the data in an annual report. In 2016, Public Health Ontario (PHO) and IQMH established a partnership to conduct an annual survey of AROs across all laboratories and hospitals for surveillance. As part of this collaboration, IQMH resumed laboratory survey administration, while PHO administered the hospital survey on infection control programs. Questions have evolved each year to capture the changing trends in AROs in Ontario.

A survey to capture information about 2022 was distributed to all licensed microbiology labs and all public hospitals in Ontario. Participants were surveyed on screening and infection control programs, as well as the prevalence of AROs: methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), extended spectrum beta-lactamases (ESBLs), carbapenemase-producing organisms (CPOs), *Clostridioides difficile* infections (*C. difficile*, CDI) and *Candida auris* (*C. auris*). The survey also included questions to better understand the impact of the SARS-COV-2 pandemic on the screening and management of health care-associated infections in Ontario hospitals.

The objective of this report is to summarize the findings of the annual survey on antimicrobial resistance of common hospital pathogens from 2022.

# Survey Methods

Information from two surveys was collected for this report: a laboratory survey and an infection control survey. The lab survey was distributed by IQMH to all 51 hospital-based laboratories in Ontario, 11 community-based private laboratories, and 11 PHO reference laboratories across the province. All laboratories surveyed were licensed bacteriology laboratories and able to access the survey via the existing IQMH questionnaire platform in QView. The infection control survey was also appended to the laboratory survey for hospital-based laboratories that were able to provide the infection control survey to onsite infection control staff. The laboratory survey was administered to collect data from 2022. Surveys included questions on the number of new patients identified with MRSA, VRE, ESBLs, CPO and CDI and *C. auris*. In addition, questions were included to understand any impact of the pandemic on existing screening and management practices of health care-associated infections in Ontario hospitals.

Concurrently, PHO distributed the infection control survey to all hospitals in Ontario using the PHO survey tool, Acuity4 Survey by Voxco. This survey invited infection control professionals to answer questions about their screening programs for MRSA, VRE, ESBLs, CPO, CDI and *C. auris* and infection control practices in 2022.

The surveys were made available from February 22, 2023 to June 30, 2023.

Data from both surveys were extracted and linked on unique identifiers. Duplicates and incomplete data entries were removed. Data from the Canadian Institute for Health Information - Discharge Abstract Database accessed through IntelliHEALTH were used as denominator data to calculate MRSA, VRE, and CPO rates.[4] Population Estimates 2022 from Statistics Canada, also accessed through IntelliHEALTH, were used as denominator data for calculating CDI rates.[5]Ontario Health Region boundaries were assigned based on the location of the laboratories. Data were analyzed using SAS 9.4 and Microsoft Excel. ArcMap v10.3.1 software was used to generate the maps, displayed by Ontario Health Region.

# Results

Highlights of the surveys' results have been combined and presented in three sections for a majority of the organisms: screening, infection control practices and laboratory data. Aggregated responses to the surveys are available upon request.

## Survey Response

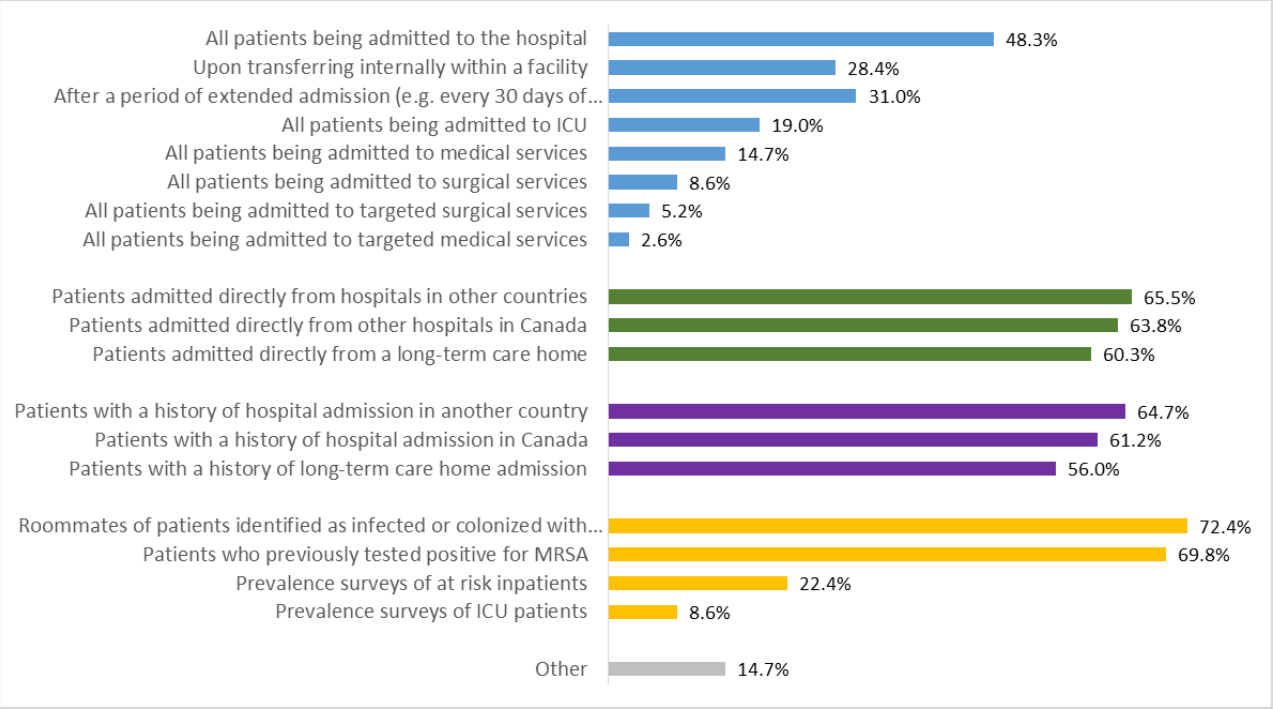
A total of 116/133 (87.2%) hospital corporations responded to the infection control survey questions. Of the currently licensed bacteriology laboratories, 70/73 (95.9%) responded to the 2022 survey. This included 48/51 (94.1%) hospital-based laboratories, 11/11 private community-based and 11/11 PHO laboratory sites.

## Methicillin-resistant *Staphylococcus aureus* (MRSA)

### Hospital Screening

All 116 hospital corporations responded as having a screening program for MRSA in 2022 which is consistent with past results. Hospitals were most likely to screen patients who were roommates of patients positive for MRSA, patients previously positive for MRSA, and patients admitted from other hospitals in Canada or other countries (Figure 1).

**Figure 1. Criteria used by hospitals for MRSA patient screening, 2022**



## Infection Control Practices

All hospitals responded that Additional Precautions were used to care for all patients identified (infected or colonized) with MRSA. Most 95/116 (81.9%) hospitals indicated that Additional Precautions for MRSA are discontinued once three negative swabs were taken, one week apart in the absence of antibiotic therapy. Thirteen (11.2%) hospitals responded that patients with MRSA remain in Additional Precautions for the duration of their hospitalization.

The majority (79/116; 68.1%) of hospitals responded that their institutions do not decolonize patients with MRSA; with 9 (7.8%) hospitals responding that decolonization protocols are applied to all MRSA positive patients. There were 25 (21.5%) hospitals that indicated they may consider MRSA decolonization on a case-by-case basis. Of these, ten (8.6%) hospitals decolonize upon physician or IPAC request, seven (6.0%) hospitals decolonize to facilitate patient placement (e.g. long term care), three (2.6%) hospitals decolonize as part of the pre-operative procedure for surgical patients and two (1.7%) hospitals consider decolonization during outbreak.

Twenty three of the 116 hospitals (19.8%) reported changes to their MRSA screening and management practices due to the pandemic. Disruptions to practices included the halting of patient admission screening, the inability to place patients in single rooms, halting contact precautions for positive patients and/or their contacts, pauses on the testing of contacts and the discontinuation of prevalence surveys. Most hospitals (19/23; 82.6%) reported disruptions of these MRSA screening and management practices had been reinstated at the time of survey with the exception of 4 hospitals that reported they were ongoing.

## Laboratory Data

A total of 18,332 new patients with MRSA isolated from any specimen site (i.e., colonizations or infections) were reported by hospital-based laboratories in 2022, with an overall rate of 16.6 per 1,000 patients.

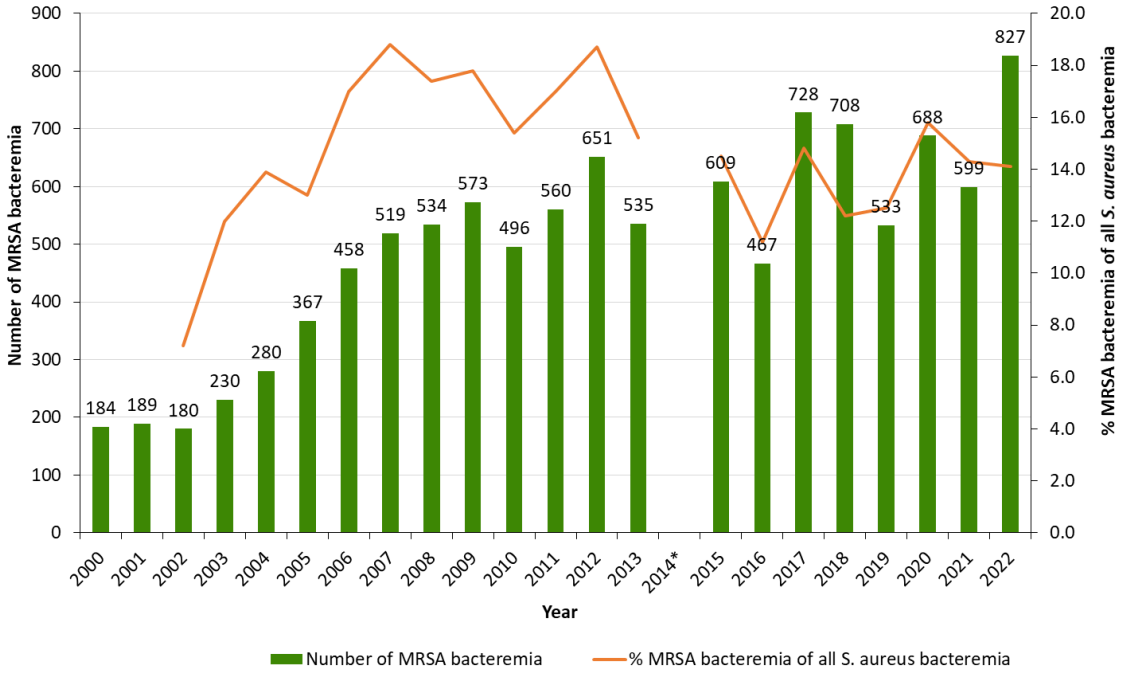
- 827 (4.5%) patient specimens were isolated from blood culture in 2022.
- 5,830 (31.8%) patients with MRSA had specimens isolated from non-screening sites, excluding blood culture in 2022.

The total number of new patients with MRSA isolated from any specimen site increased by 46.5% from 12,516 in 2021 to 18,332 in 2022. The proportion of patients with MRSA from blood culture in 2022 was 4.5% (827/18,332), similar to the proportion in 2021 (599/12,516; 4.8%).

In 2022, the total number of methicillin-susceptible *S. aureus bacteremia* reported was 5,019. Methicillin-resistant *S. aureus bacteremia* as a proportion of all *S. aureus bacteremia* was 14.1% (827/5,846) in 2022, similar to the proportion in 2021 (14.3%) (Figure 2).

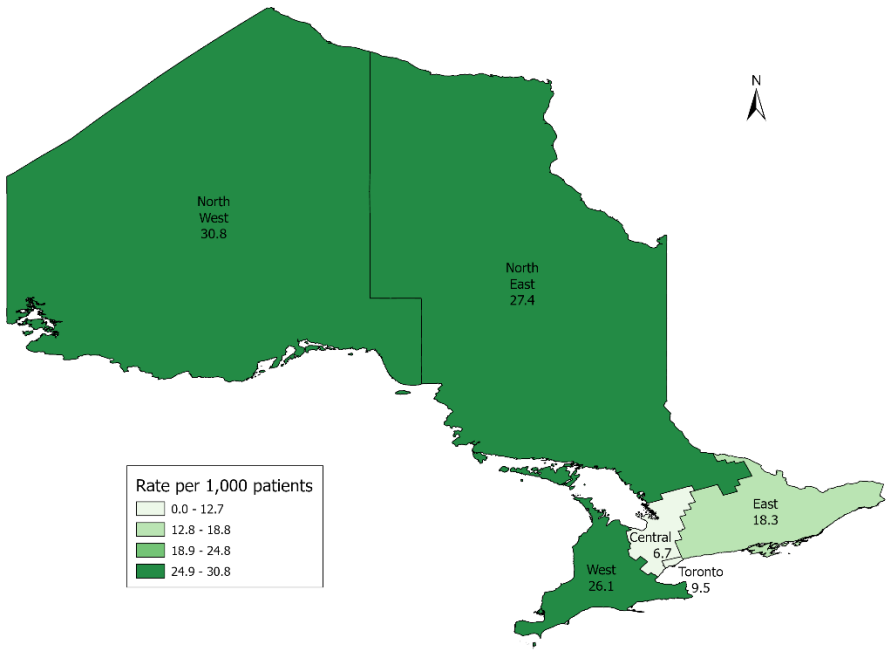
The North West, North East and West regions had the highest rates of new patients with MRSA isolated from any specimen site in 2022 (Figure 3, Appendix A).

**Figure 2. Number of MRSA bacteremia and percentage of all *S. aureus bacteremia* reported from hospital laboratories in Ontario, 2000–2022**




*Survey was not conducted in 2014.

**Figure 3. Rate of patients with MRSA isolated from any specimen site (colonizations and infections) per 1,000 patients reported from hospital laboratories in Ontario, by Ontario Health Region, 2022**

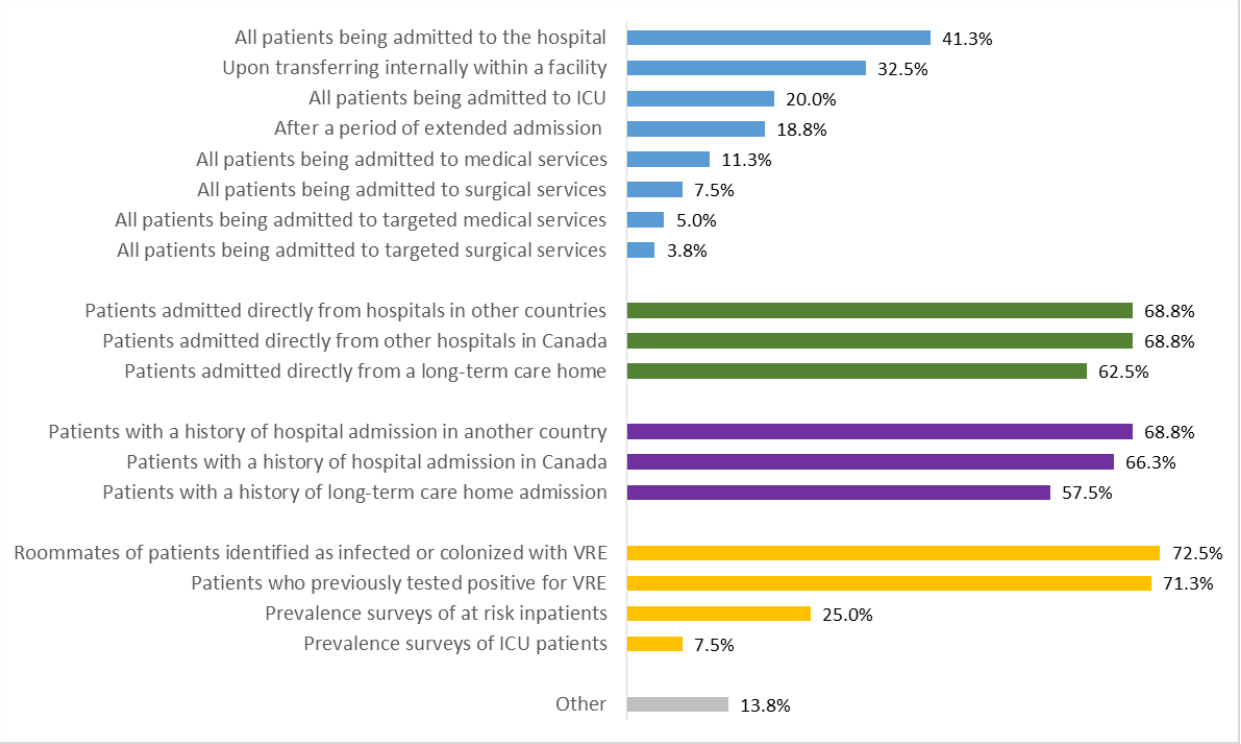


# Vancomycin-resistant Enterococci (VRE)

## Hospital Screening

Of the 116 responding hospital corporations, there were 80 (68.9%) that reported having a screening program for VRE in 2022, similar to the 67.2% of hospital corporations reporting having VRE screening programs in 2020/21. Hospitals were most likely to screen patients who previously tested positive for VRE and those who were roommates of patients positive for VRE (Figure 4).

**Figure 4. Criteria used by hospitals for VRE patient screening, 2022**




## Infection Control Practices

There were 83/116 (71.6%) hospitals that responded that Additional Precautions were used to care for all patients colonized and infected with VRE; four (3.4%) hospitals responded that Additional Precautions were only used for patients with VRE infections. There were 29 (25.0%) hospitals that reported Additional Precautions were not used for patients with VRE in 2022.

In hospitals reporting the use of Additional precautions for VRE, 65/87 (77.0%) reported Additional precautions are discontinued once three negative swabs for VRE have been taken, one week apart and in the absence of antibiotic therapy. Several hospitals also indicated discontinuation of precautions also requires a negative swab three months following a positive result and that one swab must be from stool. Ten (11.5%) hospitals reported patients with VRE remain in Additional Precautions for the duration of their hospitalization.

There were 20/116 (17.2%) hospitals that reported changes to their VRE screening and management practices due to the pandemic. Disruptions to practices included halting screening, the inability to place patients in single rooms, the stopping of contact precautions on positive patients and/or their contacts, pauses on the testing of contacts and the discontinuation of prevalence surveys. By the time of this survey, most reported disruptions to VRE screening and management practices were reinstated, however two hospitals reported they are still not screening for VRE, one hospital is still unable to place VRE patients in single rooms and two hospitals are not testing contacts of VRE patients and also not undergoing prevalence screens.

## Laboratory Data

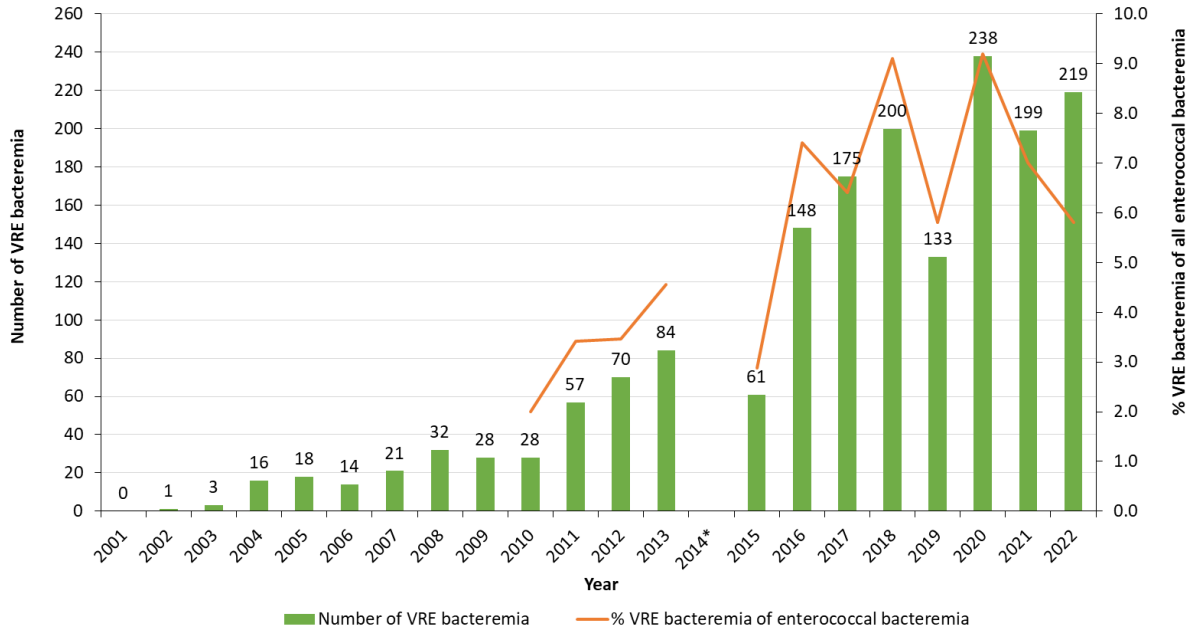
A total of 4,178 new patients with VRE isolated from any specimen site (i.e., colonizations and infections) were reported by hospital laboratories in 2022.

- In 2022, 219/4,178 (5.2%) patients with VRE had specimens isolated from blood culture:
    - *E. faecium*: 198/219 (90.4%)
    - *E. faecalis*: 11/219 (5.0%)
    - Other enterococci: 10/219 (4.6%)
- In 2022, 937/4,178 (22.4%) patients with VRE had specimens isolated from non-screening sites, excluding blood culture:
    - *E. faecium*: 859/937 (91.7%)
    - *E. faecalis*: 24/937 (2.6%)
    - Other enterococci: 54/937 (5.8%)

The total number of vancomycin-susceptible enterococcal bacteremia was 3,571 in 2022. The proportion of vancomycin-resistant enterococcal bacteremia of all enterococcal bacteremia was 5.8% (219/3,790) in 2022 (Figure 5).

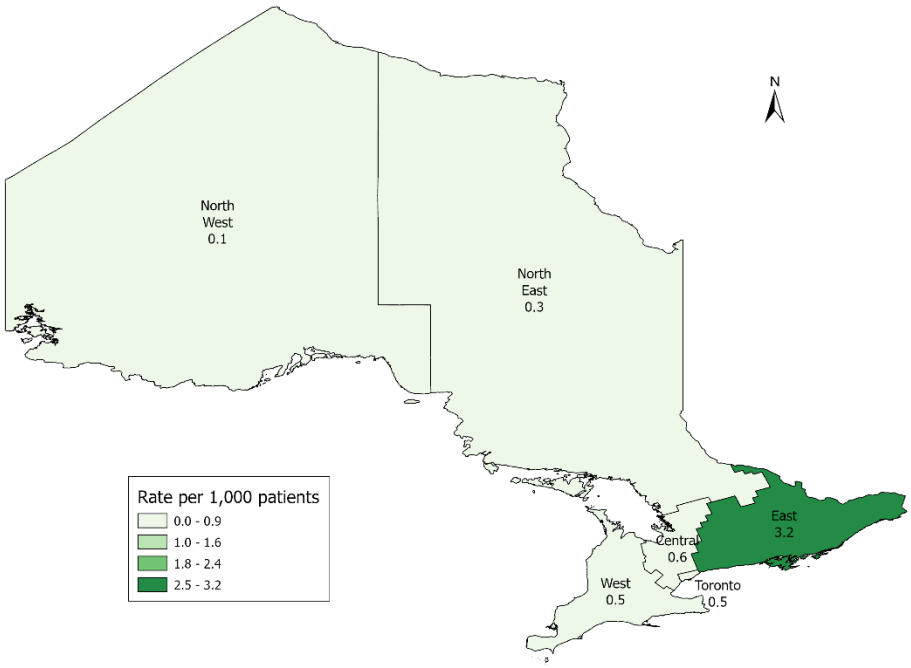
Hospital laboratories in the Ontario East region reported the highest rate of new patients with VRE isolated from all non-screening specimen sites (including blood cultures) in 2022 (Figures 6, Appendix A).

**Figure 5. Number of VRE bacteremia and percentage of all enterococcal bacteremia reported from hospital laboratories in Ontario, 2001–2022**




*Survey was not conducted in 2014

**Figure 6. Rate of patients with VRE isolated from all non-screening specimen sites (including blood cultures) per 1,000 patients reported from hospital laboratories in Ontario, by Ontario Health Region, 2022**



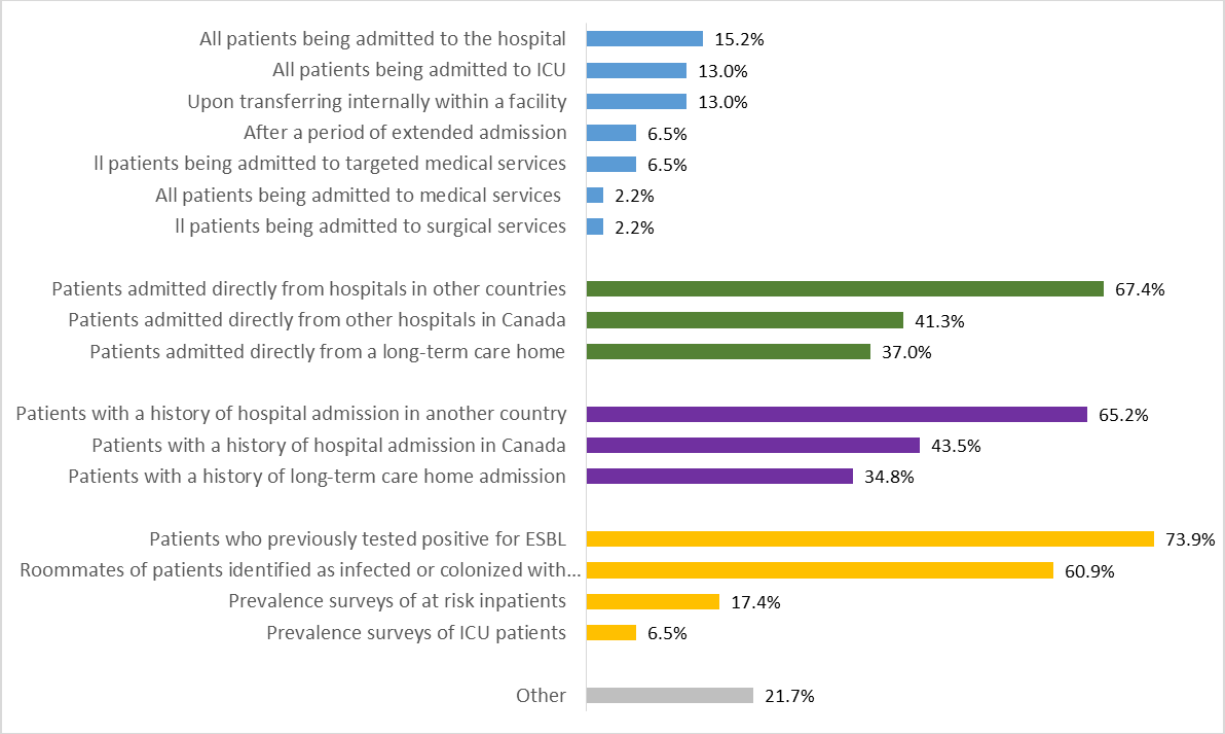
# Gram-Negative Bacilli

## Extended spectrum beta-lactamases (ESBL) Hospital Screening

Of the 116 responding hospital corporations, 46 (39.7%) reported having a screening program for extended spectrum beta-lactamases (ESBLs) in 2022. In 2020/21, 49.2% of hospitals surveyed reported having an ESBL screening program.

Hospitals with a screening program for ESBLs were most likely to screen patients who previously tested positive for ESBL, and admitted directly from a hospital abroad (Figure 7).

**Figure 7. Criteria used by hospitals for ESBL patient screening, 2022**




## ESBL Infection Control Practices

A total of 67/116 (57.7%) hospitals responded that Additional Precautions were used for all patients colonized and infected patients with ESBLs; five (4.3%) hospitals responded that Additional Precautions were only used for patients infected with ESBLs. There were 36 (31.0%) hospitals that reported Additional Precautions were not used for patients with ESBLs.

In hospitals reporting the use of Additional Precautions for ESBL, 40/80 (50.0%) reported Additional Precautions are discontinued once three negative swabs for ESBL have been taken, one week apart in the absence of antibiotic therapy. Twenty seven (33.8%) hospitals reported that patients who test positive for ESBLs remain on Additional Precautions for the duration of their hospitalization.

There were 8/46 (17.4%) hospitals that reported changes to their ESBL screening and management practices due to the pandemic. Disruptions to practices reported by hospitals included halting screening programs, not placing patients in single rooms, the stopping of contact precautions on positive patients and/or their contacts, and pauses on the testing of contacts and the discontinuation of prevalence surveys. Most reported disruptions to ESBL screening and management practices were later reinstated, however three hospitals reported ongoing disruption including one hospital that reported they are were still unable to place patients in single rooms at the time of the survey.

## Laboratory Data

In 2022, 459,438 isolates of *E. coli*, 103,192 isolates of *Klebsiella* spp., 50,143 isolates of *Pseudomonas aeruginosa,* and 3,193 isolates of *Acinetobacter* spp*.* from any specimen site were reported by laboratories.

Resistance to third-generation cephalosporins among *E. coli* isolated from all specimen sites has decreased slightly from 10.5% in 2020 to 8.7% in 2022 (Figure 8). Resistance to third-generation cephalosporins among *Klebsiella* spp*.* isolated from all specimen sites has increased slightly from 4.7% in 2017 to 6.8% in 2022.

Resistance among *E. coli* isolates to ciprofloxacin has been decreasing - from 20.7% in 2020 to 16.4% in 2022 (Figure 9). Resistance among *P. aeruginosa* isolates to ciprofloxacin also decreased from 18.0% in 2020 to 11.4% in 2022. *Klebsiella* spp. resistance to ciprofloxacin increased to 7.6% in 2020 and remained somewhat stable at 7.2% in 2021 and 7.1% in 2022. Resistance to ciprofloxacin in *Acinetobacter* spp. isolates decreased slightly from 8.1% in 2019 to 6.1% in 2022.

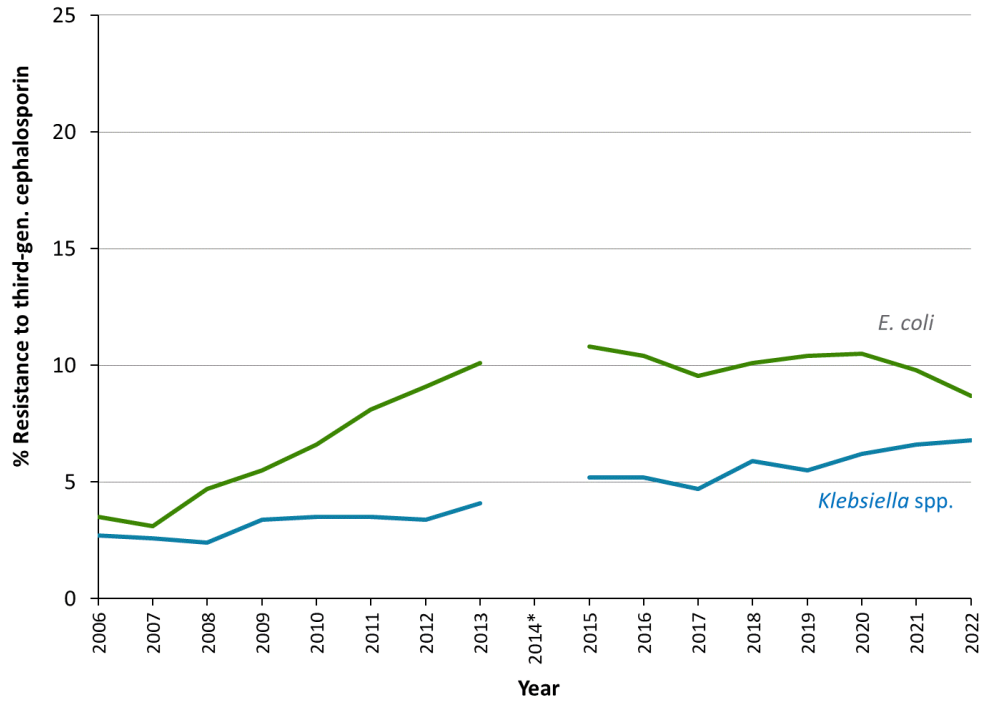
*P. aeruginosa* resistance from any specimen site to third-generation cephalosporins has fluctuated in recent years, from 7.8% in 2020 to 8.1% in 2021 to 6.5% in 2022; resistance to meropenem increased slightly from 6.5% in 2019, to 7.1% in 2022 (Figure 10). *Acinetobacter* spp. resistance to third-generation cephalosporins fluctuated from 7.2% in 2019 to 11.3% in 2020 to 8.4% in 2021 to 5.1% in 2022; resistance to meropenem decreased from 6.0% in 2020 to 2.9% in 2021 and 3.0% in 2022.

Percent resistance of *P. aeruginosa* from blood to third-generation cephalosporins has increased from 4.5% in 2019 to 6.4% in 2021 to 8.9% in 2022; resistance to meropenem also increased from 4.3% 2019 to 9.0% in 2021 and 8.8% in 2022 (Figure 11a). Among *Acinetobacter* spp. isolates, percent resistance from blood to third-generation cephalosporins increased from 7.5% in 2019 to 12.5% in 2020 and 13.1% in 2021 and 14.5% in 2022.

*E. coli* resistance from blood to third-generation cephalosporins and ciprofloxacin has fluctuated in recent years from 16.2% and 20.9% in 2020 to 11.8% and 15.7% in 2022, respectively (Figure 11a). *Klebsiella* spp. resistance from blood to cephalosporin and to ciprofloxacin increased from 2019 (4.6% and 4.1%, respectively) to 2022 (9.9% and 9.3%, respectively)

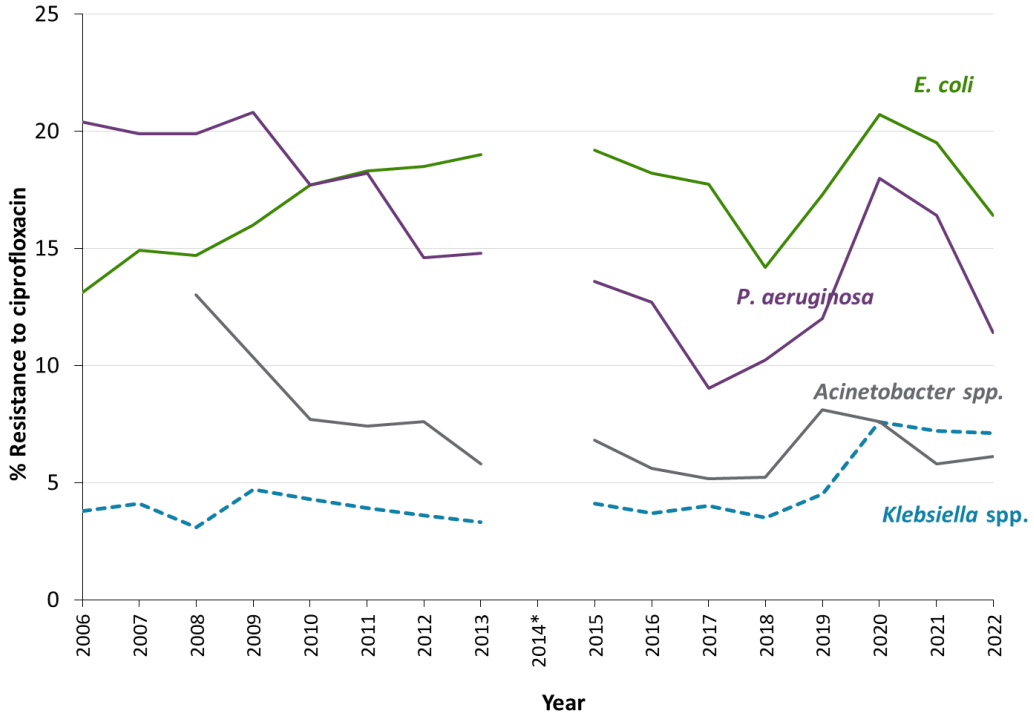
*E. coli* resistance in urine to third-generation cephalosporins remains stable from 10.0% in 2021 to 9.9% in 2022 (Figure 11b). Resistance to ciprofloxacin also remains stable from 19.9% in 2021 to 19.2% in 2022. Resistance to third-generation cephalosporins among *Klebsiella* spp. isolated from urine increased slightly, 5.5% in 2021 to 6.3% in 2022 while resistance to ciprofloxacin at 6.8% in 2021 to 7.1% in 2022.

**Figure 8. Percent resistance of all isolates of *E. coli* and *Klebsiella* spp. to third generation cephalosporins, 2006–2022**



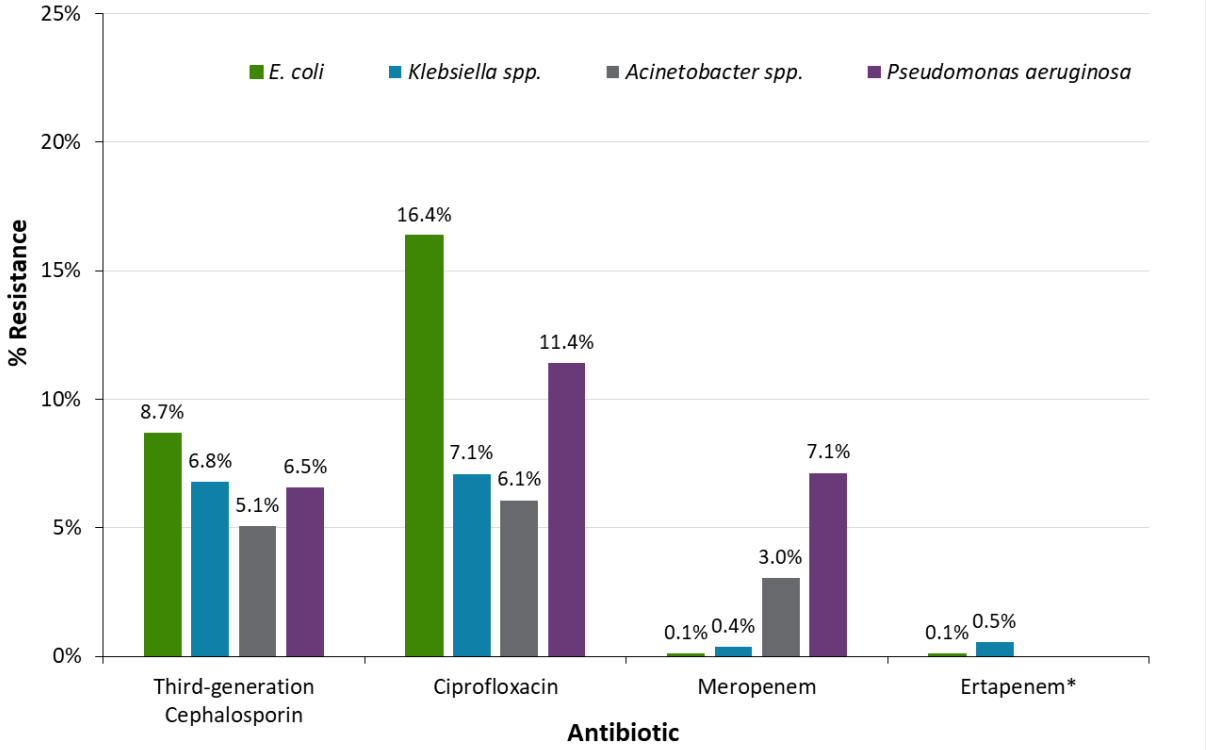

*Survey was not conducted in 2014.

**Figure 9. Percent resistance of all isolates of *E. coli* and *Klebsiella* spp., *P. aeruginosa*, and *Acinetobacter* spp. to ciprofloxacin, 2006–2022**




*Survey was not conducted in 2014.

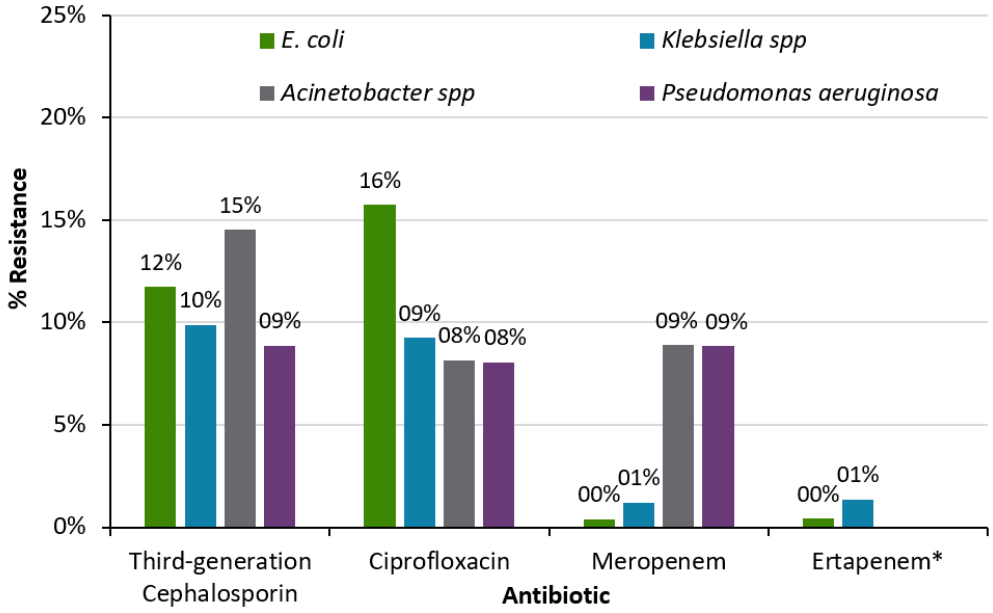
**Figure 10. Percent resistance of all isolates of *E. coli, Klebsiella* spp., *Acinetobacter* spp., and *P. aeruginosa* to third-generation cephalosporins, ciprofloxacin and carbapenems, 2022**



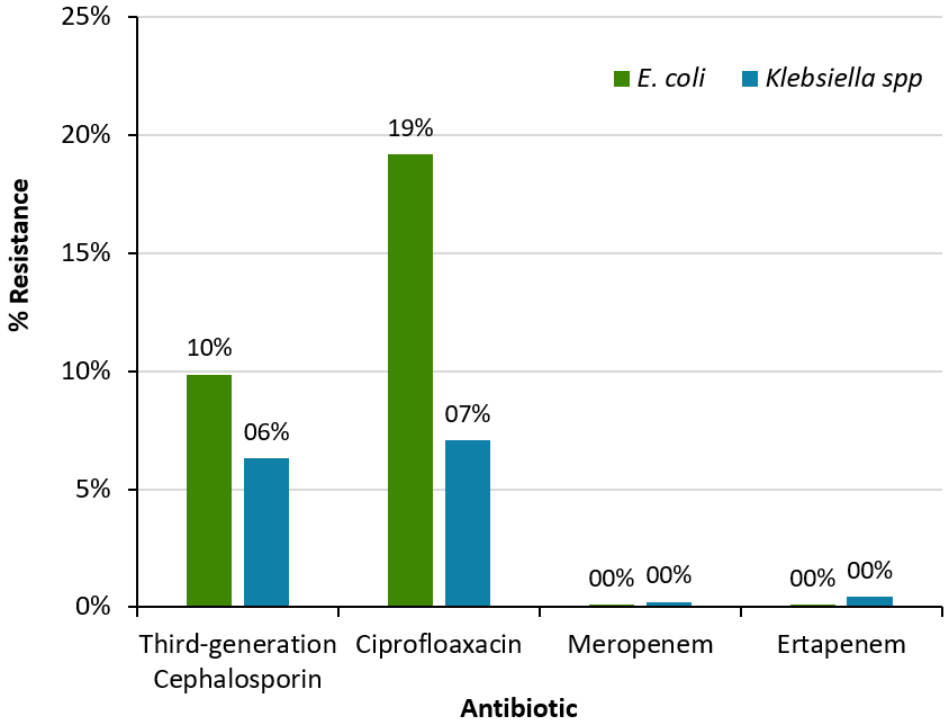

*Note: Resistance to ertapenem is shown for *E. coli* and *Klebsiella* spp. only.

**Figures 11. Percent resistance of *E. coli*, *Klebsiella* spp., *Acinetobacter* spp., and *P. aeruginosa* from blood and urine to third-generation cephalosporins, ciprofloxacin and carbapenems, 2022***

**A. Isolates from blood**




**B. Isolates from urine**




*Note: Resistance to ertapenem is shown for *E. coli* and *Klebsiella* spp. only.

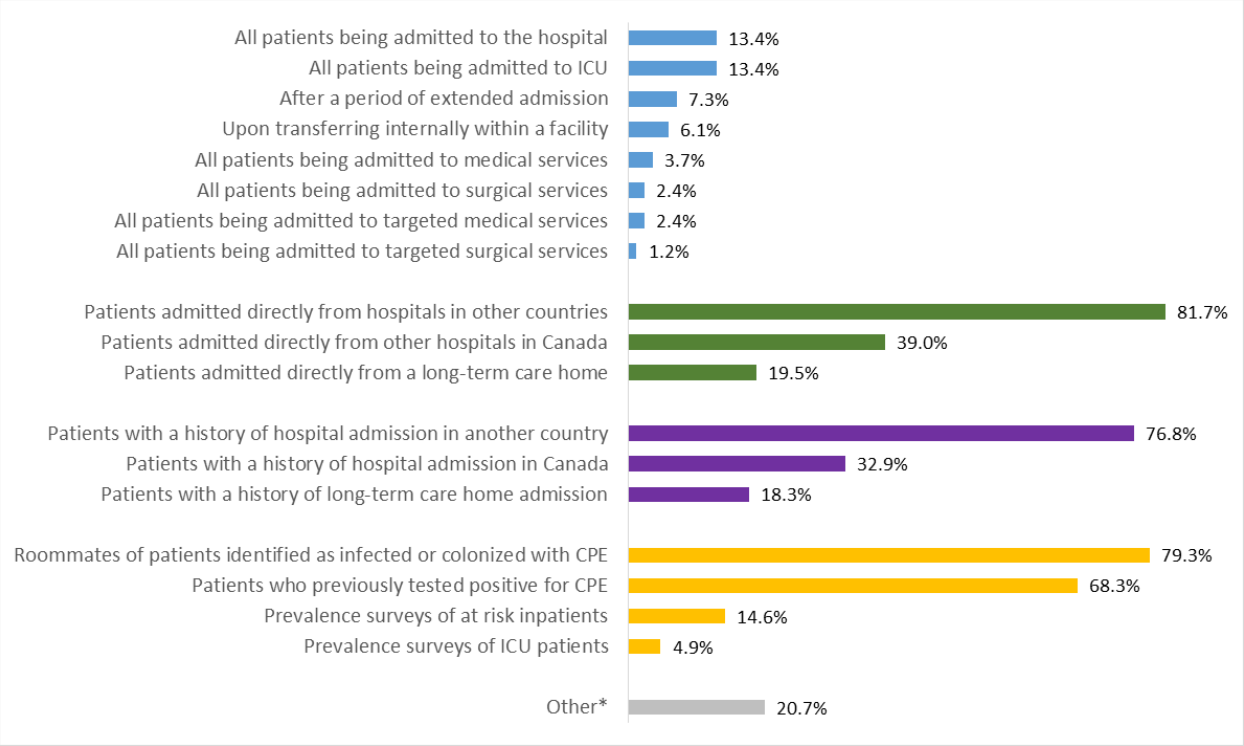
# Carbapenemase-producing organisms (CPO)

## Hospital Screening

Of the 116 responding hospital corporations, there were 82 (70.7%) that reported having a screening program for Carbapenemase-producing *Enterobacteriaceae* (CPE) in 2022. Most (64/82; 78.0%) hospitals with screening programs indicated that they manage all CPO colonizations/infections the same, even if they are not from the *Enterobacteriaceae* family (CPE). There were 18/82 (21.9%) hospitals that replied they only apply Additional Precautions for CPE cases.

Hospitals were most likely to screen patients admitted directly from hospitals in other countries, with a history of hospital admission in another country and roommates of known CPE cases (Figure 12).

**Figure 12. Criteria used by hospitals for CPE patient screening, 2022**




*In the 'other' category, four hospitals indicated they screen patients reporting history of travel to the Indian subcontinent.

## Infection Control Practices

A total of 104/116 (89.7%) hospitals responded that Additional Precautions were used for all patients with CPE colonizations and infections. Four (3.4%) hospitals responded that Additional Precautions were only used for patients with CPE infections. There were four (3.4%) hospitals that reported Additional Precautions were not used for patients with CPEs.

Most hospitals (94/111; 84.7%) using Additional Precautions for CPE positive patients reported that these patients remain in Additional Precautions for the duration of their hospitalization. Eleven (9.9%) reported that Additional Precautions may be discontinued once three negative swabs have been taken in the absence of antibiotic therapy and 6 (5.4%) provided other information such as after consulting with IPAC professionals or physicians.

There were 79/116 (68.1%) hospitals that reported special attention was paid to cleaning sinks and drains used by patients with CPE. Sixty-eight (58.6%) reported double cleaning of rooms on CPE patient discharge/transfer or discontinuation of precautions and 65 (56.0%) reported twice-a-day cleaning.

There were 5/82 (6.0%) hospitals that reported halting patient admission screening for CPEs due to the pandemic. Other disruptions to practices reported by hospitals included the discontinuation of placing CPE patients in private rooms and prevalence surveys. All reported disruptions to CPE screening and management practices were later reinstated.

## Laboratory Data

A total of 658 new patients with CPO isolated from any specimen site (colonizations and infections) were reported in 2022. Of these new CPO patients, 655 (99.5%) were associated with *Enterobacteriaceae* organisms.

- 240/658 (36.4%) specimens were identified from non-screening sites
- 47/658 (7.1%) specimens were isolated from blood culture
- 560/658 (85.1%) specimens were reported from hospital laboratories (Figure 13)

Among hospital-based laboratories, Central and Toronto regions had the highest rates of new patients with CPOs per 10,000 patients in 2022 (Figure 14, Appendix A). The overall rate increased from 2.8 per 10,000 patients in 2021 to 5.1 per 10,000 patients in 2022 (Figure 13).

The most commonly reported carbapenemase in 2022 was New Delhi Metallo-beta-lactamase (NDM; 333, 50.6%), followed by Oxacillinase (OXA; 181, 27.5%), *Klebsiella pneumoniae* carbapenemase (KPC; 121, 18.4%); Verona Integron-Encoded Metallo-beta-lactamase (VIM; 16, 2.4%); and, Imipenemase (IMP; 5, 0.8%) (Figure 15).

**Figure 13. Number of patients with CPOs isolated from any specimen site (colonizations and infections) rate per 10,000 patients reported from hospital laboratories in Ontario, 2017–2022**

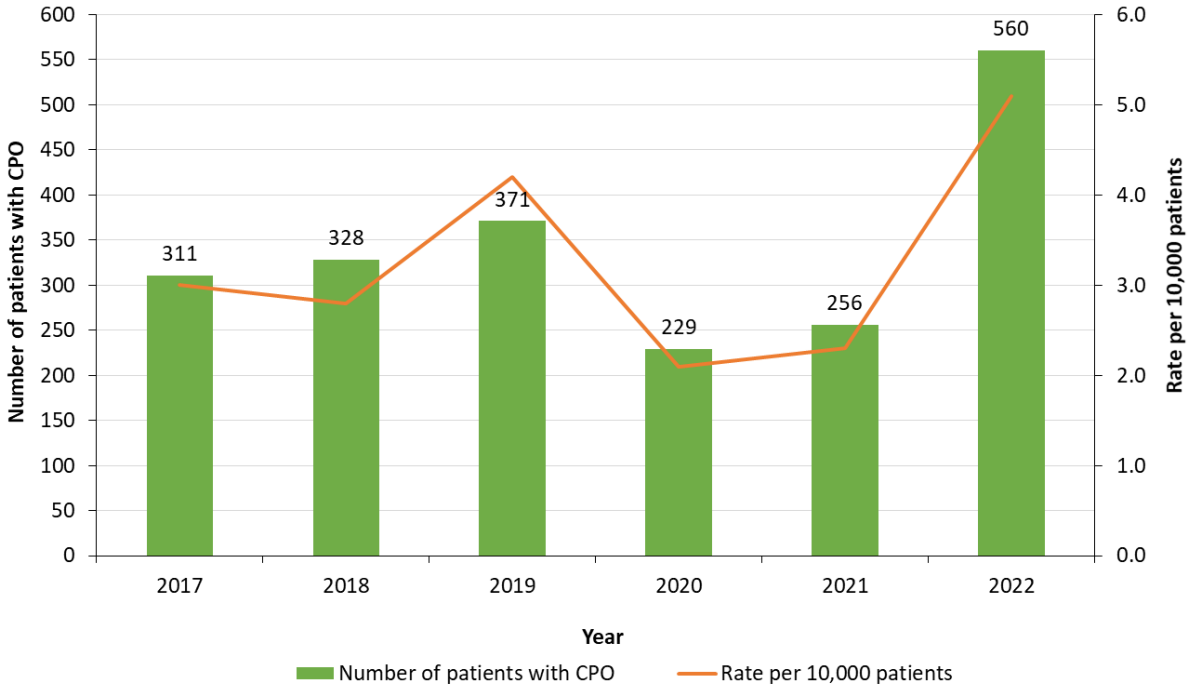



**Figure 14. Rate of patients with CPOs isolated from any specimen site (colonizations and infections) per 10,000 patients reported from hospital laboratories in Ontario, by Ontario Health Region, 2022**

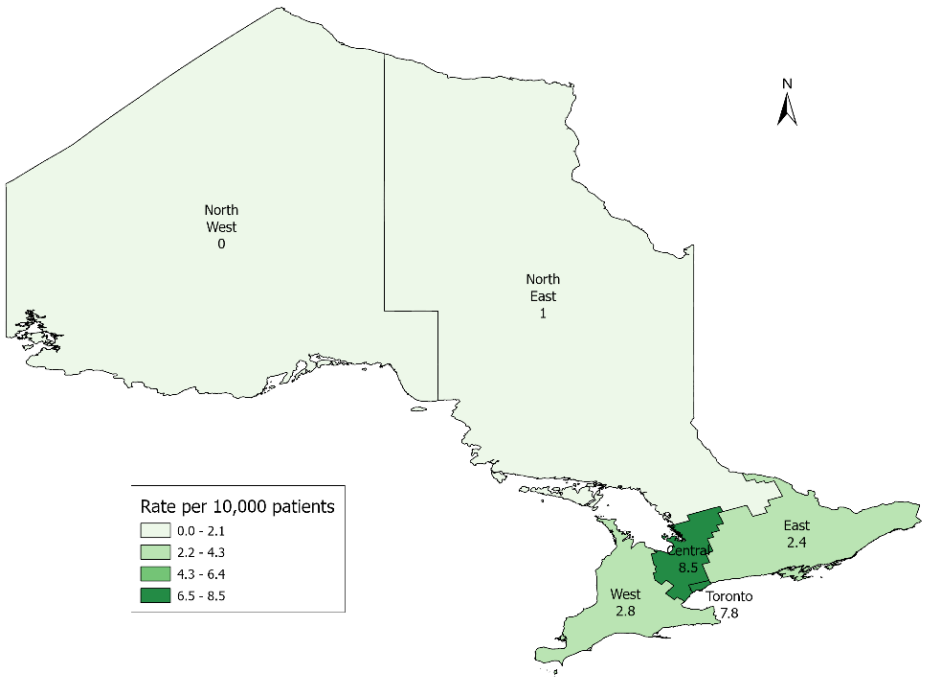
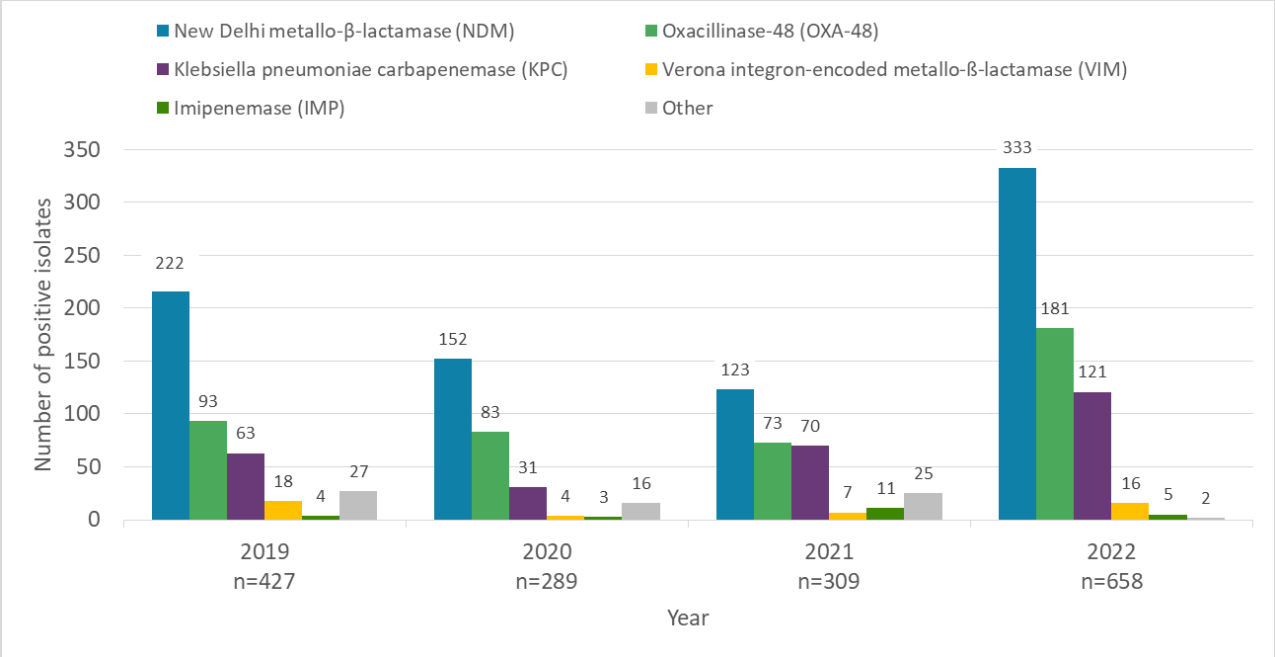


**Figure 15. Number and proportion of CPO isolated from any specimen site (colonizations and infections) by carbapenemase and year, 2019–2022**




# *Clostridioides difficile* infections (CDI)

## Infection Control Practices

Most hospitals 80/116 (69.0%) hospitals responded that Additional Precautions were used for patients identified with symptomatic CDI infections. Thirty four (29.3%) hospitals responded that Additional Precautions were used for all colonized as well as symptomatically infected patients.

There were 89/116 (76.7%) hospitals that reported Additional Precautions for CDI are discontinued when patients have had at least 48 hours of return to baseline stool pattern and 2 (1.7%) reporting that CDI patients remain in precautions for the duration of their hospitalization. Twenty three (19.8%) provided other information such as waiting ≥72 after the patient returns to baseline stool patterns or waiting ≥48 hours following the completion of treatment to remove additional precautions.

A total of 97/116 (83.6%) hospitals reported daily double cleaning of CDI patient rooms using a sporicidal agent. Seventy-eight (67.2%) also reported double cleaning with a sporicidal agent after terminal/discharge or discontinuation of precautions. Most (66; 56.9%) hospitals also reported additional cleaning of patient equipment using a sporicidal disinfectant.

Of the 116 responding hospitals, there were no reported changes to CDI screening or management practices due to the SARS-COV-2 pandemic.

## Laboratory Data

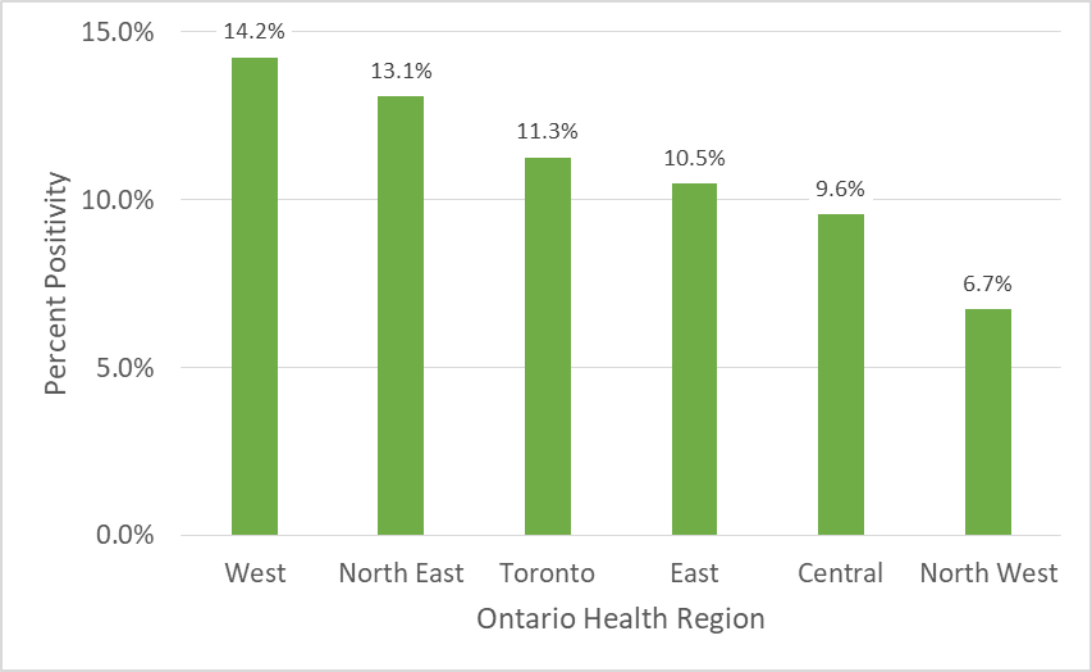
A total of 123,782 specimens were tested for *C. difficile* toxin by Ontario laboratories in 2022.

- 14,874 (12.0%) specimens were positive for *C. difficile* toxin from 12,960 people (overall rate 8.6 per 10,000 population).
- The *C. difficile* percent specimen positivity rate has increased slightly from 10.9% (each year 2019 – 2021) to 12.1% in 2022.

Laboratories in West and North East regions reported the highest proportion of specimens positive for *C. difficile* toxin in 2022 (Figure 16, Appendix A).

The Ontario Ministry of Health recommends turnaround time (TAT) from specimen collection to reporting is ≤24 hours. Due to limitations in understanding the interval between specimen collection and receipt at the laboratory, the survey asks laboratories about their average TAT from the time specimens are received to reporting test results. There were 47/52 (90.3%) laboratories that reported average TATs from specimen receipt at the laboratory to reporting <24 hours in 2022. Three (5.8%) laboratories reported an average TAT between 25–48 hours and two (3.8%) laboratories reported TATs between 49–72 hours.

**Figure 16. *C. difficile* percent specimen test positivity based on laboratory location by Ontario Health Region, 2022**



# *Candida auris*

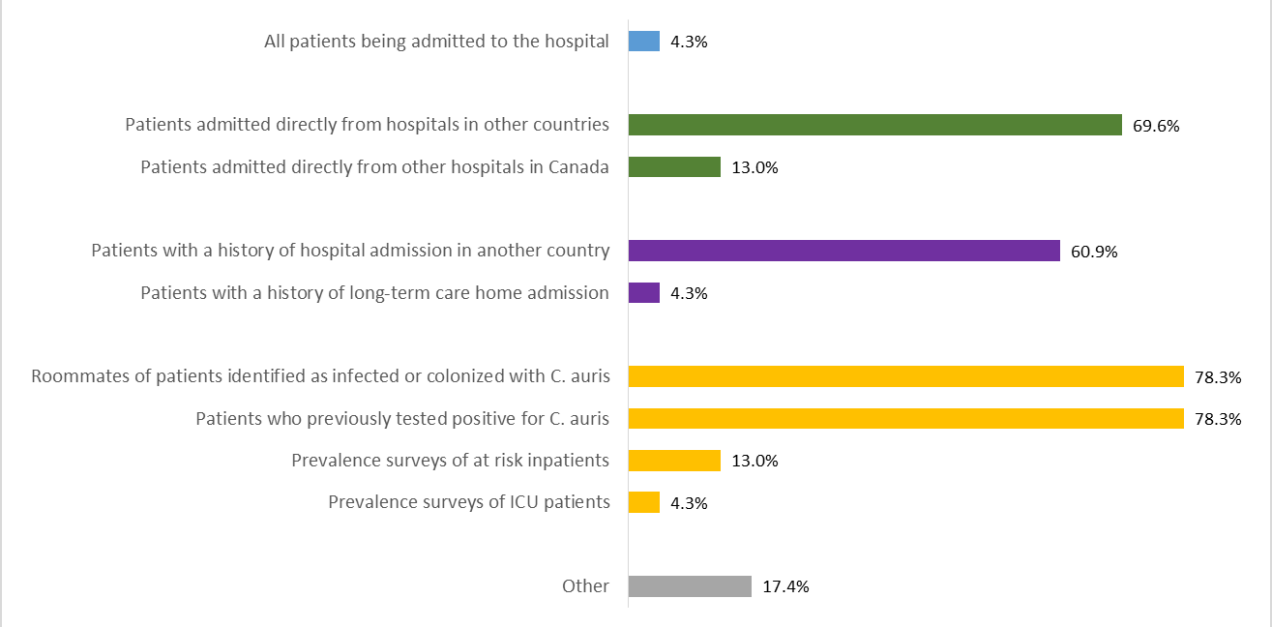
## Infection Control Practices

Of the 116 responding hospital corporations, 76 (66.5%) reported they did not have a *Candida auris* screening program at the time of the survey. Twenty-three (19.8%) hospitals reported they did have a screening program in place with 14 (12.0%) more reporting they were planning to implement a program by the end of 2023. Three hospitals did not respond to this question.

The primary reason reported by hospitals for not having a *Candida auris* screening program was that they had yet to see a case (44/76; 57.9%). Other reasons for not having a screening program for C auris include thirty-six (47.4%) hospitals reporting they have competing priorities and/or insufficient resources available to implement testing and 33 (43.4%) percieving the risk level in their geogrphic area did not yet warrant a screening program. Twelve (15.8%) hospitals also reported they did not yet have access to laboratory testing for *Candida auris.*

Hospitals were most likely to screen patients who had previously tested positive for *Candida auris*, were roommates of known *Candida auris* cases and patients admitted directly from hospitals outside of Canada (Figure 17).

**Figure 17. Criteria used by hospitals for *Candida auris* patient screening, 2022**




## Laboratory Data

There were 32/70 (45.7%) laboratories that reported having procedures in place to identify Candida *auris* from routine clinical specimens at the time of the survey. Eighteen (25.7%) laboratories indicated they had procedures to identify *Candida auris* from surveillance specimens, with 15/70 (21.4%) reporting having a process for both surveillance and routine clinical specimens.

Laboratories with procedures for identifying *Candida auris* reported using chromogenic media, matrix-assisted laser desorption ionization-time of flight (MALDI-TOF) and Vitek2 methods with some laboratories indicating they then send specimens to the Public Health Ontario Laboratory for confirmation and susceptibility testing.

A total of four new patients with *Candida auris* isolated from any specimen site (colonizations and infections) were reported in 2022.

- 2/4 (50.0%) specimens were identified from screening sites
- 2/4 (50.0%) specimens were isolated from blood culture
- All 4 positive patients were reported from hospital laboratories, 2 reported from the Central region, 1 from the Toronto region and 1 from the West region (Appendix A).

# Discussion

Health care-associated infections contribute to increased morbidity, mortality and burden on the health care system. The hospital survey results describe some of the effects of the SARS-COV-2 pandemic on the screening and management of health care-associated infections in Ontario hospitals. While most disruptions due to the pandemic have been reinstated, some hospitals did report ongoing interruptions to their screening and management programs.

Incidence rates of MRSA and VRE in Ontario increased in 2022 compared with 2021. Increases in rates of MRSA and VRE in Canadian acute care hospitals has also been observed by the Canadian Nosocomial Infection Surveillance Program.[6] Similar to previous years, there was noticeable regional variation across Ontario among pathogens. Rates of MRSA were highest in the North Regions in 2022, whereas the rates of VRE remain the highest in the East region in 2022.

The rate of CPO in Ontario hospitals is increasing, with rates nearly doubling from 2.8 per 10,000 patients in 2021 to 5.1 per 10,000 patients in 2022. The abundance of travel and migration from the Indian subcontinent to the south central region of Ontario has been reflected in the higher prevalence of CPOs compared to other parts of the province.[7,8] As of May 2018, carbapenemase-producing *Enterobacteriaceae* was designated a disease of public health significance in Ontario. Case data are now captured in the integrated Public Health Information System (iPHIS) by all public health units. In 2022, 581 cases were reported by public health units in the reportable disease data[9] while 658 cases were reported in 2022 in the current survey by laboratories.

While hospital-based rates of CDI have been decreasing since 2012[10], CDI prevalence rates from this survey increased from 5.3 per 10,000 population in 2021 to 8.6 per 10,000 population in 2022. Community-associated cases may have contributed to this trend. Differential trends in CDI rates were also observed in a study on the epidemiology of *Clostridioides difficile* infection which reported a decreasing rate of hospital-acquired CDI and an increasing rate of community-acquired CDI in Canada.[11]

Percent resistance varies by antibiotic and by Gram-negative organism. However since 2020, a decrease in percent resistance to ciprofloxacin was observed for *E. coli* and *P. aeruginosa.*

There has been exponential growth in colonizations and infections of *Candida auris* in the United States and in Europe.[12-14] Given Canada's proximity to the US, *Candida auris* infections across Canada are expected to increase. Ontario laboratories are encouraged to submit all *Candida auris* isolates to the Public Health Ontario (PHO) laboratory for confirmation and susceptibility testing. Since 2014, there have been 18 cases of *C. auris* voluntarily submitted to PHO laboratory, 10 (56%) of which were cases of invasive disease.[15] Understanding the true incidence of *Candida auris* in Ontario is difficult as only half of the responding laboratories reported established processes for identification and only ~20% of responding hospitals indicated they had screening programs in 2022. Despite this, 4 positive isolates were reported by responding laboratories, half of which were isolated from blood cultures indicating invasive disease.

Infection control practices vary widely throughout hospitals in Ontario. Best practice documents by the Provincial Infectious Diseases Advisory Committee on Infection Prevention and Control (PIDAC-IPC) provide guidance on the recommended approaches to infection control. Consistent approaches to MRSA and CDI infection control are more common (e.g., all hospitals responded that they have a screening program for MRSA and all hospitals reported using additional precautions for patients with CDI), whereas screening and infection control of VRE, ESBL, CPO and *C. auris* continue to be inconsistent among hospitals in Ontario. Diverging infection control policies for VRE and changing epidemiology of VRE were observed in the current survey results and highlighted in a study by Johnstone et al. (2020) that found increasing rates of VRE bloodstream infections were highly associated with discontinuation of screening programs and Additional Precautions for VRE.[16]

# Conclusion

The epidemiological data obtained from Ontario laboratories and hospital infection prevention and control programs helps in understanding the impact of AROs and informs recommendations to prevent spread within our province. Continued surveillance of AROs are necessary to understand the current landscape of resistance. Identifying regional variation in incidence of organisms can inform provincial and local decisions regarding appropriate application of infection control policies.

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# Appendix A: Number of new patients and Rates by Ontario Health Region, 2022

| Ontario Health Region | MRSA Number of new patients* | MRSA Rate per 1,000 patients* | VRE Number of new patients* | VRE Rate per 1,000 patients* | CPO Number of new patients* | CPO Rate per 10,000 patients* | *C. auris* Number of new patients* | *C. auris* Rate per 10,000 patients* |
|---|---|---|---|---|---|---|---|---|
| Central | 1,666 | 6.7 | 159 | 0.6 | 212 | 8.5 | 2 | 0.1 |
| East | 3,846 | 18.3 | 676 | 3.2 | 51 | 2.4 | 0 | 0.0 |
| North East | 848 | 27.4 | 10 | 0.3 | 3 | 1.0 | 0 | 0.0 |
| North West | 837 | 30.8 | 4 | 0.1 | 0 | 0.0 | 0 | 0.0 |
| Toronto | 2,422 | 9.5 | 126 | 0.5 | 200 | 7.8 | 1 | 0.0 |
| West | 8,713 | 26.1 | 181 | 0.5 | 94 | 2.8 | 1 | 0.0 |
| Total | 18,332 | 16.6 | 1,156 | 1 | 560 | 5.1 | 4 | 0.0 |

*Reported from hospital laboratories

# Appendix B: Data Caveats and Assumptions

## Data Caveats

### Data Collection

The survey was administered in two components. For hospital-based laboratories, instructions were provided to complete the laboratory survey and facilitate completion of the infection control practices with the relevant infection control personnel for the hospital or corporation. The hospital infection control survey was also distributed separately to all hospital corporations in Ontario. Each corporation was requested to complete the survey once on behalf of all corporate sites that followed the same infection control policies. The data in this report has assigned Ontario Health Region boundaries based on postal codes of the laboratories, which potentially impacts comparisons to previous reports. In addition, rates by Ontario Health Region were calculated excluding patient discharges from hospitals served by laboratories that did not respond to the laboratory survey. Survey completion was greatest among hospital-based laboratories who were able to facilitate data entry for the infection control portion of the survey into IQMH's QView survey platform.

Different approaches to survey administration have been attempted in previous years. In 2016, we began to provide pre-survey notification and follow-up reminder emails during the survey period. Collection of infection control data through the IQMH platform from hospital-based laboratories was an approach that started in 2018. While efforts were made to ensure dissemination contact lists were up to date, infection control staff may have changed. Additionally, the survey was conducted during the pandemic and some hospital infection control staff may not have participated due to pandemic-related duties. We continue to explore opportunities to strengthen networks between PHO and hospitals, as well as streamline future surveys to encourage infection control personnel to provide important data on the prevalence of AROs.

### Laboratory Data

Data on ESBLs and CDIs were requested at the specimen-level, thus duplicate specimens submitted for a single patient may be included.

For MRSA, VRE and CPOs, we assumed that the number of new patients reported by a laboratory was not duplicated by another testing laboratory; however, it is likely there were a number of patients who may have been identified and reported by multiple laboratories due to different hospital visits or admissions within the same year. This would contribute to overestimating the prevalence of AROs. Not all laboratories responded fully to each question in the survey, which may have resulted in underestimating AROs.

For both the laboratory and hospital surveys, several assumptions were made during the data cleaning process. The assumptions listed below provides a detailed list of these assumptions. Additionally, these

surveys are dependent on complete and accurate responses in order to provide useful information on AROs that may benefit laboratories practicing bacteriology as well as infection control hospital staff. In most cases, no attempt was made to verify the submitted data therefore, inaccuracies may be present. Finally, 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).

# Assumptions

## Laboratory Data

1. Counts provided in the survey were assumed to be accurate.
2. The total number of isolates was used where the subtotals did not match the total number of isolates.
3. Interpretation of questions may vary between laboratories, especially when different laboratory personnel respond to the survey year to year.
4. Regionally stratified data were based on the location of the submitting laboratory.

## Hospital Data

1. Infection control practices submitted by the corporation were assumed to apply across all institutions under the corporation.
2. Reinstatement of disruptions to screening and management practices due to the pandemic were assumed if respondents indicated an end date or 'unknown' to questions asking if practices were later reinstated.

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