Antimicrobial Resistance in Common Hospital Pathogens in Ontario

By A. McGeer, C.A. Fleming, B.M. Willey, D.E. Low

©2011 Quality Management Program—Laboratory Services
Department of the Ontario Medical Association
Published: April 2011
QMP–LS has been tracking the evolution of resistance in common hospital pathogens in Ontario since 1996. In January 2011, QMP–LS conducted its 15th annual survey assessing the incidence of resistant hospital pathogens in the province in 2010. All 80 (64 hospital-based, 15 community-based and 1 public health laboratory) currently licensed bacteriology laboratories responded. These 80 laboratories provide service for 211 hospitals. See Table 2 (p. 12–27) for detailed responses.

**Methicillin-Resistant *Staphylococcus aureus* (MRSA)**

Seventy-eight of the 80 laboratories reported MRSA data for 2010; two community-based laboratories did not provide numbers of MRSA cases. The laboratories that responded identified a total of 21,002 patients colonized or infected with MRSA (median: 75; range 0–1496). This represents an 8% increase over 2009 (Figure 1). Rates increased in all regions of Ontario (Figure 2).

Laboratories/hospitals reporting 19,683 (94%) of the patients with MRSA provided data on site of acquisition of the MRSA. In these laboratories/hospitals, the source could not be determined for 10,823 (55%) patients. For the remaining patients, 3,639/8,860 (41%, down from 62% in 2009) were thought to have been acquired in acute care hospitals (2,729 in the reporting hospital and 910 in another hospital), 1,479 (17%, up from 11% in 2009) in a nursing home, and 3,742 (42%, up from 27% in 2009) in the community. While the differences between hospital and community-acquired sources are significant compared with 2009, this could be related to the fact
that laboratories were not able to determine the source in more than half of cases in 2010 (compared with 24% in 2009).

The percentage of patients infected (as opposed to colonized) with MRSA was 33% (4241/12 900), about the same as 2008 (32%) and up from 2009 (29%) (Note: not all laboratories answered this question; those that did, represented 12 900 patients in total). The number of reported MRSA bacteraemias in 2010 decreased to 496 from 573 in 2009, a 13% decrease (Figure 3). In laboratories reporting data, 15% (447/2912) of all S. aureus isolated from blood cultures were MRSA, down from 2009 (17%). This percentage was lowest in laboratories/hospitals from postal code P (northern Ontario) (24/230; 9.7%) and M (metropolitan Toronto) (87/823; 12.7%) intermediate in laboratories from postal code K (eastern Ontario) (77/552; 13.9%) and L (central Ontario) (100/787; 12.7%) and highest in laboratories/hospitals from postal code N (western Ontario) (30.6%; 159/520). The proportion decreased in all areas of the province, with the exception of southwestern and northern Ontario, which both showed an increase over 2009.

Data on MRSA screening programs were reported for 196/211 (93%) hospitals. All 196 hospitals reported having a screening program; 89% (182/204, down from 97% in 2009) had an admission screening program consistent with or more stringent than the 1996 Ontario recommendations: that is, screening patients who have been in a health-care institution (hospital or nursing home) within the past six months. Sixty-three hospitals (31%, up from 21% in 2009) reported screening all admissions for MRSA, and four (2%) reported screening all medical, surgical and ICU admissions (i.e. excluding obstetrics and psychiatry). In addition, 11 (6%) reported screening all medical admissions, 25 (13%) all ICU admissions and 3 (2%) all surgical admissions. In hospitals using a history of prior admission to determine whether screening should be performed, the majority (102/124; 82%) included patients with a history of admission within the previous year. Most hospitals (168/196; 86%) reported screening roommates of patients identified as colonized or infected with MRSA and almost two-thirds (121/196; 62%) reported screening patients on the same ward. Sixty-four per cent (126/196) of hospitals reported performing intermittent prevalence screens of inpatients, a decrease from 73% in 2009.

In the 203 hospitals reporting on screening sites, 203 (100%) reported obtaining nasal swabs, 165 (81%) obtained wound/skin lesion swabs and 193 (95%) obtained groin, perineal or rectal swabs. The majority of hospitals (163/203, 80%) reported routinely screening the combination of nasal, wound/skin lesion and rectal/perineal/groin swabs.
Sixty-eight laboratories (13 community, 1 public health and 54 hospital-based) serving 181 hospitals reported screening for hVISA. The most common screening methods were BHIV (6 mg/L) agar screen with or without other methods, used by 48/68 (71%) laboratories, and Vitek cards with or without other methods, used by 13/68 (19%) laboratories (seven of which also reported using BHIV screening agar).

**Vancomycin-Resistant Enterococci (VRE)**

The total number of patients reported colonized or infected with VRE decreased from 6541 in 2009 to 5567 in 2010 (15% decrease) (Figure 4) (Note: not all laboratories answered this question; those that did, represented 4001 patients in total). The number of reported VRE infections decreased from 97 in 2009 to 81 in 2010 and the number of bacteremias was unchanged at 28 (Figure 3). Significant decreases in reported VRE cases occurred in postal codes L (central Ontario) and N (western Ontario), but eastern Ontario (postal code K), metropolitan Toronto (postal code M) and northern Ontario (postal code P) all reported increases in VRE (Figure 5). The majority of patients (2451/2866; 86%) for whom the site of acquisition could be attributed were judged to have acquired their VRE in acute care hospitals (83% in the hospital reporting the patient, 17% in another hospital). Five per cent (142/2866) of patients were thought to have acquired VRE in nursing homes, and 10% (273/2866) in the community, increased from <1% and 5%
respectively, in 2009. As with MRSA, the significant change in the source of VRE compared with 2009 may be due to the fact that the source could only be identified for about one-half of the isolates in 2010 (compared with 70% in 2009).

All but two of the 203 hospitals for which information was available, reported one or more VRE screening programs (Figure 6). In 2010, 28% (57/201) of hospitals in Ontario reported screening all admissions for VRE, increased from 21% in 2009. In addition, 21% (44/201) reported screening all admissions to ICU (Note: 14 also reported screening all admissions). Eighty-one per cent (163/201) of hospitals reported screening roommates of patients identified as colonized or infected with VRE and 59% (119/201) reported screening patients on the same ward as those with VRE, which is a marked decrease from 2009 (81%).

Nine laboratories reporting 512 VRE isolates were unable to provide information on the species isolated. In the remaining laboratories, 2488 (98%) were Enterococcus faecium and 42 (2%) were Enterococcus faecalis. Only nine laboratories reported identifying the vancomycin gene that was responsible for resistance (7 by PCR; 2 by antimicrobial susceptibility testing). In these laboratories, 715 (97%) patients had isolates containing vanA, and 25 (3%) had isolates containing vanB.

Only two laboratories (one community-based, and one hospital-based) reported not screening all clinically significant enterococci for vancomycin-resistance; both screened only sterile site isolates.

**Antibiotic-resistant Gram-negative bacilli**

All but six laboratories were able to provide at least some information on the number of susceptible and resistant isolates of *Escherichia coli* and *Klebsiella* spp. (Figure 7). Resistance to third-
generation cephalosporins and ciprofloxacin increased in E. coli whereas resistance to third-generation cephalosporins remained stable and resistance to ciprofloxacin in Klebsiella spp. decreased slightly in 2010 compared to 2009. While third-generation cephalosporin and ciprofloxacin-resistant isolates were reported from all areas of the province, the prevalence of resistance continues to be most common in laboratories in metropolitan Toronto (postal code M) and surrounding areas (postal code L) (Figure 8).

Laboratories providing data on resistance in Pseudomonas aeruginosa in 2010 identified 6825/38 477 (17.7%) isolates resistant to ciprofloxacin and 2775/34 126 (8.1%) resistant to imipenem/meropenem both of which have decreased from 22.8% and 10.4%, respectively, when compared to 2009. Laboratories reported 36/23 575 (0.15%) isolates as resistant to all antimicrobial agents tested. These isolates were reported from all areas of the province and were not confined to tertiary-care hospitals. Fourteen laboratories reporting 15108 isolates of P. aeruginosa were not able to provide data for the number of isolates that were resistant to all agents tested. One hundred seventy-four of 2269 (7.7%) isolates of Acinetobacter spp. were resistant to ciprofloxacin, a proportion substantially lower than that reported in 2009 (404/1710; 23.6%) and 2008 (229/1746; 13%). Fifty-seven of 1978 (2.9%) isolates of Acinetobacter spp. were reported to be resistant to imipenem/meropenem, the same proportion (43/1473; 2.9%) as reported in 2009.

Sixty-seven of the 201 (33%) hospitals providing information reported having a screening program to identify patients colonized with extended-spectrum beta-lactamase (ESBL)-producing E. coli or Klebsiella spp. in 2010. This is up slightly from 2009 (65/209; 31%). Most commonly, this involves screening roommates of colonized/infected patients (46 hospitals). The rectum is the most common body site screened (80 hospitals). One hundred ninety-six of 211 hospitals (93%) provided data on precautions recommended for patients colonized or infected with E. coli or Klebsiella spp. resistant to third-generation cephalosporins. Of these, 20 (10%) recommended no additional precautions, 116 (59%) recommended additional precautions for all such patients, and 60 (31%) recommended additional precautions for some patients (e.g. patients in the intensive care unit, if patient is soiling environment, clinical isolates only, class A ESBL isolates only). Of the 172 hospitals using additional precautions, 132 (77%) recommended private room plus contact precautions, 38 (22%) contact precautions without a private room and 2 (1%) a private room only.
Carbapenemase-producing *Enterobacteriaceae* (CPE)

Eight laboratories in Ontario (four hospital-based and four community-based) do not test any carbapenems, nine test and report carbapenems using routine Clinical and Laboratory Standards Institute (CLSI) interpretive breakpoints (six use M100-S20,\(^1\) three use M100-S20-U),\(^2\) and 62 screen for carbapenemase-production in *Enterobacteriaceae* (CPE) (Table 1).

### Table 1: Isolates for which additional testing for carbapenemase production is performed in laboratories screening for CPE in Ontario, 2010 (n=62)

<table>
<thead>
<tr>
<th>No. of Labs</th>
<th>Isolates for which additional testing for CPE is performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Ertapenem, meropenem or imipenem MIC ≥2 mg/L (CPE screening test M100-S20 and M100-S20-U)</td>
</tr>
<tr>
<td>9</td>
<td>Ertapenem, meropenem or imipenem MIC ≥1 mg/L:</td>
</tr>
<tr>
<td>9</td>
<td>Ertapenem zone diameter of 16–21 mm (CPE screening test M100-S20-U)</td>
</tr>
<tr>
<td>6</td>
<td>Ertapenem, meropenem or imipenem MIC ≥2 mg/L or ertapenem zone diameter of 16–21 mm (CPE screening test M100-S20-U)</td>
</tr>
<tr>
<td>5</td>
<td>Meropenem zone diameter of 14–21 mm (CPE screening test M100-S20-U):</td>
</tr>
<tr>
<td>3</td>
<td>Ertapenem, meropenem or imipenem MIC ≥2 mg/L or meropenem zone diameter of 14–21 mm (CPE screening test M100-S20-U)</td>
</tr>
<tr>
<td>2</td>
<td>Ertapenem zone diameter of ≤21 mm:</td>
</tr>
<tr>
<td>1 each</td>
<td>All isolates R to ceftazidime or ceftriaxone; all <em>Enterobacteriaceae</em> I or R to ceftazidime or cefotaxime by Vitek; Vitek 2 AES alert; Ertapenem, meropenem or imipenem MIC ≥1 mg/L or meropenem zone diameter of ≤15 mm; Ertapenem MIC ≥4 mg/L or imipenem MIC ≥8 mg/L; Imipenem MIC ≥4 mg/L</td>
</tr>
</tbody>
</table>

Twenty-three laboratories in Ontario do not test for ertapenem. Of those that do, 35 use M100-S20 breakpoints for resistance (8 use both MIC and disk diffusion, 19 use MIC only and 8 use disk diffusion only), 12 use M100-S20-U breakpoints for resistance (1 uses both MIC and disk diffusion, 3 disk diffusion only and 8 MIC only), 1 uses M100-S20-U disk diffusion breakpoint but M100-S20 MIC breakpoint and 1 uses M100-S20 disk diffusion breakpoint but M100-S20-U MIC breakpoint. Only 12/50 laboratories that test ertapenem changed their interpretive breakpoints in 2010.

For imipenem/meropenem resistance interpretation, 51 laboratories use M100-S20 breakpoints for resistance (12 use both MIC and disk diffusion, 32 use MIC only and 7 use disk diffusion only), 16 use M100-S20-U breakpoints for resistance (1 uses both MIC and disk diffusion, 3 disk diffusion only and 12 MIC only), uses M100-S20-U disk diffusion breakpoint but M100-S20 MIC breakpoint and 1 uses a zone diameter of ≤15 mm. Only 14/70 laboratories that test imipenem/meropenem changed their interpretive breakpoints in 2010.

A total of 58 laboratories (73%) are using either the current CLSI-recommended CPE screening criteria or more stringent criteria for detection of carbapenemase resistance and 20 (25%) are using the current CLSI-recommended breakpoints for ertapenem and/or imipenem/meropenem resistance.\(^2,3\)
Further testing in individual laboratories on screen-positive isolates include: the modified Hodge test (performed by 36 laboratories), PCR testing (performed by four laboratories, three of which also perform the Hodge test), meropenem MIC testing by Etest with interpretation using the M100-S21 CLSI standard (performed by one laboratory) and the ROSCO testing kit (one laboratory). Twenty-three laboratories refer all screen-positive isolates for additional testing and 17 laboratories refer only modified Hodge test-positive isolates.

Of the 62 laboratories screening Enterobacteriaceae for carbapenemase production, 18 screen all clinical isolates, 25 screen all clinically significant isolates, 10 screen all clinically significant isolates from sterile sites, urines and wounds, 2 screen only ESBLs. Others screen the following: sterile site isolates only (1); sterile site and wound isolates (1); sterile site and urine isolates (1); all clinically significant cefpodoxime-resistant isolates (1); all clinically significant isolates and those from surveillance swabs (1); all isolates from sterile sites, wounds and sputa (1); and isolates from sterile sites and wounds if all first-line antibiotics are resistant (1). Thirty-four laboratories screen all Enterobacteriaceae for carbapenemase production, 8 screen all Enterobacteriaceae except Proteus, Providencia and Morganella, 2 screen all E. coli and Klebsiella spp. isolates and Proteus mirabilis from sterile sites only, 16 screen E. coli and Klebsiella spp. isolates only and 2 screen only ESBLs.

Sixteen laboratories were unable to provide information regarding the number of isolates of imipenem/meropenem resistant E. coli and Klebsiella spp. The remaining laboratories reported a total of 85 isolates of imipenem/meropenem-resistant E. coli (compared to 64 such isolates reported in 2008 and 77 in 2009) and 110 isolates of imipenem/meropenem-resistant Klebsiella spp. (compared to 36 isolates reported in 2008 and 48 in 2009). Half of the carbapenem-resistant E. coli were reported by one laboratory in central Ontario and 74 of 110 carbapenem-resistant Klebsiella spp. isolates were reported by two laboratories (40 isolates reported by a laboratory in central Ontario and 34 isolates by a laboratory in metropolitan Toronto). In 2011, for the first time, laboratories were asked how many patients had been identified as being colonized or infected with one or more carbapenemase-resistant Enterobacteriaceae. Forty-two of 80 laboratories (53%) reported a total of 71 such patients (thirty of these were reported from the hospital that reported 34 carbapenem-resistant K. pneumoniae).

Twenty-two of the 202 (11%) hospitals reported having a screening program to identify patients colonized or infected with a CPE. This most frequently includes screening patients with a history of hospital admission in another country (12 hospitals, including two that specify history of hospitalization in India) and/or roommates of patients infected or colonized with CPE. Of 149 of the 159 hospitals providing information about precautions used for CPE-infected or colonized patients, 94 (59%) recommend private room and contact precautions, 43 (27%) contact precautions without private room and 2 (1%) private room only.
Conclusion

Although the number of patients identified as colonized or infected with MRSA increased significantly in 2010 compared to 2009, there are indications that Ontario is having some degree of success in managing antimicrobial resistant Gram-positive organisms. In 2010, for only the second time in a decade, the number of MRSA bacteremias decreased compared to the previous year and the number of VRE bacteremias remained stable. While there is reason to be concerned about the impact that public reporting has on reporting itself, these numbers may also be the first indication that the efforts of microbiology laboratories, infection control and public health departments, the Ministry of Health and Long-Term Care and the Ontario Agency for Health Protection and Promotion may be beginning to have an impact on the transmission of MRSA and VRE within hospitals, and the health care-associated risks of staphylococcal and enterococcal bacteremia.

While antimicrobial resistance in Klebsiella spp. is increasing only very slowly in these data (and resistance in P. aeruginosa and Acinetobacter appears, if anything, to be decreasing), antimicrobial resistance in E. coli is increasing steadily. It has been generally accepted that, if the rate of resistance in urinary isolates to a given antibiotic is greater than 20%, that antibiotic is not optimal for empiric therapy of urinary tract infections. The newly released Infectious Disease Society of America guidelines for the diagnosis and management of urinary tract infections also suggest that fluoroquinolones should not be the choice of empiric therapy for pyelonephritis in areas where the rate of ciprofloxacin resistance in urinary tract infection is above 10%. In metropolitan Toronto and surrounding areas, ciprofloxacin resistance in E. coli was above 20% in 2010, suggesting that laboratories should be looking at the rates of resistance in their particular patients, and considering warning their client physicians about the resistance rate and the implications for empiric therapy for urinary tract infections. The simultaneous increase in ciprofloxacin resistance (presumptively due to ciprofloxacin use) and cephalosporin resistance (which appears to be due to global spread of resistance determinants) now threatens the availability of oral agents for the treatment of urinary tract infections in the community.

There is now considerable global concern about the emergence of carbapenemases in Enterobacteriaceae. Two hospitals in Ontario have published their first experience with carbapenemase-resistant organisms involving Klebsiella pneumoniae carbapenemase (KPC)-containing K. pneumoniae likely associated with clonal spread from hospitals on the US eastern seaboard, and one hospital has published a case report of New Delhi metallo-beta-lactamase (NDM)-1 containing E. coli in a traveller to India. As is evident from the variable approaches in different laboratories in Ontario, laboratory detection of carbapenemases is challenging, and guidelines are changing rapidly. Keeping up with the changing recommendations and adopting new screening practices will be difficult for all laboratories in 2011. It is now clear that carbapenemases may be found in Enterobacteriaceae other than E. coli and Klebsiella spp., that such isolates may be ertapenem or imipenem-intermediate (or even susceptible) on occasion and that the modified Hodge test is not always adequate for identification. It seems likely that, particularly for the identification of NDM-1-production, laboratories will need to screen isolates with ertapenem MICs of 1 mg/L, and adopt testing such as PCR or inhibitor-disk analysis.
However, it is clear that laboratories are key to both individual patient management and the prevention of the spread of carbapenem-resistant organisms—Canadian, US, European and UK guidelines all emphasize the importance both of optimal detection methods in laboratories, and rapid communication of results to infection control and public health authorities. The survey results also emphasize how difficult it is to identify how quickly carbapenem-resistant Enterobacteriaceae are evolving. Results of this survey demonstrate that a significant minority of laboratories are not testing for carbapenemase resistance; these laboratories could be missing isolates. On the other hand, QMP–LS surveys from 2008 and 2009 suggested that a total of 225 isolates of E. coli and Klebsiella species were identified from a total of 28 laboratories. Follow-up with these laboratories reveal that the vast majority of these isolates are not carbapenem-resistant, but rather either typographical errors, or results that had not been checked because carbapenem susceptibility had not been reported clinically; to date, fewer than 10 of these have been confirmed as carbapenem-resistant. QMP–LS surveillance, while it produces very useful data, may not be either accurate enough or timely enough to serve Ontario’s needs for surveillance for carbapenem-resistant Enterobacteriaceae.
References


Table 2: Detailed Responses to Bacteriology Questionnaire BACT-1101-Q (MRSA, VRE, resistant Gram-negative bacilli data for 2010) (continues on p. 13–27)

(Note: responses to some of the questions may apply to more than one hospital served by an individual laboratory and this may not be reflected in the data that follow.)

<table>
<thead>
<tr>
<th>Type of laboratory:</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>15</td>
</tr>
<tr>
<td>Hospital</td>
<td>64</td>
</tr>
<tr>
<td>PHL</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
</tr>
</tbody>
</table>

Number of hospitals served: 211
Number of admissions 2009/10 (please provide either admissions or discharges for the most recent year available): 1 107 712
Note: 65 laboratories were able to provide this information for 192 institutions.

Methicillin-Resistant *Staphylococcus aureus* (MRSA)

5. How many new patients with MRSA did your laboratory identify in 2010? (Please count only one isolate per patient.)

<table>
<thead>
<tr>
<th>Source</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your hospital</td>
<td>2729</td>
</tr>
<tr>
<td>Another hospital</td>
<td>910</td>
</tr>
<tr>
<td>Nursing Home</td>
<td>1479</td>
</tr>
<tr>
<td>Community*</td>
<td>3742</td>
</tr>
<tr>
<td>Unable to determine</td>
<td>12142</td>
</tr>
</tbody>
</table>

* Positive culture obtained within the first 48 hours of hospital admission without history of prior hospital encounter or admission to nursing home.

6. How many of the patients identified had an MRSA infection?

Note: not all laboratories answered this question; those that did, represent 12 900 patients total (infected and colonized).

7. How many of the patients identified had a positive blood culture for MRSA?

8. How many blood cultures were positive for methicillin-susceptible *S. aureus* (MSSA) in 2010?

9. How many patients had a blood culture positive for MSSA in 2010?

10. How many patients identified with MRSA in your hospital/laboratory had been previously identified in another Ontario laboratory?

    Actual #: 441 Estimated #: 161 Unknown #: 88 facilities did not provide actual or estimated number

11. How many blood cultures in total did your laboratory perform for this hospital in 2010?

    No. of Responses |
    594 174

VISA/hVISA

12. Does your laboratory screen clinical isolates of MRSA or MSSA to detect VISA and/or hVISA?

<table>
<thead>
<tr>
<th>Screen for VISA/hVISA</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>11 labs (representing 21 hospitals)</td>
</tr>
</tbody>
</table>

(continued on following page)
<table>
<thead>
<tr>
<th>Yes</th>
<th>68 labs (representing 181 hospitals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>2 labs (representing 8 hospitals)</td>
</tr>
</tbody>
</table>

If yes, how do you screen?

<table>
<thead>
<tr>
<th>Screen Method</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agar dilution</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen</td>
<td>28</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen (MRSA isolates only)</td>
<td>2</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen (for patients with treatment failure, history of vancomycin treatment, are I or R for vancomycin or exhibit reduced susceptibility to vancomycin and are penicillin R)</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vancomycin M.I.C.E.</td>
<td>2</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vancomycin Etest</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen (MRSA isolates only) &amp; Vancomycin M.I.C.E. (MRSA isolates from blood only)</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Disk diffusion</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; MicroScan (MIC of 4 or 8 mg/L)</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vitek MIC</td>
<td>2</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vitek 2 MIC</td>
<td>5</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vitek 2 MIC (≥4 mg/L)</td>
<td>2</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vancomycin MIC (method not specified)</td>
<td>2</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; Vancomycin MIC ≥2 mg/L (method not specified)</td>
<td>1</td>
</tr>
<tr>
<td>Biorad MRSA Select plate, cefoxitin disk, MicroScan MIC</td>
<td>1</td>
</tr>
<tr>
<td>Etest</td>
<td>2</td>
</tr>
<tr>
<td>Vancomycin MIC ≥4 mg/L (method not specified)</td>
<td>1</td>
</tr>
<tr>
<td>Vancomycin MIC ≥2 mg/L (method not specified)</td>
<td>2</td>
</tr>
<tr>
<td>Vancomycin MIC ≥1 mg/L (method not specified)</td>
<td>1</td>
</tr>
<tr>
<td>Vancomycin MIC (method not specified)</td>
<td>2</td>
</tr>
<tr>
<td>MicroScan</td>
<td>1</td>
</tr>
<tr>
<td>Phoenix</td>
<td>1</td>
</tr>
<tr>
<td>Vitek</td>
<td>2</td>
</tr>
<tr>
<td>Vitek 2</td>
<td>3</td>
</tr>
<tr>
<td>Vitek 2 MIC ≥2 mg/L results flagged</td>
<td>1</td>
</tr>
<tr>
<td>VISA isolation agar (Oxoid)</td>
<td>1</td>
</tr>
</tbody>
</table>

If yes, how do you confirm?

<table>
<thead>
<tr>
<th>Confirmation Method</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referral to reference laboratory</td>
<td>44</td>
</tr>
<tr>
<td>Referral to reference laboratory if vancomycin MIC ≥2 and/or growth on BHIV screen</td>
<td></td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen &amp; referral</td>
<td>1</td>
</tr>
<tr>
<td>BHIV (6 mg/L) agar screen, Etest &amp; referral</td>
<td>1</td>
</tr>
<tr>
<td>Broth microdilution</td>
<td>1</td>
</tr>
</tbody>
</table>

(continued on following page)
### Vancomycin-Resistant Enterococci (VRE)

13. What clinical isolates of enterococci do you test for vancomycin susceptibility? *(Check all that apply)*

<table>
<thead>
<tr>
<th>Source of Isolate</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>All isolates</td>
<td>33</td>
</tr>
<tr>
<td>All clinically significant isolates</td>
<td>44</td>
</tr>
<tr>
<td>Sterile sites</td>
<td>25</td>
</tr>
<tr>
<td>Wound</td>
<td>18</td>
</tr>
<tr>
<td>Urine</td>
<td>15</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>6</td>
</tr>
<tr>
<td>[All in-patients (1); Any special request from Physician (1); Except isolates from urine (1); Surveillance swabs on first isolation of organism (1); Urine samples on in-patients only/wound samples with <em>Enterococcus</em> in pure or predominating quantities (1); Urine - only if a hospital patient and upon request (1)]</td>
<td></td>
</tr>
</tbody>
</table>

14. How many new patients with VRE did your laboratory identify in 2010? *(Please count only one isolate per patient. Please exclude *E. gallinarum* and *E. casseliflavus*)

<table>
<thead>
<tr>
<th>Source</th>
<th>New VRE Patients (2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number</td>
<td>5567</td>
</tr>
<tr>
<td>Your hospital</td>
<td>2026</td>
</tr>
<tr>
<td>Another hospital</td>
<td>425</td>
</tr>
<tr>
<td>Nursing Home</td>
<td>142</td>
</tr>
<tr>
<td>Community*</td>
<td>273</td>
</tr>
<tr>
<td>Unable to determine</td>
<td>2701</td>
</tr>
</tbody>
</table>

* Positive culture obtained within the first 48 hours of hospital admission without history of prior hospital encounter or admission to nursing home.

15. How many isolates were vancomycin-resistant *E. faecium*? 4144
16. How many isolates were vancomycin-resistant *E. faecalis*? 54

Data not available: 1369

(continued on following page)
ANTIMICROBIAL RESISTANCE IN COMMON HOSPITAL PATHOGENS IN ONTARIO

By A. McGeer, C.A. Fleming, B.M. Willey, D.E. Low

April 2011

17. Does your laboratory distinguish between vanA and vanB isolates?:

No: 69 labs (representing 151 hospitals)
Yes: 9 labs (representing 49 hospitals)
Blank: 2 labs (representing 10 hospitals)

If yes, how?: by antibiotic susceptibility: 2
by PCR: 7 (1 lab reported both methods)

If yes, how many patients had vanA isolates?: 715
van B isolates?: 24 other van types?: 0

18. How many of the patients identified had a VRE infection?

Note: not all laboratories answered this question; those that did, represent 4001 patients total (infected and colonized).

19. How many of the patients identified had a positive blood culture for VRE?

20. How many blood cultures were positive for vancomycin-susceptible enterococci in 2010?

21. How many patients had a blood culture positive for a vancomycin-susceptible enterococcus in 2010?

22. How many patients with VRE identified in your hospital/laboratory had been previously identified in another Ontario laboratory?

Actual #: 87  Estimated #: 72  Unknown #: 77 facilities did not provide actual or estimated number

Antibiotic-Resistant Gram-Negative Bacilli

Please indicate the number of ISOLATES in each of the following categories for the period Jan.1 to Dec. 31, 2010:

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of <em>Escherichia coli</em> isolates from all sites</td>
<td>349417</td>
</tr>
<tr>
<td>No. of <em>Escherichia coli</em> isolates from all sites resistant to any 3rd-generation cephalosporin</td>
<td>17167</td>
</tr>
<tr>
<td>No. of <em>Escherichia coli</em> isolates from all sites resistant to ciprofloxacin</td>
<td>59813</td>
</tr>
<tr>
<td>No. of <em>Escherichia coli</em> isolates from all sites resistant to imipenem/meropenem</td>
<td>85</td>
</tr>
<tr>
<td>No. of <em>Escherichia coli</em> isolates from blood cultures</td>
<td>8753</td>
</tr>
<tr>
<td>No. of <em>Escherichia coli</em> isolates from blood cultures resistant to any 3rd-gen cephalosporin</td>
<td>606</td>
</tr>
<tr>
<td>No. of <em>Klebsiella</em> spp. isolates from all sites</td>
<td>63413</td>
</tr>
<tr>
<td>No. of <em>Klebsiella</em> spp. isolates from all sites resistant to any 3rd-generation cephalosporin</td>
<td>1764</td>
</tr>
<tr>
<td>No. of <em>Klebsiella</em> spp isolates from all sites resistant to ciprofloxacin</td>
<td>2681</td>
</tr>
<tr>
<td>No. of <em>Klebsiella</em> spp isolates from all sites resistant to imipenem/meropenem</td>
<td>110</td>
</tr>
<tr>
<td>No. of <em>Klebsiella</em> spp. isolates from blood cultures</td>
<td>2979</td>
</tr>
<tr>
<td>No. of <em>Klebsiella</em> spp. isolates from blood cultures resistant to any 3rd-gen cephalosporin</td>
<td>200</td>
</tr>
<tr>
<td>No. of <em>Pseudomonas aeruginosa</em> isolates from all sites</td>
<td>38813</td>
</tr>
<tr>
<td>No. of <em>Pseudomonas aeruginosa</em> isolates from all sites resistant to ciprofloxacin</td>
<td>6825</td>
</tr>
<tr>
<td>No. of <em>Pseudomonas aeruginosa</em> isolates from all sites resistant to imipenem/meropenem</td>
<td>2775</td>
</tr>
<tr>
<td>No. of <em>Pseudomonas aeruginosa</em> isolates from all sites resistant to ALL antimicrobial agents tested</td>
<td>36</td>
</tr>
<tr>
<td>No. of <em>Pseudomonas aeruginosa</em> isolates from blood cultures</td>
<td>1671</td>
</tr>
<tr>
<td>No. of <em>Acinetobacter</em> spp. isolates from all sites</td>
<td>2381</td>
</tr>
<tr>
<td>No. of <em>Acinetobacter</em> spp. isolates from all sites resistant to ciprofloxacin</td>
<td>174</td>
</tr>
<tr>
<td>No. of <em>Acinetobacter</em> spp. isolates from all sites resistant to imipenem/meropenem</td>
<td>57</td>
</tr>
</tbody>
</table>

Please indicate the number of PATIENTS in each of the following categories for the period Jan. 1 to Dec. 31, 2009:

Data not available

(continued on following page)
### Antimicrobial Resistance in Common Hospital Pathogens in Ontario

By A. McGeer, C.A. Fleming, B.M. Willey, D.E. Low

**April 2011**

<table>
<thead>
<tr>
<th>Question</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients with at least one E. coli isolate (any site) resistant to any 3rd-generation cephalosporin</td>
<td>4731</td>
</tr>
<tr>
<td>No. of patients with at least one Klebsiella isolate (any site) resistant to any 3rd-generation cephalosporin</td>
<td>508</td>
</tr>
<tr>
<td>No. of patients with at least one P. aeruginosa isolate (any site) resistant to ciprofloxacin</td>
<td>1624</td>
</tr>
<tr>
<td>No. of patients with at least one carbapenemase-producing Enterobacteriaceae</td>
<td>71</td>
</tr>
</tbody>
</table>

#### Carbapenemase-Producing Enterobacteriaceae

48. Does your laboratory screen for carbapenemases in any Enterobacteriaceae?

| Yes | 62 |

**a)** If yes, in which organisms does your laboratory perform screening for carbapenemase production?

<table>
<thead>
<tr>
<th>Organisms</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Enterobacteriaceae</td>
<td>35</td>
</tr>
<tr>
<td>Some Enterobacteriaceae (Check all that apply):</td>
<td></td>
</tr>
<tr>
<td>E. coli</td>
<td>26</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>24</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>0</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>13</td>
</tr>
<tr>
<td>[All Enterobacteriaceae except Proteus, Providencia and Morganella species (8); ESBLs only (2); Proteus mirabilis from sterile sites (1); Cefpodoxime resistant isolates on which a DDD test is set up (1); Proteus mirabilis from sterile sites only plus any other Enterobacteriaceae where a carbapenem is required to be reported (1)]</td>
<td></td>
</tr>
</tbody>
</table>

**b)** If yes, what clinical isolates does your laboratory perform screening for carbapenemase-producing Enterobacteriaceae? (Check all that apply)

<table>
<thead>
<tr>
<th>Source of Isolate</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>All isolates</td>
<td>18</td>
</tr>
<tr>
<td>All clinically significant isolates</td>
<td>40</td>
</tr>
<tr>
<td>Sterile sites</td>
<td>15</td>
</tr>
<tr>
<td>Wound</td>
<td>13</td>
</tr>
<tr>
<td>Urine</td>
<td>11</td>
</tr>
<tr>
<td>Other (specify):</td>
<td></td>
</tr>
<tr>
<td>[Any isolate that is identified as an AmpC or EBSL is screened (1); ESBLs (1); If cefpodoxime resistant (1); Only if all first-line antibiotics are resistant (1); Potential ESBLs from all sites (1); Sputum (1); Surveillance swabs from Infection Control (1)]</td>
<td>7</td>
</tr>
</tbody>
</table>

**c)** If yes, how does your laboratory screen for potential carbapenemase-producing Enterobacteriaceae?

<table>
<thead>
<tr>
<th>Testing Method</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) We do further testing on isolates that have an ertapenem, meropenem or imipenem MIC of 2 mg/L or greater in our routine testing.</td>
<td>30</td>
</tr>
<tr>
<td>ii) We do further testing on isolates that have an ertapenem, meropenem or imipenem MIC of 1 mg/L or greater in our routine testing.</td>
<td>10</td>
</tr>
<tr>
<td>iii) We do further testing on isolates that have an ertapenem zone diameter of 16–21 mm in our routine testing</td>
<td>17</td>
</tr>
<tr>
<td>iv) We do further testing on isolates that have an meropenem zone diameter of 14–21 mm in our routine testing</td>
<td>7</td>
</tr>
</tbody>
</table>

(continued on following page)
v) Other (specify):
[Also resistant to one or more agents of cephalosporins subclass III (1); Use Ceftriaxone and/or Cefazidime resistance as possible ESBL and KPC production (1); Further testing on isolates resistant to one or more cephalosporin subclass III-ceftriaxone, cefazidime AND positive screening test with ertapenem and/or meropenem AND meropenem needs to be reported according to SOP (1); Further testing when i), iii), iv) occurs, and resistance to one or more cephalosporin subclass III - ceftriaxone, cefazidime occurs, and meropenem needs to be reported according to SOP (1); Screen isolates I or R to cephalosporins in subclass 3 with CLSI initial screening test for carbapenemase production, KB zone ≤21 mm - send to PHL for Modified Hodge Testing, All ESBLs tested (1); All ESBL +ve E. coli and Klebsiella spp., any SPICE group isolated, any Enterobacteriaceae I or R to cefazidime or cefotaxime in Vitek (1); Any isolates tested by Vitek 2 compact with meropenem breakpoint higher than 0.25 mg/L is further screened by disk diffusion using a 10 μg meropenem disc (1); Ertapenem MIC 2 to 4 mg/L or meropenem 2 to 8 mg/L (1); Ertapenem MIC ≥4mg/L, Imipenem MIC≥8mg/L get further testing (1); For E. coli, Klebsiella & Proteus clinical isolates being screened for ESBL, we further investigate if the ertapenem zone is <21 mm (1); Ertapenem zone diameter ≤15 mm (1); Ertapenem zone diameter ≤21 mm (1); Imipenem MIC of 4mg/L or greater in routine testing (1); Isolate that tests R or I for ertapenem by Vitek 2 method (1); Further testing on isolates with ertapenem, meropenem or imipenem MIC ≤22 mg/L if meropenem is reported based on cascade rules (1); Refer isolates with meropenem zone diameters 14–21mm to PHL for Modified Hodge Test and further susceptibility testing if required (1); Refer isolates with meropenem zone diameters 16–21mm to OAHPP (1); Vitek 2 AES looks at all β-lactams and carbapenems and alerts us in the case of a possible carbapenemase producer (1); Screen all E. coli, Klebsiella, Proteus mirabilis that are being tested for ESBL/AmpC using ertapenem disc (1)]

d) Further testing performed:

| i) Modified Hodge test | 36 |
| ii) Isolates are sent to OAHPP | 29 |
| iii) In-house PCR | 4 |

| iv) Other (specify): |
| [Modified Hodge test positives referred (5); Referred to other reference lab for modified Hodge test or PCR (6); Referred to other reference lab for PCR (1); ROSCO kit (1); Meropenem MIC by Etest (1);] | 13 |

49. What breakpoints is your laboratory currently using for ertapenem resistance in Enterobacteriaceae?

| Not applicable—do not test carbapenems | 8 |
| Not applicable—do not test ertapenem | 23 |
| Zone diameter ≤15 mm=Resistant | 17 |
| Zone diameter ≤19 mm=Resistant | 5 |
| MIC ≥8 mg/L=Resistant | 26 |
| MIC ≥1 mg/L=Resistant | 10 |
| Other (specify): | 3 |

[Breakpoint from Vitek 2 M100-S20 (1); PCR to confirm resistance NDM or KPC (1); Test but don’t report (1)]

50. Has your laboratory changed its breakpoints for ertapenem susceptibility in the last year?

| Not applicable—do not test carbapenems | 8 |

(continued on following page)
### Methicillin-Resistant *Staphylococcus aureus* (MRSA)

53. Does your hospital have a screening program to detect patients colonized with MRSA?

<table>
<thead>
<tr>
<th>Screening Program</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable – Do not serve a hospital</td>
<td>9</td>
</tr>
<tr>
<td>No – Hospital does not have a screening program</td>
<td>0</td>
</tr>
<tr>
<td>Yes – If yes, which patients are included? (Check all that apply)</td>
<td>204</td>
</tr>
<tr>
<td>a) All patients being admitted to the hospital</td>
<td>63</td>
</tr>
<tr>
<td>b) All patients being admitted to medical services (e.g. general medicine, cardiology)</td>
<td>31</td>
</tr>
<tr>
<td>c) All patients being admitted to surgical services (excluding obstetrics)</td>
<td>21</td>
</tr>
<tr>
<td>d) All patients being admitted to the ICU</td>
<td>43</td>
</tr>
<tr>
<td>e) Patients admitted directly from hospitals in other countries</td>
<td>156</td>
</tr>
<tr>
<td>f) Patients admitted directly from other hospitals in Ontario</td>
<td>155</td>
</tr>
<tr>
<td>g) Patients admitted directly from nursing homes in Ontario</td>
<td>146</td>
</tr>
<tr>
<td>h) Patients with a history of hospital admission in another country</td>
<td>144</td>
</tr>
<tr>
<td>i) Patients with a history of hospital admission in Ontario</td>
<td>146</td>
</tr>
<tr>
<td>j) Patients with a history of nursing home admission in Ontario</td>
<td>142</td>
</tr>
<tr>
<td>k) Prevalence surveys of at risk in-patients</td>
<td>126</td>
</tr>
<tr>
<td>l) Roommates of patients identified as infected or colonized with MRSA</td>
<td>168</td>
</tr>
<tr>
<td>m) Ward-mates of patients identified as infected or colonized with MRSA</td>
<td>121</td>
</tr>
<tr>
<td>n) [Data not available (11); Admission screening to high-risk units and re-screening of previously colonized pts (1); All patients admitted except obstetrics, paediatrics, mental health (7); All patients admitted to Oncology (1); Any patient with overnight stay in an acute care facility (1); Communal settings, i.e. shelters, group homes, etc. (4); Correctional facilities and group homes (Selectively) (1);</td>
<td>98</td>
</tr>
</tbody>
</table>

(continued on following page)
54. If patients with a recent history of previous admission are screened, what is the time period you include?

<table>
<thead>
<tr>
<th>Time Period</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>4</td>
</tr>
<tr>
<td>3 months</td>
<td>3</td>
</tr>
<tr>
<td>6 months</td>
<td>15</td>
</tr>
<tr>
<td>1 year</td>
<td>129</td>
</tr>
<tr>
<td>2 years</td>
<td>4</td>
</tr>
</tbody>
</table>

Other (specify):

[Data not available (11); Previous 72 months (7); 1 year if from outside Canada (2); 3 months if out of country (2); > 12 h admission (3); Patients with 12 or more consecutive hours of hospital stay in last 12 months (1); 12 months if outside of Canada (1); 72 h (1); All admissions are screened/universal screening (8); None (1); On admission day only (1); Targeted screening on each admission (1)]
55. In your screening program, or in cluster investigations, what body sites are usually screened for MRSA? (Check all that apply)

<table>
<thead>
<tr>
<th>Body Site</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal</td>
<td>203</td>
</tr>
<tr>
<td>Wound/Skin lesion</td>
<td>165</td>
</tr>
<tr>
<td>Groin</td>
<td>27</td>
</tr>
<tr>
<td>Perineum</td>
<td>70</td>
</tr>
<tr>
<td>Rectum</td>
<td>147</td>
</tr>
<tr>
<td>Indwelling device sites</td>
<td>132</td>
</tr>
<tr>
<td>Other (specify): Axilla (10); Tracheostomy, G tube (5); Throat (3); Left and right axilla to groin (2); Perineal swab also acceptable (2); Catheter urine (1); Colostomy (1); Colostomy site, peg site (1); Excoriated skin (1); Largest wound (1); Open skin lesions, colostomy site, peg site (1); Ostomy (4); Perianal (1); Previous site of infection (1); Sputum (cystic fibrosis pts) (1);</td>
<td>63</td>
</tr>
</tbody>
</table>

56. Does your hospital have a screening program to detect patients colonized with VRE?

<table>
<thead>
<tr>
<th>Screening Program</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable – Do not serve a hospital</td>
<td>9</td>
</tr>
<tr>
<td>No – Hospital does not have a screening program</td>
<td>2</td>
</tr>
<tr>
<td>Yes – If yes, which patients/specimens are included? (Check all that apply)</td>
<td>201</td>
</tr>
<tr>
<td>a) Stools submitted for C. difficile testing</td>
<td>79</td>
</tr>
<tr>
<td>b) Stools submitted for C &amp; S</td>
<td>14</td>
</tr>
<tr>
<td>c) All patients being admitted to the hospital</td>
<td>57</td>
</tr>
<tr>
<td>d) All patients being admitted to medical services (e.g. general medicine, cardiology)</td>
<td>31</td>
</tr>
<tr>
<td>e) All patients being admitted to surgical services (excluding obstetrics)</td>
<td>23</td>
</tr>
<tr>
<td>f) All patients being admitted to the ICU</td>
<td>44</td>
</tr>
<tr>
<td>g) Patients admitted directly from hospitals in other countries</td>
<td>152</td>
</tr>
<tr>
<td>h) Patients admitted directly from other hospitals in Ontario</td>
<td>151</td>
</tr>
<tr>
<td>i) Patients admitted directly from nursing homes in Ontario</td>
<td>142</td>
</tr>
<tr>
<td>j) Patients with a history of hospital admission in another country</td>
<td>144</td>
</tr>
<tr>
<td>k) Patients with a history of hospital admission in Ontario</td>
<td>144</td>
</tr>
<tr>
<td>l) Patients with a history of nursing home admission in Ontario</td>
<td>138</td>
</tr>
<tr>
<td>m) Prevalence surveys of at risk in-patients</td>
<td>121</td>
</tr>
<tr>
<td>n) Roommates of patients identified as infected or colonized with VRE</td>
<td>163</td>
</tr>
<tr>
<td>o) Ward-mates of patients identified as infected or colonized with VRE</td>
<td>119</td>
</tr>
</tbody>
</table>

(continued on following page)
p) Other (specify):

| Data not available (10); All patients admitted except obstetrics, paediatrics, mental health (7); Communal settings shelters, group homes, halfway houses, etc. (4); All patients admitted to hospital are screened (3); Patients transferred to another floor within the hospital (4); Dialysis patient, home health care (3); History of previous positive (2); Only when indicated (2); Patients with a history of positive VRE (2); Patients with hospital stay >30 days (2); Recent admission to Correctional or Mental Health Facility (2); Transfer to rehab, chronic palliative (2); Admission screening to high-risk units and re-screening of previously colonized pts. (1); All admissions to Oncology (1); All patients admitted to the Acute Care & Transition (ACT) unit (1); All patients admitted to the hospital if patient agrees with collection of rectal swab (1); Any patient with overnight stay in an acute care facility (1); Correctional Facilities (1); Home health service patients, dialysis patients, communal living patients (1); Internal transfer from one floor to another (1); IVDU, dialysis, home care, underhoused, living in communal setting (1); Known VRE patients flagged by the Hospital Information System on registration (1); Labouring mothers and psych admits are not screened (1); Length of stay >30 days (1); o) Known VRE positive patients; p) patients over 80 years (1); Occasional prevalence surveys (3); Ostomy (4); Patients admitted directly from other hospitals in Ontario with admissions > than 2 weeks (1); Patients admitted for CV vascular or transplant surgery, patients with a history of positive VRE, all patients admitted to general internal medicine (1); Patients readmitted from our own hospital (1); Patients receiving CCAC, hemodialysis (1); Patients who have been in another hospital/nursing home in the past 12 months (1); Patients who have spent 12 hours or more in a health-care setting (1); Patients with a history of VRE (10); PIDAC standards-home care in the last year (1); Prevalence survey - all patients - once per year (1); Receiving Dialysis or Home care (1); Residents from group homes (1); Immunocompromised, all contacts of VRE + patients, home health-care services, indwelling medical device, communal setting, hx of IV drug use, household contact (1); Immunocompromised, all contacts of VRE + patients, those admitted with home health-care services, indwelling medical device, communal setting, history of IV drug use (1); Screened after 30 days of admission (30-60-90 etc...) (1); Stools positive for C. difficile toxin (1); Stools with an absence of normal fecal flora (1); Transfer and Discharge screening from outbreak wards. For 3 months all admissions were screened (Jan-Feb-Mar) (1); Universal screening (1); Universal screening except paeds, obstetrics and mental health (1); When wards are in outbreak (4) |

57. If patients with a recent history of previous admission are screened, what is the time period you include?

<table>
<thead>
<tr>
<th>Time Period</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>5</td>
</tr>
<tr>
<td>3 months</td>
<td>2</td>
</tr>
<tr>
<td>6 months</td>
<td>15</td>
</tr>
<tr>
<td>1 year</td>
<td>122</td>
</tr>
<tr>
<td>2 years</td>
<td>4</td>
</tr>
</tbody>
</table>

(continued on following page)
Other (specify):
[Data not available (11); 1 year if admitted from outside Canada (2); 3 months if out of country (2); > 12 h admission (3); 12 months if outside of Canada (1); 72 h (1); All ACT admissions are screened regardless of time period (1); All admissions are screened/universal screening (8); None (2); Patients with 12 or more consecutive hours of hospital stay in last 12 months (1); Targeted screening on each admission (1)]

<table>
<thead>
<tr>
<th>Screening Program</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable – Do not serve a hospital</td>
<td>9</td>
</tr>
<tr>
<td>No – Hospital does not have a screening program</td>
<td>134</td>
</tr>
<tr>
<td>Yes – If yes, which patients are included? (Check all that apply)</td>
<td>67</td>
</tr>
<tr>
<td>a) All patients being admitted to the hospital</td>
<td>3</td>
</tr>
<tr>
<td>b) All patients being admitted to medical services (e.g. general medicine, cardiology)</td>
<td>3</td>
</tr>
<tr>
<td>c) All patients being admitted to surgical services (excluding obstetrics)</td>
<td>2</td>
</tr>
<tr>
<td>d) All patients being admitted to the ICU</td>
<td>7</td>
</tr>
<tr>
<td>e) Patients admitted directly from hospitals in other countries</td>
<td>16</td>
</tr>
<tr>
<td>f) Patients admitted directly from other hospitals in Ontario</td>
<td>9</td>
</tr>
<tr>
<td>g) Patients admitted directly from nursing homes in Ontario</td>
<td>10</td>
</tr>
<tr>
<td>h) Patients with a history of hospital admission in another country</td>
<td>16</td>
</tr>
<tr>
<td>i) Patients with a history of hospital admission in Ontario</td>
<td>10</td>
</tr>
<tr>
<td>j) Patients with a history of nursing home admission in Ontario</td>
<td>10</td>
</tr>
<tr>
<td>k) Prevalence surveys of ICU patients</td>
<td>7</td>
</tr>
<tr>
<td>l) Prevalence surveys of other in-patients</td>
<td>13</td>
</tr>
<tr>
<td>m) Roommates of patients identified as infected or colonized with an ESBL-producing <em>E. coli</em> or <em>Klebsiella</em></td>
<td>46</td>
</tr>
<tr>
<td>n) Ward-mates of patients identified as infected or colonized with an ESBL-producing <em>E. coli</em> or <em>Klebsiella</em></td>
<td>23</td>
</tr>
<tr>
<td>o) Other (specify):</td>
<td>52</td>
</tr>
<tr>
<td>[Data not available (10); Isolates by antibiogram (4); Clinical specimens only (3); No screening available to I.D. at-risk patients, ESBL’s are only identified on C&amp;S reports (2); Previous positive patients (2); Transfer to rehab, chronic palliative (2); All in-patient cultures (1); Ask if ever had an ESBL (2); Discontinued regular screening in July 2010 (1); Follow-up screening for known ESBL positive patients (3); If ever had ESBL/outbreak exposed (2); If foley catheter in situ, if central line in (2); In development (1); Known travel history in past 12 months to certain countries (1); Lab screens all isolates and reports to IC and all previous positive ARO are placed in contact precautions on admissions (4); No screening program, but once identified then roommates and ward-mates are screened (1); Passive surveillance through routine cultures (2); Patient with a history of ESBL (4); Patients admitted directly from hospitals in Ontario with admissions &gt; 2 weeks (1); Patients with positive clinical specimens (1); Positive urine culture (1); Universal screening except paediatrics, obstetrics and mental health (1); When requested by Infection Control (1)]</td>
<td></td>
</tr>
</tbody>
</table>
59. If patients with a recent history of previous admission are screened, what is the time period you include?

<table>
<thead>
<tr>
<th>Time Period</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>1</td>
</tr>
<tr>
<td>3 months</td>
<td>3</td>
</tr>
<tr>
<td>6 months</td>
<td>3</td>
</tr>
<tr>
<td>1 year</td>
<td>16</td>
</tr>
<tr>
<td>2 years</td>
<td>4</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>41</td>
</tr>
</tbody>
</table>

[Data not available (11); Not applicable (14); History of previous positive (2); No time frame at present (2);/2 h (1); All patients are screened/universal screening (3); If infection risk identified (1); No screening program (1); Patients with a history of ESBL (4); Previous positives (1); Targeted screening with each admission (1)]

60. In your screening program, or in cluster investigations, what body sites are usually screened for ESBLs? (Check all that apply)

<table>
<thead>
<tr>
<th>Body Site</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal</td>
<td>1</td>
</tr>
<tr>
<td>Wound/Skin lesion</td>
<td>12</td>
</tr>
<tr>
<td>Groin</td>
<td>4</td>
</tr>
<tr>
<td>Perineum</td>
<td>1</td>
</tr>
<tr>
<td>Rectum</td>
<td>80</td>
</tr>
<tr>
<td>Indwelling device sites</td>
<td>13</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>49</td>
</tr>
</tbody>
</table>

[Data not available (3); Isolates by antibiogram (4); Clinical specimens (3); Sputum if vented and urine if catheterized (3); Previous positive site (2); For cluster investigations only (1); No screening program (1); Previous ESBL positive sites (2); Previous site of infection (1); Stool (1); Stool, other clinical specimen (e.g. sputum, urine, etc.) (1); Urine and wounds if previously positive from these sites (7); Urine (12); Urine if applicable (5); Urine from symptomatic patients (1); Urine, draining wound, stool (1); Wounds occasionally (1)]

61. Does your hospital use isolation precautions for patients infected or colonized with E. coli or Klebsiella spp. resistant to 3rd-generation cephalosporins?

<table>
<thead>
<tr>
<th>Isolation Precautions Used</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>20</td>
</tr>
<tr>
<td>Yes, all colonized or infected patients</td>
<td>116</td>
</tr>
</tbody>
</table>

Yes, some patients (e.g. only clinical isolates, only in ICU, only if quinolone-resistant) Specify conditions:

[Data not available (10); Critical care only ESBL positive (4); If identified in clinical specimen (4); If we receive a sample from a patient with an ESBL positive E. coli or Klebsiella - that patient is put in isolation (2); Only isolate for infections with confirmed ESBL producing strains of E. coli or Klebsiella spp. (1); Class A ESBL colonized or infected (1); Only if ESBL producing isolates (1); If admitted with ESBL and if in high-risk group (1); Uncontained drainage, incontinence, high-risk area (ICU); assessed on patient by patient basis (2); Active infection, uncontained drainage - patients are assessed individually (2); Patients with clinical isolates only]

(continued on following page)
(4); Those with diarrhea (3); Fecal incontinence (1); If patient is soiling the environment (3); If flagged in EPR (electronic patient record) (1); If foley catheter in situ, if central line in (2); If isolate shows significant resistance (1); Only identifying these organisms from clinical isolates. We would only screen during outbreak situation, in which case both colonized and infected patients would be isolated (1); Only in ICU (10); Patients with indwelling foley catheters (3); Private room (1); If the carbapenemase screen is positive, then initiate contact precautions (1); Blank (2)]

62. What types of precautions are used? (check all that apply)

<table>
<thead>
<tr>
<th>Precautions Used</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>9</td>
</tr>
<tr>
<td>Contact precautions</td>
<td>170</td>
</tr>
<tr>
<td>Private room if possible</td>
<td>134</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>29</td>
</tr>
<tr>
<td>Data not available (11); Contact precautions added for ICU and incontinent patients (4); Droplet precautions if respiratory tract involved (4); Droplet/contact if ESBL isolated in sputum (4); Commode or bathroom (2); Cohort (1); Decided by Infection Control after individual assessments for all cases (1); Private room (1); Will cohort patients with same organism/same sensitivity pattern (1)</td>
<td></td>
</tr>
</tbody>
</table>

63. When are precautions discontinued?

<table>
<thead>
<tr>
<th>Precautions Discontinued</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable – precautions not used</td>
<td>10</td>
</tr>
<tr>
<td>At discharge</td>
<td>44</td>
</tr>
<tr>
<td>When clinical site originally positive becomes negative</td>
<td>57</td>
</tr>
<tr>
<td>After three negative rectal swab specimens</td>
<td>62</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>80</td>
</tr>
<tr>
<td>Data not available (10); Transfer out of ICU (7); ESBL blood infection - 4 negative rectal swab (4); If treated and 3 negative specimens (4); When discharged from critical care (4); After 3 negative clinical specimens 7 days apart (8); In consultation with IPAC; assessed on a patient by patient basis (2); Decided by Infection Control after individual assessments for all cases (1); No guidelines for discontinuing precautions (2); 4 consecutive swabs are obtained (1); After 3 consecutive weekly rectal swabs are negative and initial site of infection negative x 3 (1); After effective therapy or based on risk assessment (2); At the direction of Infection Control (1); Clinical site negative + 3 - ve rectal swabs (2); Clinical site originally positive remains negative for 3 consecutive swabs (7); Clinical Specimens (1); Flagged for screening if readmitted (1); Following weeks with multiple negative cultures from clinical sites and GI (1); If patient is not on antibiotics and clinical site originally positive becomes negative (4); If positive in urine and patient has a catheter - after 3 negative urine specimens (1); Never for ESBL (1); Or three negative site specific swabs, when foley catheter is removed, or if central line is removed (1); Removal of foley catheter (3); When foley catheter is removed or when central line is removed (1); When antibiotics are no longer in use (2); When patient stops soiling the environment (3); Wound/skin 3x (1); Blank (5)</td>
<td></td>
</tr>
</tbody>
</table>

(continued on following page)
## Carbapenemase-Producing Enterobacteriaceae

64. Does your hospital have a screening program to detect patients colonized with carbapenemase-producing Enterobacteriaceae?

<table>
<thead>
<tr>
<th>Screening Program</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable – Do not serve a hospital</td>
<td>9</td>
</tr>
<tr>
<td>No – Hospital does not have a screening program</td>
<td>181</td>
</tr>
<tr>
<td>Yes – If yes, which patients are included? (Check all that apply)</td>
<td></td>
</tr>
<tr>
<td>a) All patients being admitted to the hospital</td>
<td>0</td>
</tr>
<tr>
<td>b) All patients being admitted to medical services (e.g. general medicine, cardiology)</td>
<td>1</td>
</tr>
<tr>
<td>c) All patients being admitted to surgical services (excluding obstetrics)</td>
<td>0</td>
</tr>
<tr>
<td>d) All patients being admitted to the ICU</td>
<td>1</td>
</tr>
<tr>
<td>e) Patients admitted directly from hospitals in other countries</td>
<td>9</td>
</tr>
<tr>
<td>f) Patients admitted directly from other hospitals in Ontario</td>
<td>3</td>
</tr>
<tr>
<td>g) Patients admitted directly from nursing homes in Ontario</td>
<td>4</td>
</tr>
<tr>
<td>h) Patients with a history of hospital admission in another country</td>
<td>10</td>
</tr>
<tr>
<td>i) Patients with a history of hospital admission in Ontario</td>
<td>4</td>
</tr>
<tr>
<td>j) Patients with a history of nursing home admission in Ontario</td>
<td>4</td>
</tr>
<tr>
<td>k) Prevalence surveys of ICU patients</td>
<td>2</td>
</tr>
<tr>
<td>l) Prevalence surveys of other in-patients</td>
<td>3</td>
</tr>
<tr>
<td>m) Roommates of patients identified as infected or colonized with a carbapenemase-producing Enterobacteriaceae</td>
<td>11</td>
</tr>
<tr>
<td>n) Ward-mates of patients identified as infected or colonized with a carbapenemase-producing Enterobacteriaceae</td>
<td>9</td>
</tr>
<tr>
<td>o) Other (specify):</td>
<td>20</td>
</tr>
<tr>
<td>[Data not available (10); Previous positive patient (2); History of hospitalization in India (1); History of hospitalization in India in past 12 months (1); If travel history is known; outbreak situation (1); Patients admitted directly from other hospitals in Ontario with &gt;2 weeks admission (1); Pt infected with carbapenemase producer (2); We have never had a case (1); When requested by Infection control (1)]</td>
<td></td>
</tr>
</tbody>
</table>

65. If patients with a recent history of previous admission are screened, what is the time period you include?

<table>
<thead>
<tr>
<th>Time Period</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>0</td>
</tr>
<tr>
<td>3 months</td>
<td>1</td>
</tr>
<tr>
<td>6 months</td>
<td>0</td>
</tr>
<tr>
<td>1 year</td>
<td>4</td>
</tr>
<tr>
<td>2 years</td>
<td>1</td>
</tr>
</tbody>
</table>

**Other (specify):**

[Data not available (11); Not applicable - no screening program (12); History of previous positive (2); No time frame at present (2); All admissions, every admission (1); Targeted screening with each admission (1)]

66. In your screening program, or in cluster investigations, what body sites are usually screened for carbapenemase-producing Enterobacteriaceae? (Check all that apply)

<table>
<thead>
<tr>
<th>Body Site</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal</td>
<td>1</td>
</tr>
<tr>
<td>Wound/Skin lesion</td>
<td>8</td>
</tr>
</tbody>
</table>

(continued on following page)
### 67. Does your hospital use isolation precautions for patients infected or colonized with carbapenemase-producing Enterobacteriaceae?

<table>
<thead>
<tr>
<th>Isolation Precautions Used</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>24</td>
</tr>
<tr>
<td>Yes, all colonized or infected patients</td>
<td>119</td>
</tr>
<tr>
<td>Yes, some patients (e.g. only clinical isolates, only in ICU, only if quinolone-resistant) Specify conditions:</td>
<td>33</td>
</tr>
<tr>
<td>[Data not available (10); Critical care only (4); If identified in clinical specimen (4); Uncontained drainage, incontinence, high-risk area (ICU); assessed on patient-by-patient basis (2); Clinical isolates and/or outbreaks (1); Decided by Infection Control after individual assessments for all cases (1); Do not have a policy or directive yet (1); Do not have a surveillance program (1); If carbapenemase-producing Enterobacteriaceae is identified, patient is isolated (1); If flagged in EPR (electronic patient record) (1); If known positive patient is admitted or discovered through culture results (1); Only in ICU (3); Positive clinical isolates (1); Blank (2)]</td>
<td></td>
</tr>
</tbody>
</table>

### 68. What types of precautions are used? (check all that apply)

<table>
<thead>
<tr>
<th>Precautions Used</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>17</td>
</tr>
<tr>
<td>Contact precautions</td>
<td>137</td>
</tr>
<tr>
<td>Private room if possible</td>
<td>95</td>
</tr>
<tr>
<td>Other (specify):</td>
<td>36</td>
</tr>
<tr>
<td>[Data not available (10); Droplet if isolated from respiratory tract and patient is symptomatic (5); Droplet if respiratory tract involved (4); Droplet/contact if isolated in sputum (4); Not applicable - do not have a screening program (5); Commode or bathroom (2); Decided by Infection Control after individual assessments for all cases (1); Private room (1); Unsure (1); Will cohort with patients with same organism/same sensitivity pattern (1); Yet to be determined (1); Contact precautions added for ICU and incontinent patients (1)]</td>
<td></td>
</tr>
</tbody>
</table>

### 69. When are precautions discontinued?

<table>
<thead>
<tr>
<th>Precautions Discontinued</th>
<th>No. of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable – precautions not used</td>
<td>18</td>
</tr>
<tr>
<td>At discharge</td>
<td>35</td>
</tr>
<tr>
<td>When clinical site originally positive becomes negative</td>
<td>47</td>
</tr>
<tr>
<td>After three negative rectal swab specimens</td>
<td>46</td>
</tr>
</tbody>
</table>

(continued on following page)
Other (specify):

<table>
<thead>
<tr>
<th>Other (specify)</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Data not available (10); Still developing protocols (7); Once asymptomatic - if isolated from respiratory tract (5); Post blood infection - one negative rectal swab (4); Not applicable - do not have a screen program (4); Not discontinued (6); In consultation with IPAC, assessed on a patient-by-patient basis (2); No guidelines for discontinuing precautions (2); Patient has been discharged prior to rescreening. No policy in place (2); When clinical site originally positive becomes negative 3 continuous times one week apart (2); 3 negative cultures 1 week apart from original site (2); After 3 consecutive weekly rectal swabs are negative and initial site of infection negative x 3 (1); After clinical site is negative post-treatment (1); After complete assessment by ICP (1); At the direction of Infection Control (1); Based on risk assessment (2); Clinical site neg + 3 neg rectal swabs (2); Decided by Infection Control after individual assessments for all cases (1); Flagged for screening on readmission (1); If clinical site tests positive but rectal/stool cultures are repeatedly negative (1); Never for Carbapenemase-producing Enterobacteriaceae (1); Or three negative site specific swabs (1); Unsure (1); Upon discharge or in consult with Infectious Diseases physician (1); When antibiotics are no longer in use (2); When clinical site becomes negative x3 (1); Yet to be determined (1)]</td>
<td></td>
</tr>
</tbody>
</table>