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CANADIAN NOSOCOMIAL INFECTION SURVEILLANCE PROGRAM (CNISP):

Summary Report of Healthcare Associated Infection (HAI), Antimicrobial Resistance (AMR) and Antimicrobial Use (AMU) Surveillance Data from January 1, 2013 to December 31, 2017


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The Canadian Nosocomial Infection Surveillance Program (CNISP): Summary Report of Healthcare Associated Infection (HAI), Antimicrobial Resistance (AMR) and Antimicrobial Use (AMU) Surveillance Data from January 1, 2013 to December 31, 2017

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INTRODUCTION

This report entitled *Canadian Nosocomial Infection Surveillance Program (CNISP): Summary Report of Healthcare Associated Infection (HAI), Antimicrobial Resistance (AMR) and Antimicrobial Use (AMU) Surveillance Data from January 1, 2013 to December 31, 2017,* was produced by the Centre for Communicable Diseases and Infection Control (CCDIC) of the Public Health Agency of Canada (PHAC). The report provides a review of available HAI, AMR and AMU surveillance data from sentinel hospitals across Canada.

PHAC collects national data on various healthcare associated infections and AMU through the Canadian Nosocomial Infection Surveillance Program (CNISP), a collaborative effort of CCDIC, the National Microbiology Laboratory (NML) and sentinel hospitals across Canada who participate as members of the Canadian Hospital Epidemiology Committee (CHEC), a subcommittee of the Association of Medical Microbiology and Infectious Disease (AMMI) Canada. Their ongoing contributions to national HAI surveillance are gratefully acknowledged.

CCDIC coordinates the data collection and is responsible for the data management, analysis and report production related to this summary report. CCDIC supports the use of these data to inform public health and policy action.

CNISP surveillance provides key information that informs the development of federal, provincial, territorial and local infection prevention and control and antimicrobial stewardship programs and policies. When carried out in a uniform manner, surveillance provides a measure of the burden of illness, establishes benchmark rates for internal and external comparison, identifies potential risk factors, and allows for the assessment of specific interventions. Surveillance for HAIs is considered an important component of the quality of patient care.

METHODS

This report provides case counts and rates based on data from January 1, 2013 to December 31, 2017. All rates presented in this report represent infections and/or colonizations identified in patients admitted (inpatients) to CNISP hospitals. Where possible, rates are provided by region and include Western (British Columbia, Alberta, Saskatchewan and Manitoba), Central (Ontario and Quebec), and Eastern Regions (Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland and Labrador). The territories do not currently submit data to PHAC.

National and regional infection rates are based on total number of cases divided by the total number of patient admissions (multiplied by 1,000) or patient days (multiplied by 10,000). Molecular characterization and antimicrobial resistance testing is conducted by the National Microbiology Laboratory (NML) on all patient-linked isolates received for CDI, MRSA, VRE, CPE and CPA with select results presented. The 2017 case definitions and eligibility criteria for these surveillance programs are provided in Appendix C.

This report supersedes the data in previous CNISP reports. The most current report should be considered the most accurate. Surveillance data are dynamic and results are subject to change as more updated data are made available by the participating hospitals. Note that for all years, only hospitals that submitted both numerator and denominator data are included in the rate calculations.

For questions or more detailed information on these methods, rates or for a copy of the most recent surveillance report, please contact CNISP by sending an email to phac.cnisp-pcsin.aspc@canada.ca.

DATA HIGHLIGHTS

Clostridioides difficile Infection (CDI)

- From 2013 to 2017, healthcare associated CDI (HA-CDI)* rates have significantly decreased by 25%.
- Approximately one-third of all CDI cases[‡] were community-associated CDI from 2015 to 2017.
- The number of deaths attributable to CDI during the two-month study period each year ranged from 12 (3.0% in 2016) to 22 (4.3% in 2014)[¥].
- Among HA-CDI* strains from 2013 to 2017, NAP1 has significantly decreased by 44%, while NAP4 and NAP11 continue to increase from 17.4% to 21.6% and 6.4% to 13.7%, respectively. A similar trend is observed from 2015 to 2017 among community associated *C. difficile* strains.
- A significantly larger proportion of NAP1 strains are identified among HA-CDI* isolates (50.6%) compared to CA-CDI isolates (9.9%).

**HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.*

[‡] *Proportion calculated from hospitals that reported both HA- and CA-CDI cases.*

[¥] *Data collected during March and April, 2013 to 2017*

Methicillin-Resistant *Staphylococcus aureus* (MRSA)

- There has been a gradual but significant increase in overall MRSA infection rates (includes both bloodstream and non-bloodstream infections) since 2013. This increase in the overall rates is primarily driven by the increase in community-associated MRSA (CA-MRSA) infection rates. Healthcare-associated (HA-MRSA) infection rates have continued to steadily decrease since 2013.
- Since 2015, CMRSA10 strain type (the strain associated with community-acquired MRSA) has been the predominant strain type identified. Prior to 2015, CMRSA2 (the strain associated with CA-MRSA) represented the largest proportion of strain types identified.
- There has been a significant decrease in all-cause mortality among patients identified with MRSA-BSI from 26% in 2013 to 16% in 2017.
- From 2013 to 2017, there has been a significant decrease in Clindamycin resistance (84% to 42%) among all MRSA isolates tested (blood and non-blood).

Vancomycin-Resistant Enterococci (VRE)

- From 2015 to 2017 there has been a steady yet significant increase in VRE bloodstream infection (BSI) rates (approximately 28% each year), with the largest increase reported in Central Canada.
- From 2016 to 2017, a significant increase in VRE BSI isolates that are non-typeable using MLST was observed (9.8% to 62.1%).
- Among VRE BSI isolates, a significant increase in resistance to nitrofurantoin (18.7% to 44.8%) and HL-Gentamicin (17.3% to 38.8%) has been identified from 2013-2017.

Carbapenemase-Producing Enterobacteriaceae (CPE) and Carbapenemase-Producing *Acinetobacter* (CPA)

- CPE infection rates have remained stable from 2013 to 2017 (0.03 per 10,000 patient days). However, CPE colonization rates have significantly increased from 2014 (0.03 per 10,000 patient days) to 2017 (0.14 per 10,000 patient days), largely due to an increase in colonized cases in central Canada.
- CPA rates in Canada remain extremely low, with the exception of a 2013 outbreak attributed to one hospital in the Central region.
- Among CPEs, KPC and NDM continue to be the predominant carbapenemases, while OXA-23 continues to be the predominant carbapenemase for CPA.

Escherichia coli Antibiogram (*E. coli*)

- In 2015, CNISP initiated a pilot project to assess the feasibility of collecting hospital antibiogram data for *Escherichia coli* (*E. coli*). In 2016, surveillance using standardized antibiogram data collection was conducted. These data are presented for the first time in this report and indicate minimal changes in *E. coli* resistance patterns between 2015 and 2016.

Antimicrobial Use (AMU)

- Antimicrobial use among adult inpatients on ICU wards is significantly higher than antimicrobial use on other hospital wards; defined daily doses of antibiotics are 2.5 to 3 times higher on ICU wards compared to non-ICU wards.
- Among adult inpatients, cephalosporins were the most common class of antibiotics and represented approximately one quarter of all defined daily doses.

RESULTS

1. *Clostridioides difficile* Infection (CDI)

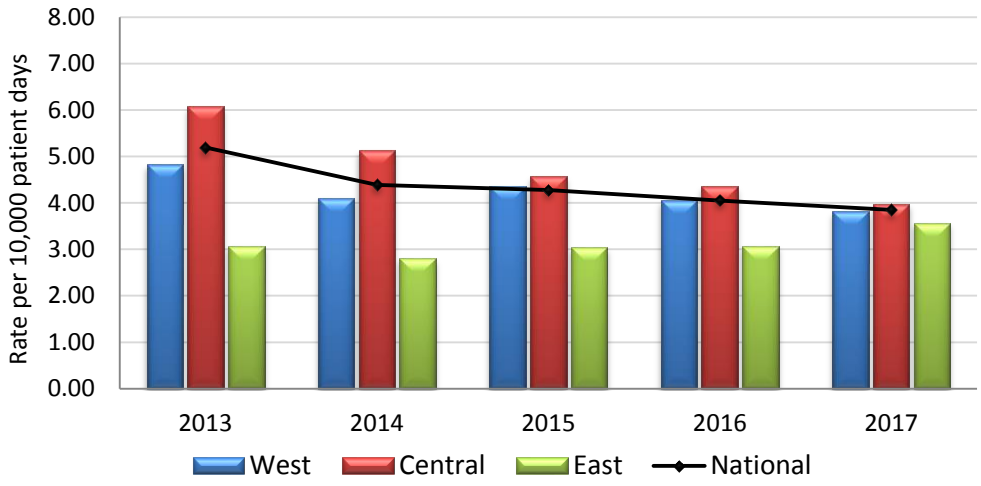
1a. Healthcare associated *Clostridioides difficile* Infection (HA-CDI)

Table 1.1 Number of HA-CDI from CNISP reporting hospitals only‡, cases and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of HA-CDI cases	3,160	2,870	2,895	2,814	2,721
Rate per 1,000 pt admissions	3.99	3.43	3.30	3.13	2.99
Rate per 10,000 pt days	5.19	4.39	4.28	4.05	3.85
No. of reporting hospitals	54	60	62	63	64
West					
No. of HA-CDI cases	1,198	1,121	1,303	1,254	1,180
Rate per 1,000 pt admissions	3.61	3.10	3.31	3.10	2.91
Rate per 10,000 pt days	4.82	4.10	4.36	4.05	3.82
Central					
No. of HA-CDI cases	1,732	1,506	1,338	1,290	1,237
Rate per 1,000 pt admissions	4.56	3.89	3.39	3.22	3.00
Rate per 10,000 pt days	6.07	5.13	4.56	4.35	3.97
East					
No. of HA-CDI cases	230	243	254	270	304
Rate per 1,000 pt admissions	2.86	2.75	2.89	2.90	3.27
Rate per 10,000 pt days	3.07	2.81	3.03	3.07	3.57

‡*HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.*

Graph 1.1 HA-CDI from CNISP reporting hospitals only‡, national and regional incidence rates per 10,000 patient days



‡*HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.*

Table 1.2 Attributable mortality rate 30 days after date of first positive CDI test in adults with HA-CDI from CNISP reporting hospitals only‡

Year	Number of deaths*	Attributable mortality rate per 100 cases (%)
2013	21	3.9
2014	22	4.3
2015	16	3.8
2016	12	3.0
2017	14	3.2

**Deaths where CDI was the direct cause of death or contributed to death 30 days after the date of the first positive lab specimen or positive histopathology specimen. Mortality data are collected during the two-month period (March and April of each year) for adults (age 18 years and older) and year-round for children (age 1 year to less than 18 years old). Among pediatric patients, there was no death attributable to HA-CDI.*

‡HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.

Table 1.3 Number and proportion of select HA-CDI from CNISP reporting hospitals only‡ NAP strain types‡‡

Strain Type	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
NAP4	90 (17.5)	92 (19.1)	103 (20.6)	91 (20.1)	107 (21.6)
NAP1	152 (29.6)	114 (23.6)	115 (23.0)	53 (11.8)	83 (16.7)
NAP11	33 (6.4)	62 (12.9)	50 (10.0)	73 (16.2)	68 (13.7)
Other NAP types*	91 (17.8)	84 (17.4)	94 (18.8)	72 (16.0)	88 (17.7)
Other-not assigned	147 (28.7)	130 (27.0)	138 (27.6)	162 (35.9)	150 (30.2)
Total	**513**	**482**	**500**	**451**	**496**

‡HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.

‡‡CDI isolates are collected for typing during the two-month period (March and April of each year) for adults (age 18 years and older) and year-round for children (age 1 year to less than 18 years old from admitted patients only).

**Other NAP strain types include NAP2, NAP3, NAP5, NAP6, NAP7, NAP8, NAP9, NAP10 and NAP12.*

Table 1.4 Antimicrobial resistance of HA-CDI from CNISP reporting hospitals only‡ isolates‡‡

Antibiotics	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Clindamycin	156 (30.5)	209 (43.1)	122 (24.4)	99 (22.0)	104 (21.0)
Moxifloxacin	166 (32.4)	137 (28.2)	138 (27.6)	72 (16.0)	89 (17.9)
Rifampin	13 (2.5)	5 (1.0)	10 (2.0)	7 (1.6)	13 (2.6)
Total isolates tested	**512**	**482**	**500**	**451**	**496**

‡HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.

‡‡CDI isolates are collected for resistance testing during the two-month period (March and April of each year) for adults (age 18 years and older) and year-round for children (age 1 year to less than 18 years old) from admitted patients only

Note: All *C. difficile* strains from 2013 to 2017 submitted to NML were susceptible to metronidazole, tigecycline and vancomycin.

1 b. Community associated *Clostridioides difficile* Infection (CA-CDI)

Table 1.5 Number of CA-CDI cases and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of CA-CDI cases	*	*	1,035	961	1,053
Rate per 1,000 pt admissions	*	*	1.56	1.39	1.49
Rate per 10,000 pt days	*	*	2.03	1.81	1.91
No. of reporting hospitals	*	*	49	51	53
West					
No. of CA-CDI cases	*	*	254	243	287
Rate per 1,000 pt admissions	*	*	1.15	1.07	1.24
Rate per 10,000 pt days	*	*	1.55	1.44	1.65
Central					
No. of CA-CDI cases	*	*	675	613	634
Rate per 1,000 pt admissions	*	*	1.91	1.64	1.65
Rate per 10,000 pt days	*	*	2.57	2.22	2.18
East					
No. of CA-CDI cases	*	*	106	105	132
Rate per 1,000 pt admissions	*	*	1.20	1.15	1.45
Rate per 10,000 pt days	*	*	1.27	1.19	1.55

CA-CDI includes all cases identified among admitted patients within a CNISP hospital as per the case definition in Appendix C.
**Data collection for CA-CDI began in 2015.*

Table 1.6 Number and proportion of select community associated *C. difficile* NAP strain types[ǂ]

Strain Type	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
NAP4	*	*	49 (17.4)	49 (19.4)	48 (22.7)
NAP11	*	*	40 (14.2)	28 (11.1)	37 (17.5)
NAP1	*	*	35 (12.4)	25 (9.9)	14 (6.6)
Other NAP types**	*	*	50 (17.7)	51 (20.2)	32 (15.2)
Other-not assigned	*	*	108 (38.3)	99 (39.3)	80 (37.9)
Total	*	*	**282**	**252**	**211**

CA-CDI includes all cases identified among admitted patients within a CNISP hospital as per the case definition in Appendix C.
[ǂ] *CDI isolates are collected for typing during the two-month period (March and April of each year) for adults (age 18 years and older) and year-round for children (age 1 year to less than 18 years old from admitted patients only).*
**Data collection for CA-CDI began in 2015.*
***Other NAP strain types include NAP2, NAP3, NAP5, NAP6, NAP7, NAP8, NAP9, NAP10 and NAP12.*

Table 1.7 Antimicrobial resistance of community associated *C. difficile* isolates ǂ

Antibiotics	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Clindamycin	*	*	73 (25.9)	60 (23.8)	40 (19.0)
Moxifloxacin	*	*	40 (14.2)	25 (9.9)	18 (8.5)
Rifampin	*	*	3 (1.1)	1 (0.4)	1 (0.5)
Total isolates tested	*	*	**282**	**252**	**211**

CA-CDI includes all cases identified among admitted patients within a CNISP hospital as per the case definition in Appendix C.

ǂ *CDI isolates are collected for typing during the two-month period (March and April of each year) for adults (age 18 years and older) and year-round for children (age 1 year to less than 18 years old from admitted patients only).*

**Data collection for CA-CDI began in 2015.*

.

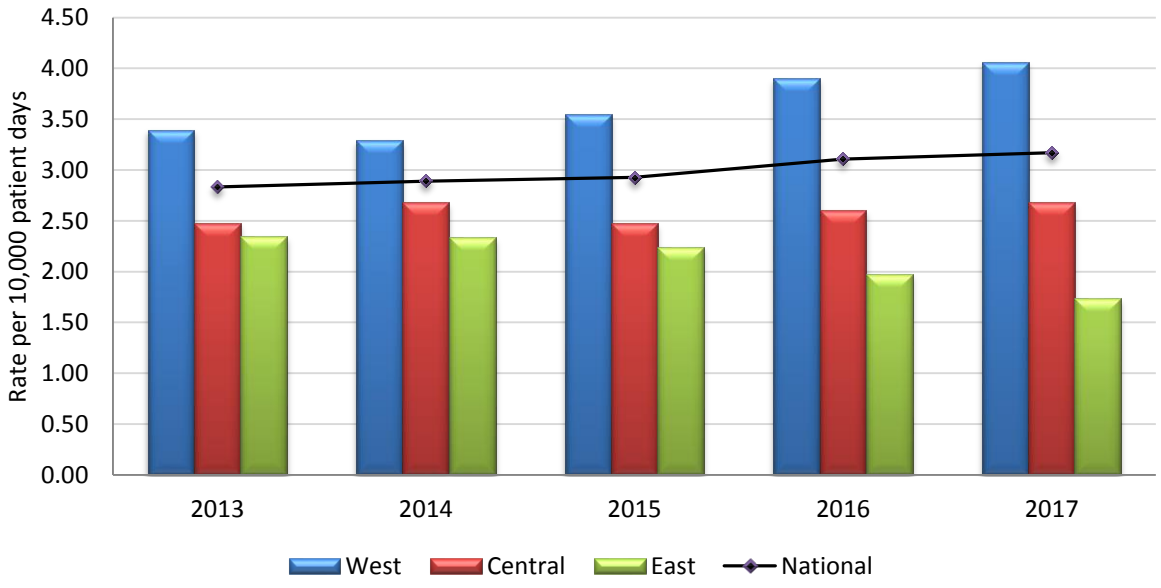
2. Methicillin-Resistant *Staphylococcus aureus* (MRSA)

Table 2.1 Number of total* MRSA infections and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of MRSA infections	1,849	1,969	2,049	2,237	2,313
Rate per 1,000 pt admissions	2.12	2.12	2.18	2.30	2.35
Rate per 10,000 pt days	2.83	2.89	2.93	3.11	3.17
No. of reporting hospitals	53	58	59	61	62
West					
No. of MRSA infections	898	949	1,117	1,268	1,303
Rate per 1,000 pt admissions	2.48	2.33	2.63	2.88	2.95
Rate per 10,000 pt days	3.40	3.29	3.54	3.90	4.06
Central					
No. of MRSA infections	739	801	732	784	851
Rate per 1,000 pt admissions	1.79	1.91	1.75	1.82	1.94
Rate per 10,000 pt days	2.48	2.68	2.47	2.60	2.68
East					
No. of MRSA infections	212	219	200	185	159
Rate per 1,000 pt admissions	2.15	2.19	2.03	1.77	1.53
Rate per 10,000 pt days	2.34	2.33	2.24	1.98	1.74

**Includes infections identified from blood AND clinical isolates as well as healthcare and community associated cases identified in admitted patients.*

Graph 2.1 Total* MRSA national and regional incidence rates per 10,000 patient days



**Includes infections identified from blood AND clinical isolates as well as healthcare and community associated cases identified in admitted patients.*

Table 2.2 Number of Healthcare associated (HA) MRSA* infections and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of HA-MRSA infections	1,141	1,171	1,193	1,206	1,202
Rate per 1,000 pt admissions	1.31	1.26	1.27	1.24	1.22
Rate per 10,000 pt days	1.75	1.72	1.70	1.67	1.65
No. of reporting hospitals	53	58	59	61	62
West					
No. of HA-MRSA infections	554	535	631	676	637
Rate per 1,000 pt admissions	1.53	1.31	1.48	1.54	1.44
Rate per 10,000 pt days	2.10	1.86	2.00	2.07	1.99
Central					
No. of HA-MRSA infections	404	459	405	381	447
Rate per 1,000 pt admissions	0.98	1.09	0.97	0.89	1.02
Rate per 10,000 pt days	1.36	1.53	1.37	1.26	1.41
East					
No. of HA-MRSA infections	183	177	157	149	118
Rate per 1,000 pt admissions	1.85	1.77	1.59	1.43	1.14
Rate per 10,000 pt days	2.02	1.89	1.76	1.59	1.29

** HA-MRSA: includes all cases identified and have been acquired within CNISP hospitals and/or from any other healthcare exposure (non-CNISP hospitals, clinics, long-term care facility, etc.) as per the case definition in Appendix C.*

Table 2.3 Number of community associated (CA) MRSA* infections and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of CA-MRSA infections	547	653	729	921	993
Rate per 1,000 pt admissions	0.63	0.70	0.77	0.94	1.01
Rate per 10,000 pt days	0.84	0.96	1.04	1.28	1.36
No. of reporting hospitals	53	58	59	61	62
West					
No. of CA-MRSA infections	321	380	449	569	637
Rate per 1,000 pt admissions	0.89	0.93	1.06	1.29	1.44
Rate per 10,000 pt days	1.21	1.32	1.42	1.75	1.99
Central					
No. of CA-MRSA infections	205	241	245	322	324
Rate per 1,000 pt admissions	0.50	0.57	0.59	0.75	0.74
Rate per 10,000 pt days	0.69	0.81	0.83	1.07	1.02
East					
No. of CA-MRSA infections	21	32	35	30	32
Rate per 1,000 pt admissions	0.21	0.32	0.35	0.29	0.31
Rate per 10,000 pt days	0.23	0.34	0.39	0.32	0.35

** CA-MRSA includes cases identified on admission to hospital with no previous history of MRSA and no prior hospital, long-term care admission or other exposure to a healthcare setting (rehab, clinics) in the past 12 months and no reported use of medical devices as per the case definition in Appendix C.*

Table 2.4 Number of MRSA bloodstream infections (MRSA-BSI) and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of MRSA BSI	365	450	490	605	608
Rate per 1,000 pt admissions	0.42	0.48	0.52	0.62	0.62
Rate per 10,000 pt days	0.56	0.66	0.70	0.84	0.83
No. of reporting hospitals	53	58	59	61	62
West					
No. of MRSA BSI	131	166	215	278	282
Rate per 1,000 pt admissions	0.36	0.41	0.51	0.63	0.64
Rate per 10,000 pt days	0.50	0.58	0.68	0.85	0.88
Central					
No. of MRSA BSI	191	240	224	281	278
Rate per 1,000 pt admissions	0.46	0.57	0.54	0.65	0.63
Rate per 10,000 pt days	0.64	0.80	0.76	0.93	0.88
East					
No. of MRSA BSI	43	44	51	46	48
Rate per 1,000 pt admissions	0.44	0.44	0.52	0.44	0.46
Rate per 10,000 pt days	0.48	0.47	0.57	0.49	0.52

Graph 2.2 MRSA-BSI National and regional incidence rates per 10,000 patient days

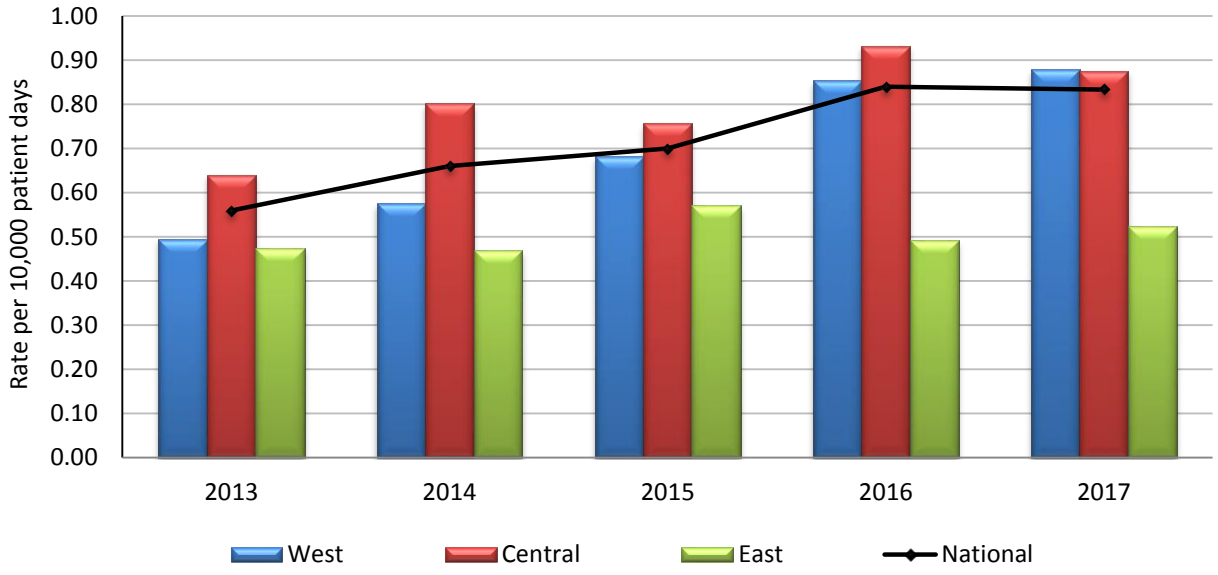


Table 2.5 All-cause mortality rate 30 days after date of positive culture per 100 MRSA-BSI cases

Year	Number of deaths*	All-cause mortality rate per 100 MRSA-BSI cases
2013	93	25.5
2014	103	24.4
2015	95	20.3
2016	111	19.0
2017	99	16.3

**All-cause mortality rate based on the number of cases with associated 30-day outcome data.*

Table 2.6 Number and proportion of select MRSA strain types identified

Strain Type	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
CMRSA 10	214 (36.5)	266 (38.7)	303 (42.3)	408 (46.2)	398 (45.2)
CMRSA 2	278 (47.4)	302 (43.9)	266 (37.2)	279 (31.6)	284 (32.3)
CMRSA 7	24 (4.1)	41 (6.0)	48 (6.7)	72 (8.1)	68 (7.7)
Other strain types*	65 (11.1)	70 (10.2)	76 (10.6)	92 (10.4)	88 (10.0)
Unassigned	6 (1.0)	9 (1.3)	23 (3.2)	33 (3.7)	42 (4.8)
Total	587	688	716	884	880

**Other strain types from 2012 to 2016 include CMRSA 1, CMRSA 3/6, CMRSA 4, CMRSA 5, CMRSA 8, ST72, ST88, ST97, ST398, ST772, USA 700, USA 1000, USA 1100 and European.*

MRSA non-blood isolates (urine, respiratory, wound, surgical site) are collected from January to March of every year and blood isolates are collected year round.

Table 2.7 Antimicrobial resistance identified for MRSA isolates

Antibiotics	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Erythromycin	495 (88.7)	535 (84.4)	576 (80.9)	624 (78.0)	689 (79.8)
Ciprofloxacin	479 (85.8)	228 (84.1)[Ŧ]	85 (81.7)[Ŧ]	609 (76.1)	659 (76.3)
Clindamycin	349 (83.5)*	374 (65.4)*	385 (54.1)	335 (41.9)	361 (41.8)
Fusidic acid	57 (10.2)	91 (14.4)	126 (17.7)	148 (18.5)	174 (20.1)
Mupirocin HLR	15 (2.7)	30 (4.7)	40 (6.6)*	Not tested in 2016	Not tested in 2017
Tetracycline	25 (4.5)	34 (5.4)	37 (5.2)	54 (6.8)	56 (6.5)
TMP/SMX	25 (4.5)	14 (2.2)	14 (2.0)	20 (2.5)	12 (1.4)
Rifampin	3 (0.5)	3 (0.5)	3 (0.4)	10 (1.3)	10 (1.2)
Tigecycline	25 (4.5)	17 (2.7)	6 (0.8)	0	0
Daptomycin	2 (0.4)	2 (0.3)	5 (0.7)	5 (0.6)	5 (0.6)
Total	558	634	712	800	864

**Total # isolates tested for clindamycin = 418 (2013), 572 (2014)*

[Ŧ]Total # isolates tested for Ciprofloxacin= 271 (2014) 104 (2015)

[¥]Total # isolates tested for Mupirocin HLR = 608 (2015)

MRSA non-blood isolates (urine, respiratory, wound, surgical site) are collected from January to March of every year and blood isolates are collected year round

2017 data not yet available

Note: All MRSA isolates from 2013 to 2017 submitted to NML were susceptible to linezolid and vancomycin

3. Vancomycin-Resistant Enterococci (VRE)

Table 3.1 Number of total VRE infections and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of VRE infections	322	297	271	299	387
Rate per 1,000 pt admissions	0.39	0.33	0.30	0.32	0.42
Rate per 10,000 pt days	0.52	0.45	0.41	0.43	0.57
No. of reporting hospitals	48	56	53	56	56
West					
No. of VRE infections	154	153	142	146	181
Rate per 1,000 pt admissions	0.52	0.45	0.40	0.40	0.51
Rate per 10,000 pt days	0.72	0.65	0.56	0.54	0.71
Central					
No. of VRE infections	161	143	127	145	201
Rate per 1,000 pt admissions	0.37	0.32	0.29	0.31	0.42
Rate per 10,000 pt days	0.51	0.44	0.41	0.45	0.61
East					
No. of VRE infections	7	1	2	8	5
Rate per 1,000 pt admissions	0.08	0.01	0.02	0.08	0.05
Rate per 10,000 pt days	0.08	0.01	0.02	0.09	0.05

Graph 3.1 Total VRE infections national and regional incidence rates per 10,000 patient days

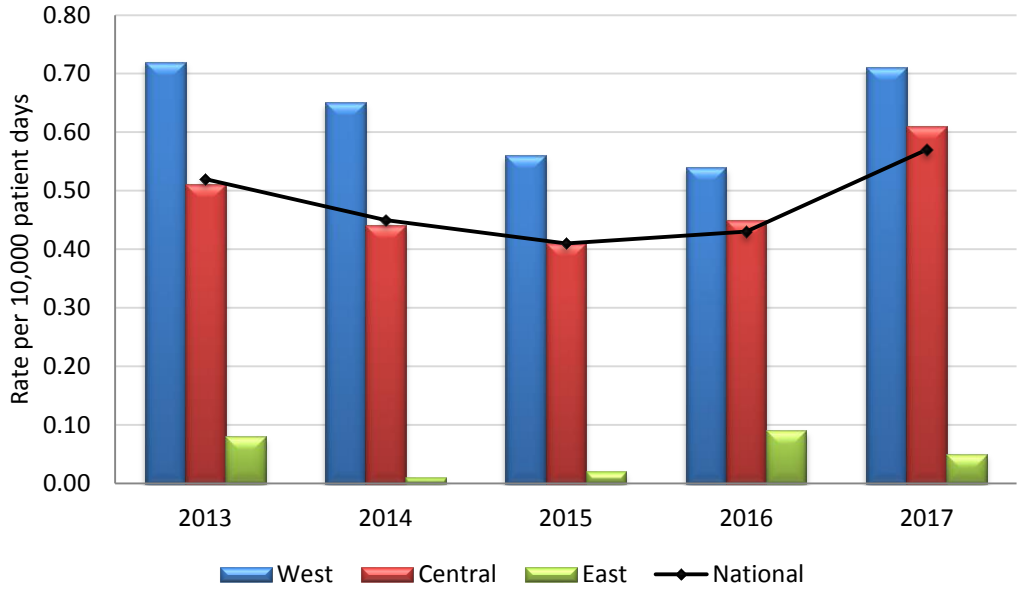


Table 3.2 Number of healthcare associated VRE infections[‡] and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of VRE infections	*	274	258	272	356
Rate per 1,000 pt admissions	*	0.31	0.29	0.29	0.38
Rate per 10,000 pt days	*	0.42	0.39	0.39	0.52
No. of reporting hospitals	*	56	53	56	56
West					
No. of VRE infections	*	143	138	131	165
Rate per 1,000 pt admissions	*	0.42	0.39	0.35	0.47
Rate per 10,000 pt days	*	0.61	0.54	0.48	0.64
Central					
No. of VRE infections	*	130	118	133	186
Rate per 1,000 pt admissions	*	0.29	0.27	0.28	0.39
Rate per 10,000 pt days	*	0.40	0.38	0.41	0.56
East					
No. of VRE infections	*	1	2	8	5
Rate per 1,000 pt admissions	*	0.01	0.02	0.08	0.05
Rate per 10,000 pt days	*	0.01	0.02	0.09	0.05

**Data of where the VRE infection was acquired was not collected in 2013.*

[‡] *Healthcare associated VRE: includes all cases identified and have been acquired within CNISP hospitals and/or from any other healthcare exposure (non-CNISP hospitals, clinics, long-term care facility, etc.) as per the case definition in Appendix C.*

From 2014 to 2017, 94.3% of VRE infections were reported as healthcare associated, while only 5.7% were community associated infections.

Table 3.3 Number of VRE bloodstream infections (VRE-BSI) and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of VRE-BSI infections	98	94	89	121	157
Rate per 1,000 pt admissions	0.12	0.10	0.10	0.13	0.17
Rate per 10,000 pt days	0.16	0.14	0.14	0.18	0.23
No. of reporting hospitals	48	56	53	56	56
West					
No. of VRE-BSI infections	31	36	35	45	48
Rate per 1,000 pt admissions	0.11	0.10	0.10	0.12	0.14
Rate per 10,000 pt days	0.15	0.15	0.14	0.17	0.19
Central					
No. of VRE-BSI infections	67	58	53	75	108
Rate per 1,000 pt admissions	0.15	0.13	0.12	0.16	0.23
Rate per 10,000 pt days	0.21	0.18	0.17	0.23	0.33
East					
No. of VRE-BSI infections	0	0	1	1	1
Rate per 1,000 pt admissions	0.00	0.00	0.01	0.01	0.01
Rate per 10,000 pt days	0.00	0.00	0.01	0.01	0.01

Graph 3.2 VRE-BSI national and regional incidence rates per 10,000 patient days

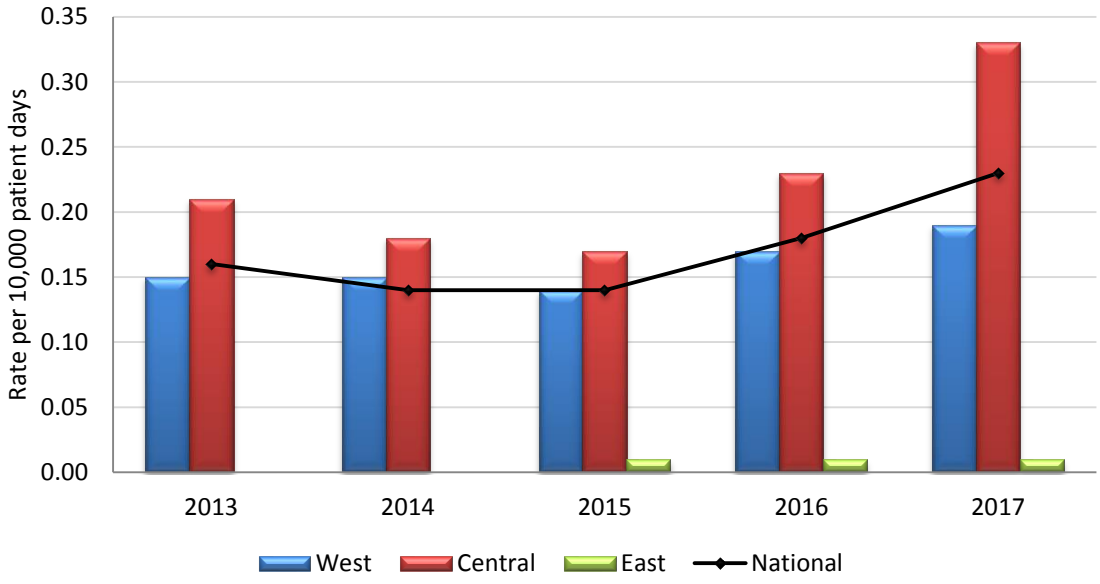


Table 3.4 Number and proportion of main VRE-BSI isolate types identified

Isolate Type	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
vanA, Enterococcus faecium	72 (96.0)	70 (100.0)	75 (100.0)	88 (96.7)	111 (95.7)
vanB, Enterococcus faecium	3 (4.0)	0 (0.0)	0 (0.0)	3 (3.3)	5 (4.3)
Total	**75**	**70**	**75**	**91**	**116**

Table 3.5 Distribution of VRE-BSI multi-locus sequence types (MLST) identified in *E. faecium*.

Sequence Type	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
ST117	26 (34.7)	16 (22.9)	13 (17.3)	23 (25.3)	11 (9.5)
ST18	15 (20.0)	20 (28.6)	11 (14.7)	14 (15.4)	3 (2.6)
ST412	14 (18.7)	7 (10.0)	12 (16.0)	12 (13.2)	5 (4.3)
ST203	1 (1.3)	5 (7.1)	6 (8.0)	5 (5.5)	7 (6.0)
ST734	4 (5.3)	2 (2.9)	13 (17.3)	4 (4.4)	8 (6.9)
Others*	13 (17.3)	20 (28.6)	16 (21.3)	23 (25.3)	10 (8.6)
Untypeable	2 (2.7)	0	4 (5.3)	10 (11.0)	72 (62.1)
Total	**75**	**70**	**75**	**91**	**116**

**Others include ST16, ST17, ST78, ST80, ST154, ST252, ST262, ST282, ST414, ST494, ST584, ST664, ST665, ST734, ST736, ST772, ST787, ST835, ST836, ST912, ST982, ST983, ST984, ST992, ST1032, ST1112, ST1113, ST1265.*

Table 3.6 Antimicrobial resistance identified for VRE-BSI isolates

Antibiotics	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Ampicillin	75 (100)	70 (100)	75 (100)	91 (100)	116 (100)
Levofloxacin	75 (100)	70 (100)	75 (100)	91 (100)	116 (100)
Penicillin	75 (100)	70 (100)	75 (100)	91 (100)	116 (100)
Vancomycin[b]	75 (100)	70 (100)	74 (98.7)	88 (96.7)	111 (95.7)
HL-Gentamicin	13 (17.3)	7 (10.0)	6 (8.0)	13 (14.3)	45 (38.8)
HL- Streptomycin	28 (37.3)	29 (41.4)	27 (36.0)	32 (35.2)	39 (33.6)
Nitrofurantoin	14 (18.7)	15 (21.4)	25 (33.3)	35 (38.5)	52 (44.8)
Chloramphenicol	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.2)	11 (9.5)
Daptomycin[a]	5 (6.7)	0 (0.0)	0 (0.0)	7 (7.7)	10 (8.6)
Linezolid	1 (1.3)	0 (0.0)	0 (0.0)	1 (1.1)	0 (0.0)
Tigecycline	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)
Total isolates tested	**75**	**70**	**75**	**91**	**116**

[a] *Daptomycin does not have breakpoints for intermediate or resistant. Therefore, these are considered non-susceptible.*
[b] *Some isolates were susceptible or intermediate to vancomycin, but all harboured VanA or VanB*

4. Carbapenemase-Producing Enterobacteriaceae (CPE) and Carbapenemase-Producing *Acinetobacter* (CPA)

Table 4.1 Number of CPE infections and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of CPE infections	19	22	17	20	17
Rate per 1,000 pt admissions	0.02	0.02	0.02	0.02	0.02
Rate per 10,000 pt days	0.03	0.03	0.03	0.03	0.03
No. of reporting hospitals	45	58	58	58	59
West					
No. of CPE infections	9	10	10	6	11
Rate per 1,000 pt admissions	0.03	0.03	0.03	0.02	0.03
Rate per 10,000 pt days	0.05	0.04	0.03	0.02	0.04
Central					
No. of CPE infections	9	12	5	14	5
Rate per 1,000 pt admissions	0.02	0.03	0.01	0.03	0.01
Rate per 10,000 pt days	0.03	0.04	0.02	0.04	0.02
East					
No. of CPE infections	1	0	2	0	1
Rate per 1,000 pt admissions	0.01	0.00	0.02	0.00	0.01
Rate per 10,000 pt days	0.01	0.00	0.02	0.00	0.01

Table 4.2 Number of CPE colonizations and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of CPE colonizations	23	20	33	69	92
Rate per 1,000 pt admissions	0.03	0.02	0.04	0.07	0.10
Rate per 10,000 pt days	0.04	0.03	0.05	0.10	0.14
No. of reporting hospitals	45	58	58	58	59
West					
No. of CPE colonizations	12	2	9	15	18
Rate per 1,000 pt admissions	0.05	0.01	0.02	0.04	0.05
Rate per 10,000 pt days	0.06	0.01	0.03	0.05	0.07
Central[‡]					
No. of CPE colonizations	11	18	24	54	74
Rate per 1,000 pt admissions	0.03	0.04	0.06	0.12	0.16
Rate per 10,000 pt days	0.04	0.06	0.08	0.17	0.23
East					
No. of CPE colonizations	0	0	0	0	0
Rate per 1,000 pt admissions	0.00	0.00	0.00	0.00	0.00
Rate per 10,000 pt days	0.00	0.00	0.00	0.00	0.00

Graph 4.1 CPE national infection and colonization incidence rates per 10,000 patient days

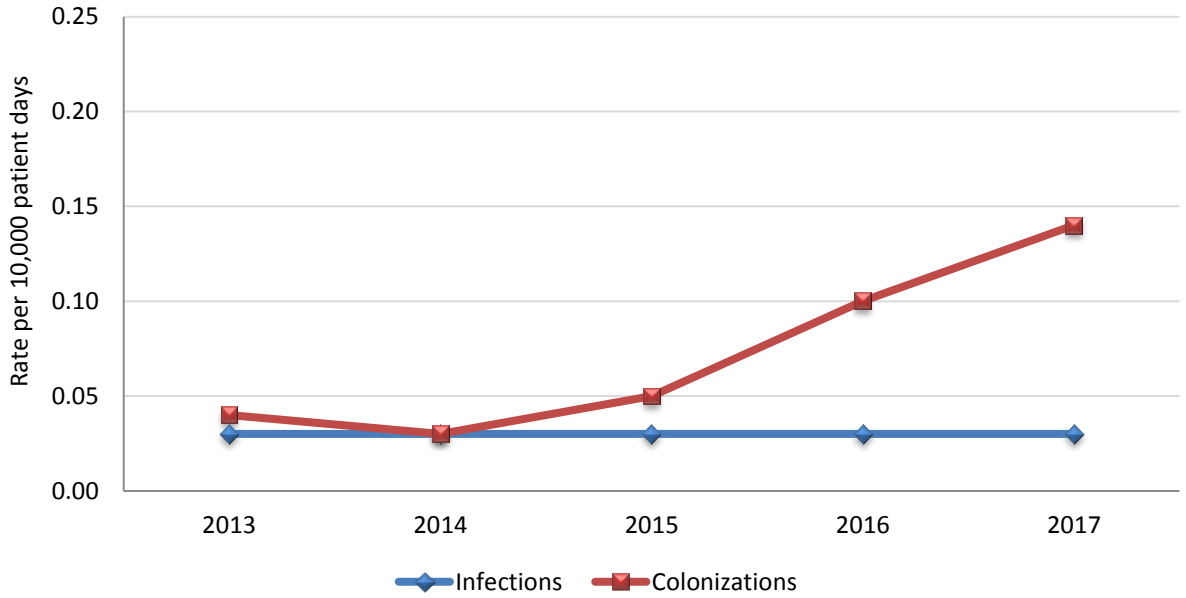


Table 4.3 Number of CPA infections and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of CPA infections	9	3	2	9	3
Rate per 1,000 pt admissions	0.012	0.003	0.002	0.010	0.003
Rate per 10,000 pt days	0.016	0.005	0.003	0.013	0.004
No. of reporting hospitals	45	58	58	58	59
West					
No. of CPA infections	0	1	2	2	3
Rate per 1,000 pt admissions	0.000	0.003	0.005	0.005	0.008
Rate per 10,000 pt days	0.000	0.004	0.007	0.007	0.011
Central[‡]					
No. of CPA infections	9	2	0	7	0
Rate per 1,000 pt admissions	0.022	0.005	0.000	0.016	0.000
Rate per 10,000 pt days	0.030	0.006	0.000	0.022	0.000
East					
No. of CPA infections	0	0	0	0	0
Rate per 1,000 pt admissions	0.000	0.000	0.000	0.000	0.000
Rate per 10,000 pt days	0.000	0.000	0.000	0.000	0.000

[‡] *The greater number of cases reported in the Central region is largely attributed to one hospital in 2013 and another hospital in 2016.*

Table 4.4 Number of CPA colonizations and incidence rates per 1,000 patient admissions and 10,000 patient days

	2013	2014	2015	2016	2017
National					
No. of CPA colonizations	17	0	3	5	7
Rate per 1,000 pt admissions	0.022	0.000	0.003	0.005	0.007
Rate per 10,000 pt days	0.029	0.000	0.004	0.007	0.010
No. of reporting hospitals	45	58	58	58	59
West					
No. of CPA colonizations	2	0	3	0	2
Rate per 1,000 pt admissions	0.008	0.000	0.008	0.000	0.005
Rate per 10,000 pt days	0.010	0.000	0.010	0.000	0.008
Central[‡]					
No. of CPA colonizations	15	0	0	5	5
Rate per 1,000 pt admissions	0.036	0.000	0.000	0.011	0.011
Rate per 10,000 pt days	0.050	0.000	0.000	0.016	0.015
East					
No. of CPA colonizations	0	0	0	0	0
Rate per 1,000 pt admissions	0.000	0.000	0.000	0.000	0.000
Rate per 10,000 pt days	0.000	0.000	0.000	0.000	0.000

[‡] *The greater number of cases reported in the Central region is largely attributed to one hospital in 2013 and another hospital in 2016.*

Table 4.5 All-cause mortality rate 30 days after date of positive culture per 100 CPE and CPA inpatient infected cases

Year	No. of deaths*	All-cause mortality rate per 100 infected cases
2013	6	21.4
2014	5	20.0
2015	4	22.2
2016	3	10.7
2017	5	20.8

**Mortality rates are based on infected cases where outcome, classification and inpatient data are available.*

Table 4.6 Number and proportion of main CPE and CPA pathogens identified[a]

Pathogen	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Klebsiella pneumoniae	27 (28.4)	27 (38.0)	30 (35.7)	49 (35.8)	44 (26.7)
Escherichia coli	5 (5.3)	11(15.5)	22 (26.2)	24 (17.5)	42 (25.5)
Enterobacter cloacae complex[b]	4 (4.2)	12 (17.0)	10 (11.9)	23 (16.8)	37 (22.4)
Acinetobacter baumannii	37 (39.0)	8 (11.3)	9 (10.7)	17 (12.4)	14 (8.5)
Serratia marcescens	11 (11.6)	6 (8.5)	3 (3.6)	3 (2.2)	3 (1.8)
Others[c]	11 (11.6)	7 (9.9)	10 (11.9)	21 (15.3)	25 (15.2)
Total	**95**	**71**	**84**	**137**	**165**

[a] *Includes data for all isolates submitted*
[b] *Enterobacter cloacae complex includes Enterobacter cloacae and other Enterobacter spp.excluding E. aerogenes*
[c] *Others includes: Acinetobacter spp., Citrobacter spp., Klebsiella oxytoca, Kluyvera cryocrescens, Morganella morganii, Providencia rettgeri, Raoutella spp.*

Table 4.7 Number and proportion of resistance to specific antimicrobials identified for CPE[a]

Antibiotics	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Piperacillin-Tazobactam	52 (91.2)	56 (88.9)	69 (92.0)	91 (76.5)	126 (96.9)*
Cefotaxime	46 (80.1)	56 (88.9)	68 (90.1)	113 (95.0)	140 (92.7)
Meropenem	53 (93.0)	59 (93.7)	66 (88.0)	106 (89.1)	139 (92.1)
Ceftazidime	46 (80.1)	56 (88.9)	66 (88.0)	109 (91.6)	137 (90.7)
Trimethoprim-sulfamethoxazole	39 (68.4)	42 (66.7)	57 (76.0)	79 (66.4)	94 (62.3)
Ciprofloxacin	29 (50.1)	35 (55.6)	49 (65.3)	75 (63.0)	93 (61.6)
Tobramycin	29 (50.9)	40(63.5)	41 (54.7)	62 (52.1)	67 (44.4)
Gentamicin	26 (45.6)	32 (50.8)	39 (53.4)	51 (42.9)	55 (36.4)
Amikacin	18 (31.6)	17 (27.0)	23 (30.7)	44 (37.0)	32 (21.2)
Tigecycline	10 (17.5)	11 (17.5)	13 (17.3)	28 (23.5)	18 (11.9)
Total no. of Isolates	**57**	**63**	**75**	**119**	**151**

[a] Includes data for all CPE isolates submitted
*The denominator for this drug was 130 as MIC values were not given in all cases due to vitek algorithms
All isolates were resistant to Ampicillin, and all but one to Cefazolin. *All CPO isolates were screened for the mcr-type gene which is an acquired gene associated with colistin resistance*

Table 4.8 Number and proportion of resistance to specific antimicrobials identified for CPA[a]

Antibiotics	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Cefotaxime	35 (92.1)	8 (100)	9 (100)	16 (88.9)	13 (92.9)
Ceftazidime	36 (94.7)	8 (100)	9 (100)	16 (88.9)	13 (92.9)
Ciprofloxacin	36 (94.7)	8 (100)	9 (100)	16 (88.9)	13 (92.9)
Piperacillin-Tazobactam	37 (97.4)	8 (100)	9 (100)	18 (100)	13 (92.9)
Meropenem	36 (94.7)	8 (100)	9 (100)	18 (100)	12 (85.7)
Trimethoprim-sulfamethoxazole	35 (92.1)	8 (100)	7 (77.8)	15 (83.3)	11 (78.6)
Gentamicin	34 (89.5)	8 (100)	7 (77.8)	14 (77.8)	10 (71.4)
Tobramycin	32 (84.2)	5 (62.5)	7 (77.8)	12 (66.7)	9 (64.3)
Tigecycline	0 (0)	0 (0)	0 (0)	0 (0)	1 (7.1)
Amikacin	5 (13.1)	0 (0)	3 (33.3)	12 (66.7)	N/A
Total no. of Isolates	**38**	**8**	**9**	**18**	**14**

[a] *Includes data for all CPA isolates submitted*
All isolates were resistant to Ampicillin, Amoxicillin/Clavulanic Acid, Cefazolin, Cefoxitin
N/A = not available
All isolates were resistant to Ampicillin, and all but one to Cefazolin. *All CPO isolates were screened for the mcr-type gene which is an acquired gene associated with colistin resistance*

Table 4.9 Number and proportion of carbapenemases identified for CPE[a]

Carbapenemase	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
KPC	30 (52.6)	31 (49.2)	26 (34.7)	62 (52.1)	69 (45.7)
NDM	14 (24.6)	17 (27.0)	29 (38.7)	38 (31.9)	55 (36.4)
OXA-48	6 (10.5)	7 (11.1)	14 (18.7)	17 (14.3)	23 (15.2)
NMC/IMI	1 (1.8)	2 (3.2)	0 (0)	2 (1.6)	4 (2.6)
VIM	0 (0)	1 (1.6)	1 (1.3)	1 (0.8)	3 (2.0)
SME*	6 (10.5)	5 (7.9)	3 (4.0)	1 (0.8)	2 (1.3)
GES-5	1 (1.8)	1 (1.6)	3 (4.0)	0 (0)	0 (0)
IMP	0 (0)	1 (1.6)	0 (0)	0 (0)	0 (0)
Total no. of Isolates	**57****	**63****	**75****	**119****	**151****

[a] *Includes data for all CPE isolates submitted*
** Only found in Serratia marcescens*
*** 1 isolate in 2013, 2 isolates in 2014, 1 isolate in 2015, 2 isolates in 2016, and 5 in 2017 harboured both NDM and OXA-48*

Table 4.11 Number and proportion of carbapenemases identified for CPA[a]

Carbapenemase	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
OXA-23	5 (13.2)	5 (62.5)	8 (88.9)	6 (33.3)	11 (78.6)
NDM	0 (0)	0 (0)	1 (11.1)	0 (0)	2 (14.3)
OXA-24	4 (10.5)	0 (0)	0 (0)	3 (16.7)	1 (7.1)
OXA-235	0 (0)	0 (0)	0 (0)	9 (50.0)	0 (0)
OXA-58	0 (0)	0 (0)	1(11.1)	0 (0)	0 (0)
OXA-237	29 (76.3)	3 (37.5)	0 (0)	0 (0)	0 (0)
IMP	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total no. of Isolates	**38**	**8**	**9****	**18**	**14**

[a]Includes data for all CPA isolates submitted
** 1 isolate in 2012 harboured OXA-23, OXA-58, and IMP*
*** 1 isolate in 2015 harboured OXA-58 and NDM*

5. *Escherichia coli* Antibiogram (*E. coli*)

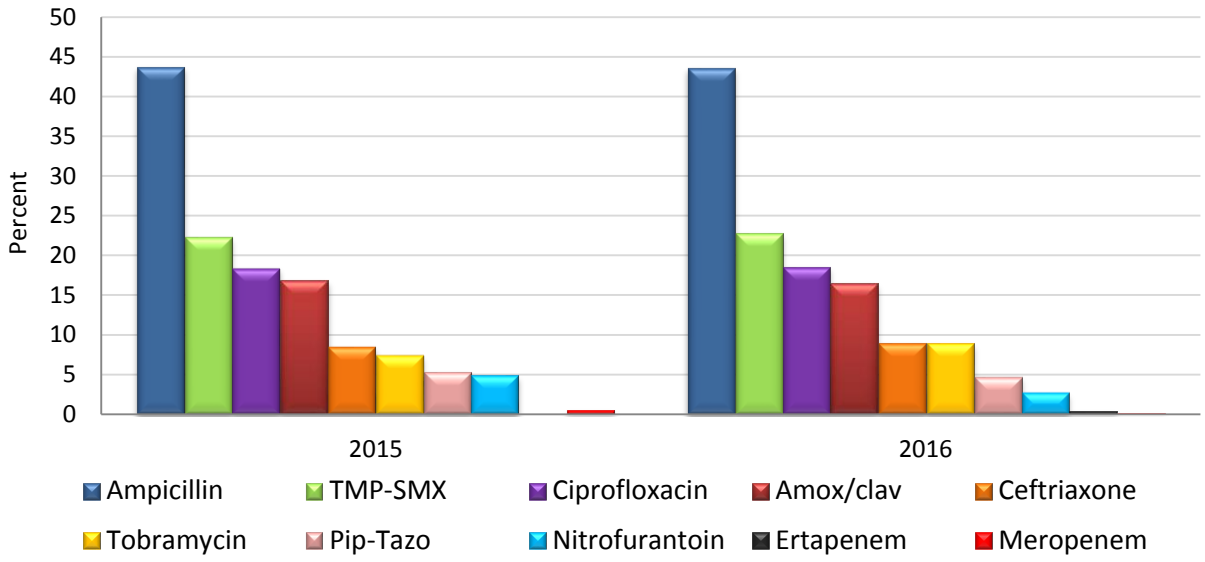
Table 5.1 Number of *E. coli* isolates tested and percent non-susceptible

National				
All patient and specimen types[a]	**2015[b]**		**2016**	
Antibiotics	No. isolates tested (N)	% non-susceptible	No. isolates tested (N)	% non-susceptible
Penicillins and Penicillin combinations				
Ampicillin	66,756	43.7	47,411	43.6
Amoxicillin/Clavulanate	56,200	16.8	40,174	16.5
Piperacillin-tazobactam	59,085	5.3	45,177	4.7
Cephalosporins				
Cephalothin	*		17,504	46.9
Cefazolin (for systemic use)	40,291	19.1	23,048	25.2
Cefazolin (marker for oral use)	n/a		19,300	22.7
Cefuroxime	*		496	7.0
Cefoxitin	*		26,162	9.4
Ceftriaxone	57,215	8.5	40,269	8.9
Cefotaxime (Pediatric)	*		1,205	9.6
Carbapenems				
Ertapenem	*		34,088	0.4
Imipenem	*		28,845	0.2
Meropenem	44,299	0.5	37,212	0.1
Fluoroquinolones				
Ciprofloxacin	64,548	18.4	47,404	18.6
Levofloxacin	*		10,550	19.4
Aminoglycosides				
Gentamicin	51,714	7.7	47,419	7.9
Tobramycin	40,654	7.4	44,102	8.9
Amikacin	*		34,679	0.1
Other				
TMP-SMX	66,760	22.3	43,884	22.8
Nitrofurantoin	62,020	4.9	35,820	2.8
No. hospitals[c]	21		42	

**Data not collected in 2015*

[a] All patient types includes inpatients and outpatients, all specimen types includes urine, blood, and any other source e.g. wound, respiratory etc.
[b] Antibiogram data collection was a pilot project in 2015
[c] includes hospitals that do and do not participate in CNISP

Graph 5.1 Percent of all non-susceptible *E. coli* isolates tested for 10 select antibiotics



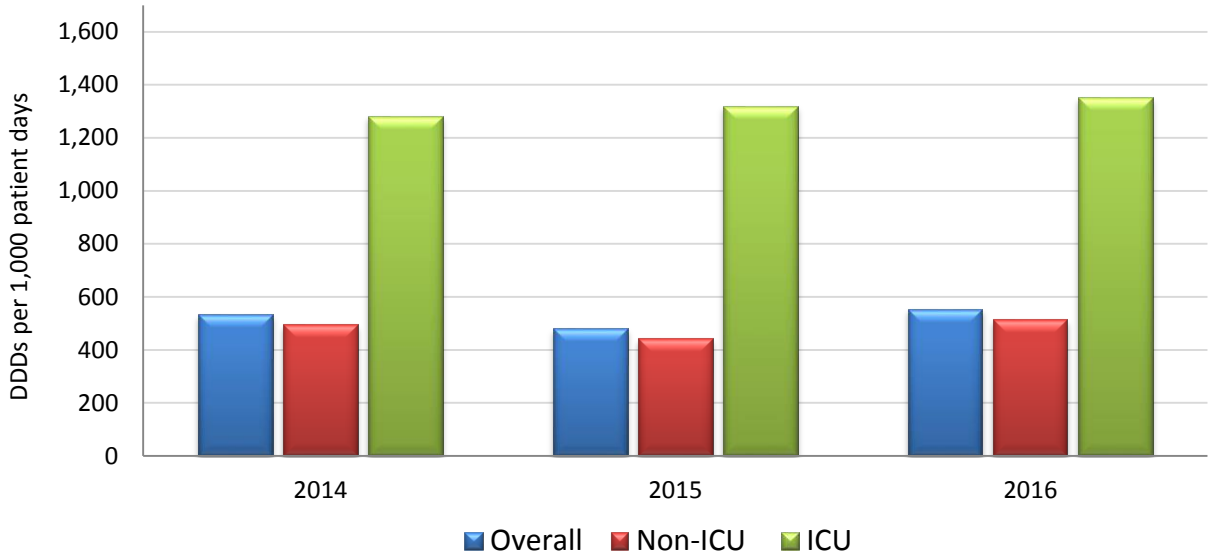
6. Antimicrobial Use (AMU)

Table 6.1 Defined daily doses (DDDs) and DDDs per 1,000 patient days[a]

	2014[c]	2015	2016
National			
DDDs	1,681,652	1,680,080	1,925,259
DDDs per 1,000 patient days	534	482	555
No. of reporting hospitals	21	21	22
West			
DDDs	631,443	692,567	726,943
DDDs per 1,000 patient days	570	492	594
No. of reporting hospitals	5	7	6
Central			
DDDs	852,196	809,677	1,020,994
DDDs per 1,000 patient days	587	567	682
No. of reporting hospitals	12	11	13
East			
DDDs	198,013	177,835	177,322
DDDs per 1,000 patient days	453	466	453
No. of reporting hospitals	4	3	3
ICU[b]			
DDDs	196,371	208,147	215,543
DDDs per 1,000 patient days	1282	1320	1353
No. of reporting hospitals	18	18	19
Non-ICUs[b]			
DDDs	1,485,281	1,471,930	1,597,835
DDDs per 1,000 patient days	496	442	514
No. of reporting hospitals	21	21	21

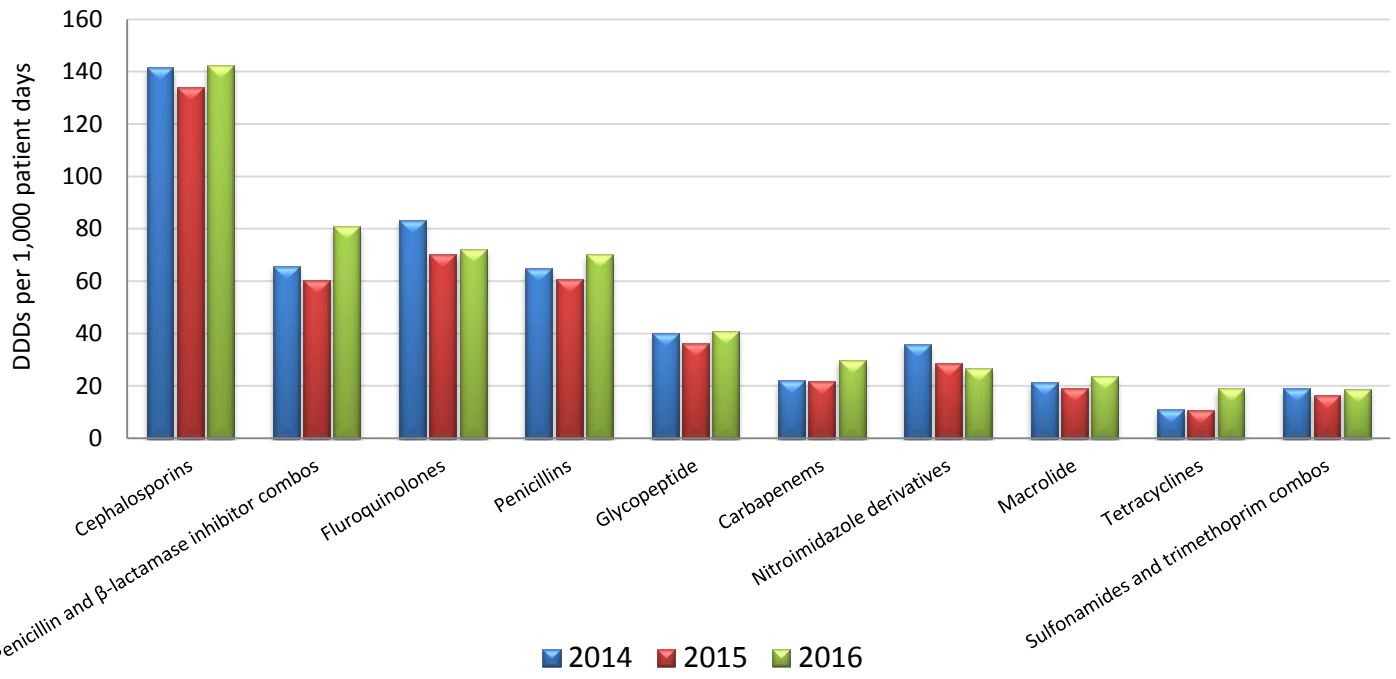
[a] *Includes only adult DDDs and adult patient days*
[b] *Counts that combined ICU and non-ICU units have been excluded*
[c] *At one site, submitted 2014 data is from fiscal year. At one site, only 9 months of data available*

Graph 6.1 Defined daily doses (DDDs) per 1000 patient days, overall and by ward type[a, b, c]



[a] *Includes only adult DDDs and adult patient days*
[b] *Counts from hospital sites that did not separate ICU and non-ICU units have been excluded from the ICU and non-ICU ward types*
[c] *In 2014: at one site, submitted 2014 data is from fiscal year; at one site, only 9 months of data available*

Graph 6.2 Top ten antibiotic classes in 2016 — defined daily doses (DDDs) per 1000 patient days by antibiotic class[a, b, c, d]



[a] *Includes only adult DDDs and adult patient days*
[b] *Presented antibiotic classes represent 94–95% of annual DDDs. Antibiotic class classification is based on WHO ATC/DDD Index 2016; see Appendix D for antimicrobials included in each category*
[c] *In 2014: at one site, submitted 2014 data is from fiscal year; at one site, only 9 months of data available*
[d] *For glycopeptides and nitroimidazole derivatives, the antibiotic class category includes only one antibiotic (vancomycin and metronidazole, respectively)*

Appendix A

Hospitals participating in the Canadian Nosocomial Infection Surveillance Program (CNISP), as of December 2017

Participating hospitals from the Western region

Vancouver General Hospital, Vancouver, BC
Richmond General Hospital, Richmond, BC
UBC Hospital, Vancouver, BC
Lions Gate Hospital, Vancouver, BC
Powell River Hospital, Powell River, BC
Sechelt Hospital, Sechelt, BC
Squamish Hospital, Squamish, BC
Children's and Women's Health Centre, Vancouver, BC
Royal Jubilee, Victoria, BC
Nanaimo Regional General Hospital, Nanaimo, BC
Victoria General Hospital, Victoria, BC
Kelowna Hospital, Kelowna, BC
University of Northern BC, Prince George, BC
Peter Lougheed Hospital, Calgary, AB
Rockyview General Hospital, Calgary, AB
Foothills Hospital, Calgary, AB
South Health Campus, Calgary, AB
Alberta Children's Hospital, Calgary, AB
University of Alberta Hospital, Edmonton, AB
Stollery Children's Hospital, Edmonton, AB
Royal University Hospital, Saskatoon, SK
St. Paul's Hospital, Saskatoon, SK
Regina General Hospital, Regina, SK
Pasqua Hospital, Regina, SK
Health Sciences Centre, Winnipeg, MB
Children's Hospital, Winnipeg, MB

Participating hospitals from the Central region

Children's Hospital of Western Ontario, London, ON
Victoria Hospital, London, ON
University Hospital, London, ON
Toronto Western Hospital, Toronto, ON
Toronto General Hospital, Toronto, ON
Princess Margaret Hospital, Toronto, ON
North York General Hospital, Toronto, ON

The Hospital for Sick Children, Toronto, ON
Mount Sinai Hospital, Toronto, ON
Bridgepoint Active Healthcare, Toronto, ON
Sunnybrook Health Sciences Centre, Toronto, ON
Kingston General Hospital, Kingston, ON
Hamilton Health Sciences Centre, McMaster, Hamilton, ON
Hamilton Health Sciences Centre, Juravinski Site, Hamilton, ON
Hamilton Health Sciences Centre, General Site, Hamilton, ON
St Joseph's Healthcare, Hamilton, ON
The Ottawa Hospital, Civic Campus, Ottawa, ON
The Ottawa Hospital, General Site, Ottawa, ON
The Ottawa Hospital, Heart Institute, Ottawa, ON
Children's Hospital of Eastern Ontario, Ottawa, ON
Health Sciences North, Sudbury, ON
Jewish General Hospital, Montréal, QC
Montréal Children's Hospital, Montréal, QC
Maisonneuve-Rosemont Hospital, Montréal, QC
Montréal General Hospital, Montréal, QC
Royal Victoria Hospital, Montréal, QC
Montréal Neurological Hospital, Montréal, QC
Hôtel-Dieu de Québec de CHUQ, Québec, QC

Participating hospitals from the Eastern region

The Moncton Hospital, Moncton, NB
Queen Elizabeth Hospital, Charlottetown, PEI
Prince County Hospital, PEI
QE II Health Sciences Centre, Halifax, NS
IWK Health Centre, Halifax, NS
Health Sciences Centre General Hospital, St. John's, NL
Janeway Children's Health and Rehabilitation Centre, St. John's, NL
St. Clare's Mercy Hospital, St. John's, NL
Burin Peninsula Health Centre, Burin, NL
Carbonear General Hospital, Carbonear, NL
Dr. G.B. Cross Memorial Hospital, Clarenville, NL
Western Memorial Regional Hospital, NL

We gratefully acknowledge the contribution of the physicians, epidemiologists, infection control practitioners and laboratory staff at each participating hospital and the Public Health Agency staff within the Centre for Communicable Diseases and Infection Control and the National Microbiology Laboratory, Winnipeg.

Appendix B: Summary of hospitals participating in CNISP, 2017

Region	Western	Central	Eastern	National
Total number of hospitals	26	28	12	66
By hospital type				
Adult*	12	18	4	34
Mixed	11	6	7	24
Pediatric	3	4	1	8
By hospital size				
Small (1-200 beds)	7	6	5	18
Medium (201-499 beds)	13	16	6	35
Large (500+ beds)	6	6	1	13
Total number of beds	8,840	9,610	3,097	21,547
Total number of admissions	452,390	475,375	103,644	1,031,409
Total number of patient days	3,261,626	3,460,831	914,818	7,637,275

**Seven hospitals classified as Adult are Adult hospitals with a NICU*

Surveillance of HAIs at participating hospitals is considered to be within the mandate of hospital infection prevention and control programs and does not constitute human research. The ability for a hospital to participate in CNISP HAI surveillance is based on funding, the site capacity for data collection, access to hospital laboratory services and their operational capacity to participate in a given year. Therefore, the variation in the number of reporting hospitals each year reflects the changes in the number of participating hospitals, which has generally increased over time.

Appendix C: 2017 Surveillance Case Definitions and Eligibility Criteria

1. *Clostridium difficile* Infection (CDI)

A "primary" episode of CDI is defined as either the first episode of CDI ever experienced by the patient or a new episode of CDI which occurs greater than eight (8) weeks after the diagnosis of a previous episode in the same patient.

A patient is identified as having CDI if:

- the patient has diarrhea* or fever, abdominal pain and/or ileus **AND** a laboratory confirmation of a positive toxin assay or positive polymerase chain reaction (PCR) for *C.difficile* (without reasonable evidence of another cause of diarrhea)

OR

- the patient has a diagnosis of pseudomembranes on sigmoidoscopy or colonoscopy (or after colectomy) or histological/pathological diagnosis of CDI

OR

- the patient is diagnosed with toxic megacolon (in adult patients only)

*Diarrhea is defined as one of the following:

- 6 or more watery/unformed stools in a 36-hour period
- 3 or more watery/ unformed stools in a 24-hour period and this is new or unusual for the patient (in adult patients only)

Exclusion

- Any patients age less than 1 year.
- Any pediatric patients (aged 1 year to less than 18 years) with alternate cause of diarrhea found (i.e. rotavirus, norovirus, enema or medication etc.) are excluded even if *C. difficile* diagnostic test result is positive.

Please note that starting in 2017, we will no longer accept an asymptomatic case identified only by a laboratory confirmation of a positive toxin assay or PCR for *C. difficile.* (i.e., a patient must have diarrhea or fever, abdominal pain and/or ileus AND a laboratory confirmation of a positive toxin assay or PCR for *C. difficile* to be identified as having CDI).

CDI case classification

Once a patient has been identified with CDI, the infection will be classified further based on the following criteria[d] and the *best clinical judgment* of the healthcare and/or infection prevention and control practitioner (ICP).

***Healthcare associated (from CNISP reporting hospitals only)* CDI case definition**

- **Related to the current hospitalization**
  - The patient's CDI symptoms occur in your healthcare facility 3 or more days (or ≥72 hours) after admission.
- **Related to a previous hospitalization**

[d] Adapted from SHEA/IDSA practice recommendations 'Strategies to Prevent Clostridium difficile Infections in Acute Care Hospitals: 2014 Update '– available at URL http://www.jstor.org/stable/10.1086/676023?origin=JSTOR-pdf

- **Inpatient**: The patient's CDI symptoms occur less than 3 days after the current admission (or <72 hours) AND the patient had been previously hospitalized at your healthcare facility and discharged within the previous 4 weeks.
- **Outpatient**: The patient presents with CDI symptoms at your ER or outpatient location[e] AND the patient had been previously hospitalized at your healthcare facility and discharged within the previous 4 weeks.

- **Related to a previous healthcare exposure[f] at your facility**
  - **Inpatient**: The patient's CDI symptoms occur less than 3 days after the current admission (or <72 hours) AND the patient had a previous healthcare exposure[f] at your facility within the previous 4 weeks.
  - **Outpatient**: The patient presents with CDI symptoms at your ER or outpatient location[e] AND the patient had a previous healthcare exposure[f] at your facility within the previous 4 weeks.

Community associated **CDI case definition**

- **Inpatient**: The patient's CDI symptoms occur less than 3 days (or <72 hours) after admission, with no history of hospitalization or any other healthcare exposure[f] within the previous 12 weeks.
- **Outpatient**: The patient presents with CDI symptoms at your ER or outpatient location with no history of hospitalization or any other healthcare exposure[f] within the previous 12 weeks.

[e] This includes all of your outpatient clinics (oncology [including chemotherapy or radiation], dialysis, day surgery, day hospital, transfusion clinic, interventional radiology), but may not be exhaustive.

[f] Healthcare exposure: The patient had 2 or more visits at any of the following locations (oncology [including chemotherapy or radiation], dialysis, day surgery, day hospital, transfusion clinic, interventional radiology or emergency department) OR had a single visit to the emergency department for more than or equal to 24 hours.

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

MRSA surveillance inclusion criteria

MRSA case definition:

- isolation of *Staphylococcus aureus* from any body site

AND

- resistance of isolate to oxacillin

AND

- patient must be admitted to the hospital[g]

AND

- is a "newly identified MRSA case" at a **CNISP hospital** at the time of hospital admission or identified during hospitalization.

This includes:

- MRSA infections identified for the first time during this hospital admission
- Infections that have been previously identified at other **non**-CNISP hospitals (since we want newly identified MRSA cases at CNISP hospitals)
- Infections that have already been identified at your site but are new infections. This can only be identified if the previously identified case has another strain. This means the person was exposed again to MRSA and acquired another strain of it from another source (a new patient identifier is assigned only if confirmed with a different strain type)
- MRSA infection identified at a new (different) site in a patient with a MRSA infection identified in a previous surveillance (calendar) year [h]

AND

- meets the criteria for MRSA infection as determined using the January 2017 CDC/NHSN surveillance definitions[i] for specific infections, and in accordance with the best judgment of the healthcare and/or IPC practitioner.

MRSA surveillance exclusion criteria:

- MRSA infections previously identified at other CNISP sites
- Emergency, clinic, or other outpatient cases who are **not admitted** to the hospital.
- Infections re-admitted with MRSA (unless it is a different strain or a new/different site of MRSA infection).

[g] includes ER and outpatients who tested positive for MRSA and then are subsequently admitted or are admitted but still in ER awaiting a bed on a ward.

[h] For example, patient identified in 2014 with a MRSA respiratory infection. Same patient admitted in 2017 and identified with SSI MRSA infection. The patient would be counted as a new infection in 2017

[i] MRSA infection is determined using the 2017 CDC/NHSN surveillance definitions for specific infections, and in accordance with the best judgement of the healthcare and/or IPC practitioner. CDC/NHSN criteria for infection can be access at https://www.cdc.gov/nhsn/PDFs/pscManual/17pscNosInfDef_current.pdf.

Healthcare associated (HA) case definition:

Healthcare associated is defined as an inpatient who meets the following criteria and in accordance with the best clinical judgement of the healthcare and/or infection prevention and control practitioner (IPC):

- Exposure to any healthcare setting (including long-term care facilities or clinics) in the previous 12 months[j]
  OR
- Patient is on calendar day 3[k] of their hospitalization

Community associated case definition:

- MRSA identified on admission to hospital (Calendar Day 1 = day of hospital admission) and/or the day after admission (day 2).
  AND
- Has no previous history of the organism.
  AND
- Has no prior hospital, long-term care admission or other exposure to a healthcare setting (rehab, clinics)[h] in the past 12 monthsa[e].
  AND
- Has no reported use of medical devices.

MRSA clinical infection

MRSA infection is determined using the 2016 CDC/NHSN surveillance definitions www.cdc.gov/nhsn/pdfs/pscmanual/17pscnosinfdef_current.pdf for specific infections, and in accordance with the best judgment of the healthcare and/or IPC practitioner.

The MRSA infection would be considered HA if all elements of a CDC/NHSN site-specific infection criterion were present on or after the 3rd calendar day of admission to the facility (the day of hospital admission is calendar day 1). The MRSA infection would be considered CA if all elements of a CDC/NHSN site-specific infection criterion were present during the two calendar days before the day of admission, the first day of admission (day 1) and/or the day after admission (day 2) and are documented in the medical record.

MRSA Bloodstream infection (bacteremia)

To be considered a MRSA bloodstream infection the patient must have MRSA cultured (lab-confirmed) from at least one blood culture

[j] Consideration should be given to the frequency and nature of exposure to a healthcare setting. For example, pediatric patients with clinic visits for otitis media, asthma, well-baby etc. in the previous 12 months may or may not be considered as HA while pediatric patients with clinic visits that involved invasive procedures or day surgery may be more likely to be considered HA.

[k] Calendar day 1 is the day of hospital admission.

3. Vancomycin-Resistant Enterococci (VRE)

VRE infection case definition:

- Isolation of *Enterococcus faecalis or faecium*

AND

- Vancomycin MIC ≥ 8 ug/ml

AND

- Patient is admitted to the hospital

AND

- Is a "newly" identified VRE-infection at a CNISP facility at the time of hospital admission or identified during hospitalization

VRE infection is determined using the January 2017 Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) definitions/criteria for infections, and in accordance with the best judgment of the ICP. These criteria should be met at the time of the culture that yielded VRE, or within 72 hours of the culture.

www.cdc.gov/**nhsn**/pdfs/pscmanual/17pscnosinfdef_current.pdf

Exclusion criteria:

- Previously identified at other CNISP sites (to avoid duplicate reporting to CNISP)
- Identified through emergency, clinic, or other outpatient areas
- Re-admitted with VRE (**UNLESS** it is a different strain)

Healthcare associated is defined as an inpatient who meets the following criteria and in accordance with the best clinical judgement of the healthcare and/or infection prevention and control practitioner (IPC):

- Exposure to any healthcare setting (including long-term care facilities or clinics) in the previous 12 months[l]

OR

- Patient is on calendar day 3[m] of their hospitalization

[l] Consideration should be given to the frequency and nature of exposure to a healthcare setting. For example, pediatric patients with clinic visits for otitis media, asthma, well-baby etc. in the previous 12 months may or may not be considered as HA while pediatric patients with clinic visits that involved invasive procedures or day surgery may be more likely to be considered HA.

[m] Calendar day 1 is the day of hospital admission.

4. Carbapenemase-Producing Enterobacteriaceae (CPE) and Carbapenem-Producing *Acinetobacter* (CPA)

Any patient admitted to a participating CNISP hospital with a hospital laboratory confirmation (and subsequent confirmation by the NML) that tested/screened positive for a least one potential carbapenem-reduced susceptible Enterobacteriaceae and *Acinetobacter spp*., from any body site that meets the following CLSI criteria.[n]

At least ONE of the following:	**Enterobacteriaceae:**	
	MIC (*µg/ml*)	Disk diffusion* (*mm*)
Imipenem	≥ 4	≤ 19
Meropenem	≥ 4	≤ 19
Doripenem	≥ 4	≤ 19
Ertapenem	≥ 2	≤ 18

At least ONE of the following:	***Acinetobacter:***	
	MIC (*µg/ml*)	Disk diffusion* (*mm*)
Imipenem	≥ 8	≤ 18
Meropenem	≥ 8	≤ 14
Doripenem	≥ 8	≤ 14

*Using a 10 µg disk of the appropriate antimicrobial

Carbapenems are a class of beta-lactam antibiotics with broad-spectrum activity recommended as first-line therapy for severe infections caused by certain gram negative organisms and as directed therapy for organisms that are resistant to narrower spectrum antibiotics.

Carbapenem resistance can be due to changes in the permeability of the organism to the antibiotic and/or the up-regulation of efflux systems that "pump" the antibiotic out of the cell, usually concomitant with the presence of an acquired extended-spectrum beta-lactamase (ESBL) or AmpC enzyme or the hyperproduction of intrinsic chromosomally –located beta-lactamase(s). More recently, resistance is increasingly due to the acquisition of enzymes that break down the carbapenems: carbapenemases (e.g. NDM-1, OXA-48, KPC, VIM, IMP etc). These latter subsets of carbapenem-resistant organisms are called carbapenemase-producing organisms (CPOs) and are of particular concern because of their ability to transfer resistance easily across different genera and species of bacteria. They are quickly becoming a public health problem not only because of the ability to cause healthcare acquired infections which have limited treatment options, but because of the potential for colonizing both inpatient and outpatient populations due to their ease of transmissibility, thus, creating a reservoir of bacterial resistance.

The data presented in this report include Enterobacteriaceae spp. and Acinetobacter spp. that are resistant to carbapenems through the production of a carbapenemase. The first positive isolate from an inpatient identified as colonized or infected with CPE or CPA is eligible. Subsequent positive isolates from the same patient in the same calendar year are eligible only if the patient tests positive for a different carbapenemase. If the patient was initially colonized and subsequently develops an infection with the

[n] Clinical and Laboratory Standards Institute. 2016. Performance standards for antimicrobial susceptibility testing; 25th informational supplement, M100-S27 (December 2016). Clinical and Laboratory Standards, Wayne, PA.

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same gene, within the same calendar year, only the infection is eligible for inclusion in surveillance. Data from previous years included in this report have been adjusted to reflect this change in reporting.

5. *Escherichia coli* (E. coli) Antibiogram

Eligibility to participate

1. Hospitals that are part of the CNISP network or affiliated with a CNISP site (and hence contributing to that institution's annual antibiogram data)

2. Able to submit annual antibiogram data for the target organism *E.coli* (non-screening specimen isolates)

3. Able to **indicate** whether the antibiogram data is from one of the following categories:

    a. Inpatient and outpatient combined, i.e., inpatients and patients seen at hospital clinics or emergency department who might or might not have been admitted
    b. Inpatient only
    c. Outpatient only

4. Able to indicate antibiogram data specimen type is 'all specimen types' or 'all urine'

Inclusion criteria

- All *E. coli* bacterial isolates (non-screening specimen isolates with duplicates removed) included in the annual antibiogram data
- A minimum of 30 isolates per reported antibiotic are required in order to submit antibiogram data.

6. Antimicrobial Use

Participating hospitals provide total adult inpatient hospital antimicrobial usage, separated by ward or ward category. Adult AMU data are collected in defined daily doses (DDDs). Hospitals additionally provide patient-day denominator data broken down by ward categories.

Inclusion criteria:

- Acute adult in-patient antibiotic use includes all systemic antibacterials (J01), metronidazole oral (ATC code: P01AB01) and vancomycin oral (ATC code: A07AA10).
- Only antibiotic use by medical, surgical, combined (medical/surgical), ICU or other wards that are comprised of inpatients are included.

Collected variables for adult inpatient AMU:

- Generic (drug name) – according to the inclusion criteria
- Dose form or route (parenteral, oral or inhalation)
- Total DDD or DDD Units (i.e. grams, milligrams or million units)
- Days of Therapy (DOTs) if possible
- Program, ward or ward category

Calculation of defined daily doses:

For adult AMU, national, regional, and ward-specific DDD quantities were calculated by antibiotic and antibiotic class. Total antibiotic use was calculated. Standardized rates per 1,000 patient days were calculated. Where DDD were not provided by the hospital site, WHO ATC/DDD Index 2016 was used to convert grams to DDD equivalents.

The following antimicrobials are special cases:

- For co-trimoxazole (J01EE01), also known as sulfamethoxazole-trimethoprim, 1.6 g per DDD was used for conversion based on Health Canada Drug Product Database (WHO does not provide DDD conversion).
- For benzylpenicillin (J01ECE01), also known as penicillin G, and benzathine benzylpenicillin (J01CE08), data received in million units (MU) was converted to grams (where 0.6 g = 1 MU), before conversion to DDDs using WHO values.

Appendix D: Antibiotics included in antibiotic class categories[o,p]

Cephalosporins	Penicillin and β-lactamase inhibitor combos	Fluroquinolones	Penicillins	Glycopeptides
Cefaclor	Amoxicillin and clavulanic acid	Ciprofloxacin	Amoxicillin	Vancomycin
Cefadroxil	Amoxicillin and other enzyme inhibitor	Levofloxacin	Ampicillin	
Cefazolin	Ampicillin and enzyme inhibitor	Moxifloxacin	Ampicillin, combinations	
Cefixime	Piperacillin and enzyme inhibitor	Norfloxacin	Cloxacillin	
Cefotaxime	Piperacillin and tazobactam	Ofloxacin	Penicillin g	
Cefotetan	Ticarcillin and clavulanic acid		Penicillin v	
Cefoxitin	Ticarcillin and enzyme inhibitor		Piperacillin	
Cefprozil			Ticarcillin	
Ceftazidime				
Ceftobiprole				
Ceftriaxone				
Ceftriaxone combinations				
Cefuroxime				
Cephalexin				
Carbapenems	**Nitroimidazole derivatives**	**Macrolides**	**Tetracyclines**	**Sulfonamides and trimethoprim combos**
Doripenem	Metronidazole	Azithromycin	Combinations of tetracyclines	Sulfadiazine and tetroxoprim
Ertapenem		Clarithromycin	Demeclocycline	Sulfadiazine and trimethoprim
Imipenem		Erythromycin	Doxycycline	Sulfadimidine and trimethoprim
Imipenem and cilastatin		Erythromycin ethylsuccinate	Minocycline	Sulfamerazine and trimethoprim
Meropenem			Tetracycline	Sulfamethoxazole and trimethoprim
			Tigecycline	Sulfametrole and trimethoprim
				Sulfamoxole and trimethoprim

[o] Source: WHO ATC/DDD Index 2016

[p] Table only includes top ten antibiotic classes in 2016