PICNet
PROVINCIAL INFECTION CONTROL NETWORK OF BRITISH COLUMBIA
A program of the Provincial Health Services Authority

Clostridium difficile Infection (CDI) Surveillance Report

For the Fiscal Year 2011/2012
(April 1, 2011 to March 31, 2012)

Prepared by:

Provincial Infection Control Network of British Columbia (PICNet)

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Table of Contents

Glossary of Acronyms

BC	British Columbia
CA	Community-associated
CDI	*Clostridium difficile* infection
CI	Confidence interval
FHA	Fraser Health Authority
FY	Fiscal year
FQ	Fiscal quarter
HA	Health authority
HAI	Healthcare-associated infection
HCA	Healthcare-associated
ICP	Infection control practitioner
IHA	Interior Health Authority
IPC	Infection prevention and control
NHA	Northern Health Authority
PHC	Providence Health Care
PHSA	Provincial Health Services Authority
PICNet	Provincial Infection Control Network of British Columbia
PCR	Polymerase chain reaction
SSC	PICNet's Surveillance Steering Committee
VCHA	Vancouver Coastal Health Authority
VIHA	Vancouver Island Health Authority

Summary

In April 2009, the surveillance of *Clostridium difficile* infection (CDI) was expanded to include all 80 acute care facilities in BC, with the main purposes being to monitor the incidence and trends of CDI in BC acute care facilities, and to provide baseline information for CDI prevention programs.

This report summarizes the cases of CDI identified among inpatients for acute care during fiscal year (FY) 2011/2012 (April 1, 2011 to March 31, 2012), with a focus on *new* cases of CDI associated with the reporting facility.

A total of 3,613 cases of CDI were reported during FY 2011/2012, of which 2,756 (76.3%) were classified as healthcare-associated (HCA). Of the HCA cases, 2,212 were new cases of CDI associated with the reporting facility (61.2% of total CDI cases).

The provincial annual rate of new cases of CDI associated with the reporting facility was 8.1 per 10,000 inpatient days [95% confidence interval (CI): 7.8-8.4] in FY 2011/2012. The rate fluctuated by fiscal quarter, and the rate was significantly higher in quarter 4 (Q4) than in the first three quarters of FY 2011/2012. However, the annual rates of CDI were relatively stable during the past three fiscal years at the provincial level when compared with the annual rate of 8.1 (95% CI: 7.8-8.4) in FY 2010/2011 and 8.6 (95% CI: 8.2-8.9) in FY 2009/2010.

The rate of new cases of CDI associated with the reporting facility varied greatly by health authority (HA). Comparing the annual rate for each HA in FY 2010/2011 with the previous two fiscal years, the rate for IHA and VIHA was significantly lower in FY 2011/2012 than in FY 2009/2010. The changes in the annual rate were not statistically significant for other HAs.

The rate of new cases of CDI associated with the reporting facility increased significantly with hospital size in FY 2011/2012, with the lowest rate in those hospitals with 50 or fewer beds, and the highest rate in those hospitals with more than 250 beds. The differences in the rates were statistically significant in the past three fiscal years. There were no significant changes in annual rates for each hospital size in FY 2011/2012 compared with FY 2009/2010 and FY 2010/2011.

The rate of new cases of CDI associated with the reporting facility in FY 2011/2012 was lowest in the community hospitals and highest in the tertiary/referral hospitals, and the differences in the rates between community, regional, and tertiary/referral hospitals were statistically significant. Comparing the annual rates of each hospital category in the past three fiscal years, the rates were relatively stable in the community and tertiary/referral hospitals, and decreased continually in the regional hospitals, where the rate was significantly lower in FY 2011/2012 than in FY 2009/2010.

The rates were also significantly higher in the teaching hospitals than in the non-teaching hospitals. Over the past three fiscal years, the changes in rates were not statistically significant for either the teaching or non-teaching hospitals, although the rate decreased continually in the teaching hospitals.

It is worth noting that the large hospitals usually serve as tertiary hospitals with specialty care to the patients, and may also provide teaching or training to the medical and nurse students, and other healthcare professionals. These hospitals are more likely to admit patients with greater severity of illness, which may in turn increase the risk of acquiring multidrug-resistant organisms.

The rates in the smaller acute care facilities changed substantially from reporting period to reporting period due to the small number of new cases of CDI and/or inpatient days. In facilities with reliable rates

during the past three fiscal years, continued decreases in the annual rate of new cases of CDI associated with the reporting facility were observed in six hospitals, while continued increases were observed in three other hospitals.

Relapses accounted for 12.9% of the cases of HCA CDI in FY 2011/2012. Compared with 15.6% in FY 2010/2011 and 16.0% in FY 2009/2010, the decrease in the proportion of relapses was statistically significant at the provincial level. This observation could be related to the improvement in CDI diagnosis and treatment, as well as infection control activities in acute care facilities. This decreasing trend requires further monitoring and assessment. The proportion of relapses did not differ significantly by HA and hospital type in FY 2011/2012.

All CDI cases are evaluated at 30 days post-diagnosis or up to the point of patient discharge or transfer (whichever comes first) for CDI-associated complications, including admission to the intensive care unit (ICU), toxic megacolon, and total or partial colectomy. Of all CDI cases, 145 were admitted to ICU (4.0%), 40 developed toxic megacolon (1.1%), and 40 required total or partial colectomy (1.1%). The percentage of each complication in FY 2011/2012 was not significantly different from previous years, although CDI-associated ICU admissions have decreased continually over the past three fiscal years.

The trends of CDI over the past three years appear consistent with progress in CDI prevention and control, i.e. a continued decrease in CDI rates in some acute care facilities, and no significant increase in the CDI rate in the HAs despite the change to use more sensitive polymerase chain reaction (PCR) testing for detection of *C. difficile* (which could result in more specimens to be identified positive with *C. difficile* by the laboratory). Localized increases in CDI rates that may have been observed at specific facilities after introduction of PCR testing may not have been reflected at the provincial level when the data were aggregated. An evaluation would be important to assist in understanding the impact of this change in laboratory best practices on CDI rates.

This report provides an overview of CDI incidence in BC acute care facilities over the past three fiscal years. Consistent and reliable surveillance data enable the effective monitoring of rate changes and trend analysis. The provincial surveillance program, along with public reporting of the results, also ensures transparency and accountability in the prevention and control of healthcare-associated infections in BC acute care facilities.

Please note that the rates of CDI presented in this report are not risk-adjusted, and are therefore not directly comparable between health authorities and facilities. Variations exist between the HAs in terms of the laboratory testing used to confirm CDI diagnosis, case classification, and different at-risk populations.

Introduction

Clostridium difficile infection (CDI) is a leading cause of healthcare-associated infectious diarrhea, and is associated with increased healthcare costs, prolonged hospitalization, and patient morbidity[1]. The disease can range from mild, self-limited diarrhea to severe diarrhea, pseudomembranous colitis, toxic megacolon, and even death.

Since 2006, the Provincial Infection Control Network of BC (PICNet), in collaboration with representatives from Interior Health Authority (IHA), Fraser Health Authority (FHA), Vancouver Coastal Health Authority (VCHA), Providence Health Care (PHC), Vancouver Island Health Authority (VIHA), Northern Health Authority (NHA), Provincial Health Services Authority (PHSA), and other relevant organizations, has been developing a standardized CDI surveillance program in the province, with the main purposes being to monitor the incidence and trends of CDI in BC acute care facilities, and to provide baseline information for CDI prevention programs. The provincial CDI surveillance protocol, including standard case definitions and minimum surveillance datasets, was developed by PICNet's Surveillance Steering Committee (SSC). The cases of CDI are classified as healthcare-associated (HCA) or community-associated (CA) according to the patient's encounter history with healthcare facilities (see Glossary for definitions). The HCA cases are further classified into two categories: those infections associated with the reporting facility, and those infections associated with another facility. Recurrence of CDI within two to eight weeks of previous CDI is defined as a relapse.

All acute care facilities in BC voluntarily participate in this CDI surveillance program. From April 2009, the surveillance data have been submitted to PICNet by the health authorities (HA) on a quarterly basis, and then reported to the Ministry of Health and the public. This report presents those cases of CDI reported from BC acute care facilities during the fiscal year (FY) 2011/2012 (April 1, 2011 to March 31, 2012), and compares the rates of CDI with previous years. To ensure patient confidentiality, when the number of cases reported by facility or HA is less than 10, it is presented as "<10" in the report.

Comparison of the numbers of cases and rates between health authorities (HA) and healthcare facilities is not recommended due to the variations in laboratory testing for detection of *C. difficile*, case classification, and different at-risk populations among HAs. Facilities with small numbers of cases may have unstable rates and percentages; therefore slight changes in the number of cases can dramatically affect the rate and percentage. In addition, reference to healthcare-associated infections (HAI) should not be interpreted as cases of infection acquired *directly* through healthcare services provided by the reporting facility or other healthcare facilities. Please refer to the "Discussion" section and "Limitations" in the "About CDI surveillance program" section for interpretation of the results and limitations of the data.

[1] Ghantoji SS, et al (2010). Journal of Hospital Infection 74, 309-318

Surveillance results

Population under surveillance

All 80 acute care facilities across BC participate in the provincial CDI surveillance program. Table 1 summarizes the characteristics of the facilities for FY 2011/2012, and the estimated general population in each HA in 2011. All patients older than one year who were admitted to these facilities for acute care were under surveillance for CDI. Psychiatric and extended care patients housed in the acute care facilities were not included.

Table 1. Summary of facilities participating in the provincial CDI surveillance program by health authority, fiscal year 2011/2012

Health authority	IHA	FHA	VCHA[a]	VIHA	NHA	PHSA	Total
Total number of facilities	**22**	**14**	**11**	**13**	**18**	**2**	**80**
By hospital size[b]							
1-50 beds	16	3	6	5	17		47
51-250 beds	5	7	2	5	1	2	22
>250 beds	1	4	3	3			11
By hospital category							
Community hospital	16	7	6	9	9		47
Regional Hospital	4	4	3	2	8		21
Tertiary/Referral Hospital	2	3	2	2	1	2	12
By teaching status							
Non-teaching hospital	21	8	5	11	16		61
Teaching hospital	1	6	6	2	2	2	19
Total acute care beds[c]	**1,011[d]**	**2,361**	**1,785**	**1,364**	**552**	**195**	**7,268**
Total acute care admissions	**66,422[e]**	**115,216**	**80,590**	**64,533**	**28,718**	**14,086**	**369,565**
Total inpatient days	**398,036[e]**	**987,835**	**628,835**	**483,684**	**183,408**	**47,814**	**2,729,612**
Estimated general population in 2011[f]	741,619	1,635,340	1,151,320	765,849	289,974	N/A	4,584,102

Note:

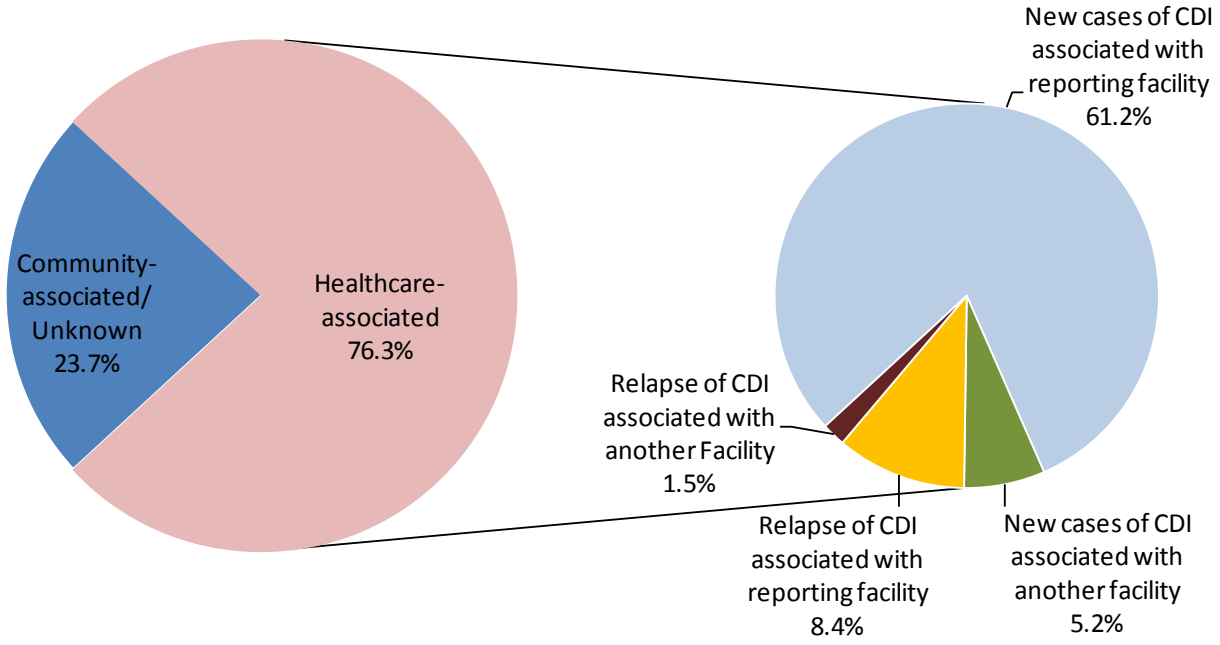
a. Includes the facilities of Providence Health Care (PHC); the same hereinafter.
b. Based on the acute care beds in Q4 of FY 2011/2012; the same hereinafter. The number of beds may vary by quarter due to temporary closure of acute care beds by facilities.
c. Based on the average of quarterly counts of acute care beds in each health authority. Neonatal beds, psychiatric beds, and extended care beds housed in the acute care facilities were excluded (see "Limitations" in the "About CDI surveillance program" section).
d. Includes nine facilities that did not have data available for Q1 and Q2 of FY 2011/2012 due to information system upgrades in progress; the same hereinafter.
e. Excluded from this report are nine facilities in IHA for Q1 and Q2 of FY 2011/2012 that did not have data available due to information system upgrades in progress; the same hereinafter.
f. BC Stats. Population projections (P.E.O.P.L.E. 36). http://www.bcstats.gov.bc.ca/

Overview of CDI cases

A total of 3,613 cases of CDI were reported during FY 2011/2012. According to the PICNet's CDI surveillance protocol, 2,756 cases were classified as HCA (76.3%), and 857 were community-associated (CA) or unknown (23.7%). Of HCA cases, 2,212 were new cases of CDI associated with the reporting facility (61.2% of total CDI cases), 188 were new cases of CDI associated with another facility (5.2%), 302 were relapses of CDI associated with the reporting facility (8.4%), and 54 were relapses of CDI associated with another facility (1.5%) (Figure 1).

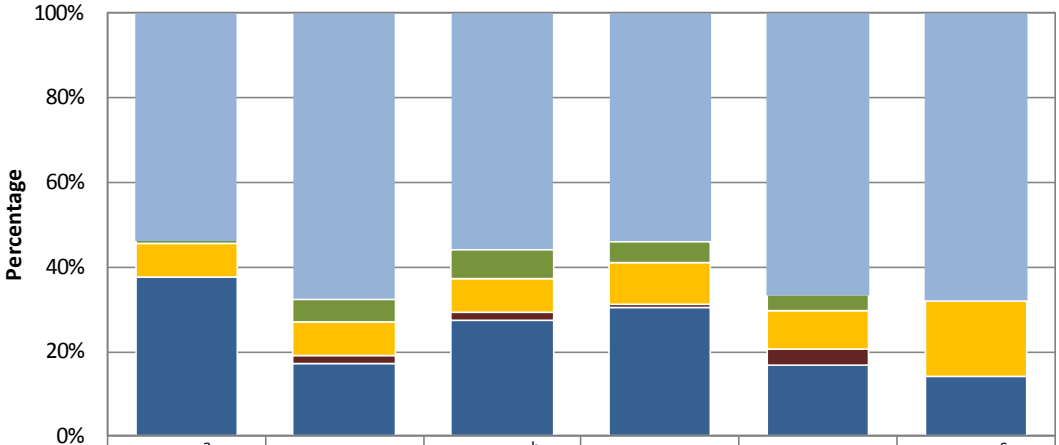
Figure 1. Proportion of CDI cases reported by case classification, fiscal year 2011/2012

(n=3,613)



The proportion of new CDI cases associated with the reporting facility over the total number of CDI cases varied by HA in FY 2011/2012 (Figure 2). This may be partially due to variation in how CDI cases were classified among HAs (see "Limitations" in the "About CDI surveillance program" section); however, the definition of new cases of CDI associated with the reporting facility is considered comparable across all HAs.

Figure 2. Proportion of CDI cases by case classification and health authority in the fiscal year 2011/2012



	IHA[a]	FHA	VCHA[b]	VIHA	NHA	PHSA[c]
New cases of CDI associated with reporting facility	54.2%	67.6%	55.8%	54.0%	66.7%	68.0%
New cases of CDI associated with another facility	0.7%	5.5%	6.9%	4.9%	3.8%	N/A
Relapse of CDI associated with reporting facility	8.0%	8.0%	8.0%	9.8%	9.0%	18.0%
Relapse of CDI associated with another Facility	0.0%	1.6%	1.9%	1.1%	3.8%	N/A
Community-associated/ Unknown	37.7%	17.3%	27.4%	30.2%	16.7%	14.0%
Total number of CDI cases	424	1,656	1,038	367	78	50

Note: Laboratory testing for detection of C. Difficile differed among the health authorities, which could affect the identification of CDI cases.

a. IHA assigns CDI cases of both new case and relapse that were associated with another facility within IHA to the appropriate facilities, and the cases that were associated with the facilities out of IHA as "healthcare-associated with another facility".

b. Includes PHC, which classified CDI cases as either "PHC-associated" or "Not-PHC-associated" for both new cases and relapses. PHC-associated cases included CDI that were associated with the reporting facility or another facility of PHC. The cases other than these were classified as Not-PHC-associated, which were grouped into the category of "Community-associated/Unknown" in this report. In addition, other facilities within VCHA include the CDI cases that were associated with the facilities out of VCHA into "healthcare-associated with another facility".

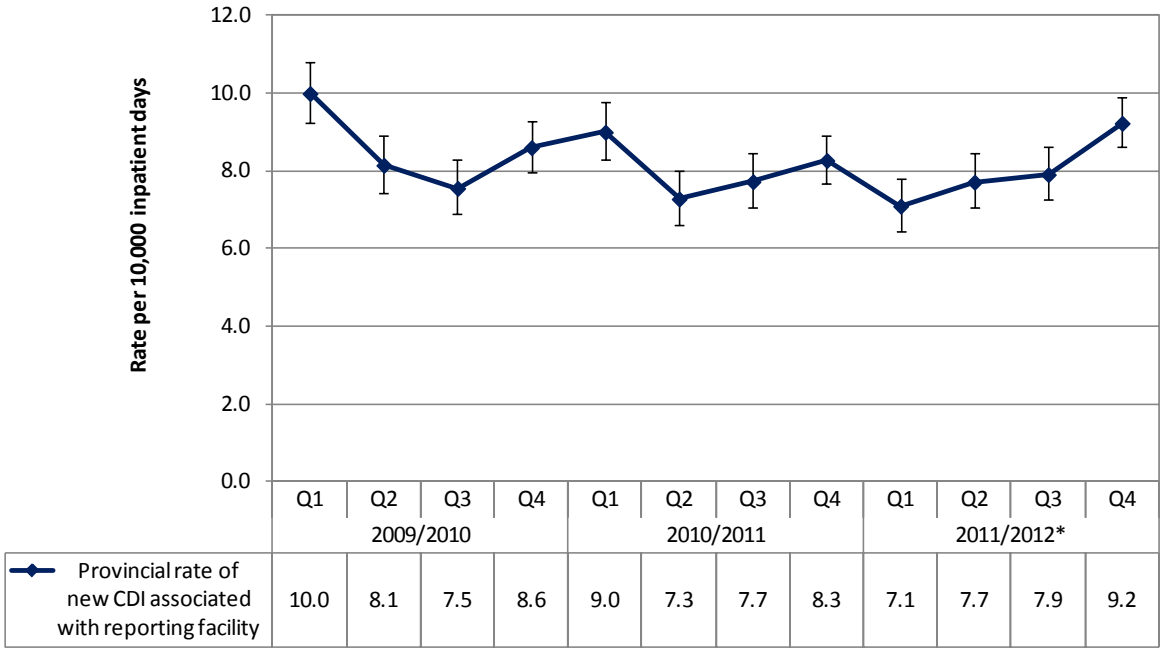
c. PHSA classified the CDI cases other than those associated with reporting facilities as "Community-associated" or unknown.

Provincial rate of new cases of CDI associated with the reporting facility

The provincial annual rate of new cases of CDI associated with the reporting facility was 8.1 per 10,000 inpatient days [95% confidence interval (CI): 7.8-8.4] in FY 2011/2012. The rate fluctuated by fiscal quarter during FY 2011/2012 and the rate was significantly higher in Q4 than in the first three quarters of FY 2011/2012 (Figure 3).

Compared with the annual rate of 8.1 (95% CI: 7.8-8.4) in FY 2010/2011 and 8.6 (95% CI: 8.2-8.9) in FY 2009/2010, the annual rate of new cases of CDI associated with the reporting facility was relatively stable at the provincial level.

Figure 3. Provincial rate of new cases of CDI associated with the reporting facility per 10,000 inpatient days and 95% confidence interval, by fiscal year and quarter



Note: * The changes in laboratory testing for *C. difficile* (see "Limitations" in the "About CDI surveillance program" section) may affect the rate of CDI.
** Data were aggregated by fiscal quarter for each HA except PHSA, which aggregated the data by calendar quarter (for start and end date of each quarter, see Fiscal year and quarter in the "Glossary"). The same hereinafter.

Rate of new cases of CDI associated with the reporting facility by health authority

The rate of new cases of CDI associated with the reporting facility varied greatly by HA and fiscal quarter in FY 2011/2012 (Table 2). Overall, the rate was higher in Q4 than in the first three quarters of FY 2011/2012 for all HAs with the exception of PHSA, whose highest rate in FY 2011/2012 was in Q3.

Comparing the annual rate of each HA in FY 2011/2012 with previous two fiscal years, the rate for IHA and VIHA was significantly lower in FY 2011/2012 than in FY 2009/2010 (the 95% CIs were not overlapped with each other). The changes in the annual rate of CDI were not statistically significant for the other HAs.

Table 2. Rate of new cases of CDI associated with the reporting facility per 10,000 inpatient days by health authority and fiscal year

Health authority	2009/2010	2010/2011	2011/2012				
	Annual rate (95% CI)	Annual rate (95% CI)	Q1	Q2	Q3	Q4	Annual rate (95% CI)
IHA[a]	9.2 (8.4-10.2)	6.6 (5.8-7.4)	4.0	4.6	5.0	8.1	5.8 (5.1-6.6)
FHA[b]	10.3 (9.6-11.0)	10.5 (9.8-11.1)	10.5	10.4	11.3	12.6	11.3 (10.7-12.0)
VCHA[c]	10.0 (9.3-10.9)	9.9 (9.1-10.7)	7.5	9.4	9.4	10.1	9.2 (8.5-10.0)
VIHA[d]	5.5 (4.9-6.2)	4.7 (4.1-5.3)	3.8	4.2	3.9	4.4	4.1 (3.6-4.7)
NHA	2.1 (1.5-2.8)	2.8 (2.1-3.7)	2.6	2.8	1.8	3.7	2.8 (2.2-3.7)
PHSA[e]	7.2 (5.1-10.2)	3.9 (2.5-6.1)	4.2	8.3	8.4	7.6	7.1 (5.1-9.9)
Total	**8.6 (8.2-8.9)**	**8.1 (7.8-8.4)**	**7.1**	**7.7**	**7.9**	**9.2**	**8.1 (7.8-8.4)**

Note:

a. IHA introduced PCR testing for *C. difficile* to Kelowna General Hospital and two-step algorithm testing to the remaining facilities in September 2009. Excluded are four facilities in Q3 and Q4 of FY 2010/2011 and nine facilities in Q1 and Q2 of FY 2011/2012 due to the unavailability of the surveillance data.
b. FHA introduced PCR testing for *C. difficile* to four facilities on October 26, 2011 and the remaining facilities on March 19. 2012.
c. VCHA introduced PCR testing for *C. difficile* in their facilities on June 27, 2008 and PHC on August 2, 2010.
d. VIHA introduced two-step algorithm testing for *C. difficile* to their facilities on April 1, 2011.
e. PHSA introduced PCR testing for *C. difficile* to their facilities in November 2011.

Rate of new cases of CDI assoicated with the reporting facility by facility type

Similar to FY 2010/2011 and FY 2009/2010, the rate of new cases of CDI associated with the reporting facility increased significantly with hospital size in FY 2011/2012, with the lowest rate in those hospitals with 50 or fewer beds, and the highest rate in those hospitals with more than 250 beds (Table 3). The rates differed significantly by hospital size for each of the past three fiscal years.

Comparing the rates in FY 2012/2011 with those of FY 2010/2011 and FY 2009/2010, there were no significant changes in the annual rate for each hospital size (Table 3).

Table 3. Annual rate of new cases of CDI associated with the reporting facility per 10,000 inpatient days by hospital size

Hospital size	Annual Rate (95% CI)		
	2009/2010	2010/2011	2011/2012
1-50 beds	3.9 (3.3-4.7)	4.1 (3.4-4.8)	3.7 (3.1-4.5)
51-250 beds	7.9 (7.3-8.4)	6.6 (6.2-7.1)	7.1 (6.6-7.6)
>250 beds	10.4 (9.8-11.0)	10.6 (10.0-11.2)	9.5 (9.0-10.0)
Total	**8.6 (8.2-8.9)**	**8.1 (7.8-8.4)**	**8.1 (7.8-8.4)**

The annual rates of new cases of CDI associated with the reporting facility differed by hospital category for each of the past three fiscal years. In FY 2011/2012, the rate was lowest in the community hospitals (6.0 cases per 10,000 inpatient days) and highest in the tertiary/referral hospitals (9.0 cases per 10,000 inpatient days) (Table 4). The differences in the rates between community hospitals, regional hospitals, and tertiary/referral hospitals were statistically significant in FY 2011/2012.

Comparing the annual rates of each hospital category in the past three fiscal years, the rates were relatively stable in the community and tertiary/referral hospitals, and decreased continually in the regional hospitals, where the rate was significantly lower in FY 2011/2012 than in FY 2009/2010 (Table 4).

Table 4. Annual rate of new cases of CDI associated with the reporting facility per 10,000 inpatient days by hospital category

Hospital category	Annual Rate (95% CI)		
	2009/2010	2010/2011	2011/2012
Community hospital	6.5 (5.8-7.3)	6.5 (5.8-7.3)	6.0 (5.4-6.8)
Regional Hospital	9.1 (8.5-9.8)	8.1 (7.5-8.8)	7.8 (7.2-8.4)
Tertiary/Referral Hospital	9.0 (8.5-9.5)	8.6 (8.1-9.1)	9.0 (8.5-9.5)
Total	**8.6 (8.2-8.9)**	**8.1 (7.8-8.4)**	**8.1 (7.8-8.4)**

Please refer to the Glossary for the definition of each hospital category.

The teaching hospitals had a significantly higher rate of new cases of CDI associated with the reporting facility than the non-teaching hospitals for each of the past three fiscal years (Table 5).

Comparing the annual rates in the past three fiscal years, the changes in the rates were not statistically significant for either the teaching or non-teaching hospitals, although the rate decreased continually in the teaching hospitals (Table 5).

Table 5. Annual rate of new cases of CDI associated with the reporting facility per 10,000 inpatient days by teaching status of hospital

Teaching status	Annual Rate (95% CI)		
	2009/2010	2010/2011	2011/2012
Non-teaching hospital	6.2 (5.7-6.8)	5.4 (4.9-5.9)	5.8 (5.3-6.3)
Teaching hospital	9.8 (9.3-10.3)	9.5 (9.0-9.9)	9.3 (8.8-9.7)
Total	**8.6 (8.2-8.9)**	**8.1 (7.8-8.4)**	**8.1 (7.8-8.4)**

Please refer to the Glossary for the definition of teaching hospital

Rate of new cases of CDI assoicated with the reporting facility by acute care facility

Table 6 below presents the rates of new cases of CDI by hospital, listed in alphabetical order. The 95% CI for the rate is provided to show the reliability of the rate. The wide range of 95% CI for some facilities is due to the small numerators (i.e., number of new cases of CDI associated with the reporting facility) and/or denominators (inpatient days). A wider range of CI denotes less confidence in the rate, because of the greater margin for error. The rates in facilities with a wide CI may vary substantially from reporting period to reporting period, because slight changes in case numbers – even one case – can considerably affect the rate. Those facilities which the difference between the upper limit and lower limit of 95% CI was greater than twice the rate are denoted with the letter 'E' in the table below, indicating that the rate may not be reliable.

Example In a facility with 30 acute care beds, if in FY 2010/2011 there were two new cases of CDI associated with the facility and 8,000 inpatient days, and in FY 2011/2012 three new cases of CDI associated with the facility and 6,000 inpatient days, the rates would be 2.5 and 5.0 per 10,000 inpatient days, respectively. As demonstrated in this example, the rate has doubled, although the number of cases has increased only by one case. For this reason, those rates with the small numerators and/or denominators are flagged with the letter 'E' in the table below.

For those facilities with reliable rates during the past three fiscal years, continued decreases in the annual rate of new cases of CDI associated with the reporting facility were observed in Burnaby Hospital, Kelowna General Hospital, Lions Gate Hospital, Queen's Park Hospital, Vernon Jubilee Hospital, and Victoria General Hospital, and the rate in FY 2011/2012 was significantly lower than the previous two years in Lions Gate Hospital. Mission Memorial Hospital, Ridge Meadows Hospital, and Royal Columbia Hospital reported continued increases in the annual rate, with a significantly higher rate for FY 2011/2012 than the previous two years in Ridge Meadows Hospital.

Please note that the laboratory testing used to confirm CDI diagnosis differed from facility to facility and has been changed over time, which can significantly affect identification of CDI (see "Discussion" section and "Limitations" in the "About CDI surveillance program" section). **The rates in the table are also not risk-adjusted, and therefore should not be used to make comparisons between individual facilities.**

Table 6. Annual rate of new cases of CDI associated with the reporting facility per 10,000 in patient days and 95% confidence intervals, by acute care facility

Acute care facility	Hospital type[a]	2009/2010	2010/2011	2011/2012
100 Mile District Hospital	S,C,N	0.0	1.5 (0.3-8.7)[E]	0.0
Abbotsford Regional Hospital	L,T,Y	3.8 (2.7-5.3)	4.3 (3.2-5.8)	4.6 (3.5-6.1)
Arrow Lakes Hospital [b]	S,C,N	28.4 (11.0-72.7)[E]	0.0	0.0
BC Children's Hospital	M,T,Y	14.7 (10.3-20.8)	6.4 (4.0-10.3)	13.4 (9.6-18.7)
BC Women's Hospital	M,T,Y	0.4 (0.1-2.5)[E]	0.9 (0.2-3.2)[E]	0.0
Bella Coola General Hospital	S,C,N	0.0	0.0	5.0 (0.9-28.4)[E]
Boundary Hospital [b]	S,C,N	14.1 (6.5-30.8)	5.2 (0.9-29.5)[E]	9.5 (2.6-34.5)[E]
Bulkley Valley District Hospital	S,R,N	5.4 (1.8-15.8)[E]	0.0	0.0

Acute care facility	Hospital type[a]	2009/2010	2010/2011	2011/2012
Burnaby Hospital	L,R,Y	18.1 (15.7-20.9)	17.1 (14.8-19.7)	15.2 (13.1-17.6)
Campbell River & District General Hospital	M,C,N	1.2 (0.4-3.4)[E]	3.0 (1.5-5.9)	5.2 (3.0-8.9)
Cariboo Memorial Hospital and Health Centre	S,C,N	2.1 (0.6-7.7)[E]	6.1 (2.8-13.4)	6.1 (2.8-13.4)
Chetwynd General Hospital	S,C,N	0.0	0.0	0.0
Chilliwack General Hospital	M,C,Y	2.6 (1.5-4.4)	2.9 (1.8-4.6)	1.8 (1.0-3.2)
Cormorant Island Community Health Centre	S,C,N	0.0	0.0	0.0
Cowichan District Hospital	M,C,N	4.0 (2.3-6.8)	4.7 (2.9-7.5)	4.9 (3.1-7.8)
Creston Valley Hospital[c]	S,C,N	12.0 (5.5-26.1)	6.7 (2.6-17.1)[E]	11.0 (3.8-32.4)[E]
Dawson Creek And District Hospital	S,R,N	0.0	0.0	1.2 (0.3-4.4)
Delta Hospital	M,C,N	4.7 (2.6-8.5)	9.5 (6.3-14.4)	9.2 (6.0-14.1)[E]
Dr. Helmcken Memorial Hospital & Health Centre	S,C,N	8.5 (1.5-47.9)[E]	0.0	0.0
Eagle Ridge Hospital	M,C,N	13.3 (10.2-17.4)	10.7 (8.1-14.3)	10.7 (8.2-14.0)
East Kootenay Regional Hospital[c]	M,R,N	11.1 (7.5-16.4)	7.4 (4.6-11.9)	10.5 (6.1-17.9)
Elk Valley Hospital[c]	S,C,N	18.5 (9.7-35.2)	15.9 (8.1-31.3)	7.7 (2.1-28.0)[E]
Fort Nelson General Hospital	S,C,N	0.0	0.0	0.0
Fort St. John General Hospital	S,R,N	1.3 (0.4-4.9)[E]	2.2 (0.8-6.5)[E]	0.7 (0.1-3.9)[E]
Fraser Canyon Hospital	S,C,N	7.5 (2.5-21.9)[E]	16.6 (7.6-36.1)	2.6 (0.5-14.9)[E]
G.R. Baker Memorial Hospital	S,R,Y	0.0	2.3 (0.8-6.8)[E]	2.2 (0.8-6.6)[E]
Golden & District General Hospital[c]	S,C,N	0.0	0.0	0.0
Invermere & District Hospital[c]	S,C,N	10.8 (3.7-31.6)[E]	11.0 (3.7-32.2)[E]	0.0
Kelowna General Hospital	L,T,Y	13.7 (11.8-15.9)	10.0 (8.4-12.0)	8.5 (7.0-10.2)
Kitimat General Hospital	S,R,N	3.1 (0.8-11.1)[E]	1.5 (0.3-8.3)[E]	2.7 (0.8-10.0)[E]
Kootenay Boundary Regional Hospital[b]	M,R,N	10.0 (6.7-15.1)	5.2 (2.2-12.2)	7.4 (3.9-14.1)
Kootenay Lake Hospital[b]	S,C,N	8.8 (5.0-15.3)	13.9 (7.0-27.4)	3.2 (0.9-11.7)[E]
Lady Minto Gulf Islands Hospital	S,C,N	3.4 (0.9-12.4)[E]	4.9 (1.7-14.4)[E]	3.1 (0.8-11.2)[E]
Lakes District Hospital and Health Centre	S,C,N	4.8 (1.3-17.6)[E]	0.0	3.2 (0.6-18.1)[E]
Langley Memorial Hospital	M,R,Y	15.3 (12.6-18.5)	13.7 (11.3-16.6)	16.5 (13.9-19.7)
Lillooet Hospital and Health Centre	S,C,N	12.7 (3.5-46.0)[E]	0.0	0.0
Lions Gate Hospital	L,R,Y	9.2 (7.4-11.4)	6.8 (5.3-8.7)	3.5 (2.5-4.9)
Mackenzie and District Hospital	S,C,N	0.0	0.0	0.0
Matsqui Sumas Abbotsford	S,C,N	2.2 (0.6-7.8)[E]	2.3 (0.6-8.5)[E]	6.4 (2.9-13.9)
McBride and District Hospital	S,C,N	0.0	0.0	0.0
Mills Memorial Hospital	S,R,N	0.6 (0.1-3.6)[E]	1.3 (0.4-4.7)	4.4 (2.1-9.0)
Mission Memorial Hospital	S,C,N	2.3 (0.6-8.5)	6.2 (3.0-12.8)	15.8 (10.1-24.7)
Mount Saint Joseph Hospital	M,C,Y	15.3 (11.9-19.8)	19.3 (15.3-24.3)	12.6 (9.5-16.7)
Nanaimo Regional General Hospital	L,R,N	7.3 (5.7-9.2)	9.6 (7.8-11.8)	6.4 (4.9-8.2)
Nicola Valley Health Centre	S,C,N	3.3 (0.6-18.6)[E]	0.0	12.1 (4.7-31.0)[E]
Northern Haida Gwaii Hospital[d]	S,C,N	0.0	0.0	11.9 (2.1-66.9)[E]
Peace Arch Hospital	M,R,N	9.0 (7.0-11.6)	6.8 (5.2-9.0)	9.5 (7.5-11.9)

Acute care facility	Hospital type[a]	2009/2010	2010/2011	2011/2012
Penticton Regional Hospital	M,R,N	4.1 (2.6-6.4)	5.6 (3.8-8.1)	4.3 (2.8-6.6)
Port Hardy Hospital	S,C,N	0.0	0.0	6.5 (1.8-23.5)[E]
Port McNeill and District Hospital	S,C,N	0.0	3.9 (0.7-22.1)[E]	0.0
Powell River General Hospital	S,C,N	0.0	1.0 (0.2-5.7)[E]	2.0 (0.6-7.3)[E]
Prince Rupert Regional Hospital	S,R,N	1.2 (0.2-6.6)	2.3 (0.6-8.4)	1.1 (0.2-6.2)
Princeton General Hospital	S,C,N	0.0	11.8 (3.2-42.9)[E]	6.4 (1.1-36.4)[E]
Queen Charlotte Islands General Hospital	S,C,N	0.0	0.0	0.0
Queen Victoria Hospital and Health Centre	S,C,N	10.0 (3.4-29.4)[E]	3.0 (0.5-16.9)[E]	0.0
Queens Park Hospital	M,C,N	14.1 (9.8-20.4)	9.9 (6.7-14.6)	9.4 (6.7-13.1)
Richmond Hospital	M,R,Y	6.5 (4.8-8.9)	7.5 (5.6-9.9)	6.8 (5.1-9.1)
Ridge Meadows Hospital	M,R,N	3.3 (2.1-5.3)	3.4 (2.2-5.3)	8.4 (6.4-11.0)
Royal Columbian Hospital	L,T,Y	7.9 (6.6-9.5)	12.6 (11.0-14.5)	12.9 (11.3-14.8)
Royal Inland Hospital	M,T,N	2.5 (1.6-3.9)	2.3 (1.5-3.6)	4.3 (3.1-6.0)
Royal Jubilee Hospital	L,T,Y	7.9 (6.5-9.7)	4.3 (3.3-5.7)	4.5 (3.5-5.9)
RW Large Hospital	S,C,N	0.0	0.0	0.0
Saanich Peninsula Hospital	M,C,N	11.2 (7.4-17.0)	1.3 (0.5-3.9)[E]	2.6 (1.2-5.7)
Shuswap Lake General Hospital	S,C,N	4.0 (1.8-8.7)	6.3 (3.4-11.5)	5.6 (2.9-10.6)
South Okanagan General Hospital	S,C,N	5.3 (1.8-15.5)[E]	6.1 (2.4-15.8)[E]	0.0
Squamish General Hospital	S,C,N	4.4 (1.2-16.0)[E]	0.0	7.5 (2.9-19.2)[E]
St. John Hospital	S,C,N	0.0	5.0 (1.7-14.6)[E]	0.0
St. Joseph's General Hospital	M,R,N	5.3 (3.2-8.7)	2.6 (1.3-5.0)	4.0 (2.3-6.8)
St. Mary's Hospital	S,C,N	3.4 (1.5-8.0)	5.4 (2.7-10.6)	4.9 (2.4-10.1)
St. Paul's Hospital	L,T,Y	9.9 (8.4-11.6)	10.2 (8.7-11.9)	10.1 (8.6-11.9)
Stuart Lake Hospital	S,C,N	0.0	0.0	0.0
Surrey Memorial Hospital	L,T,Y	14.1 (12.5-16.0)	13.1 (11.6-14.8)	14.4 (12.9-16.1)
Tofino General Hospital	S,C,N	0.0	0.0	0.0
UBC Hospital	S,R,Y	0.9 (0.2-5.2)[E]	2.9 (1.0-8.4)[E]	0.0
University Hospital of Northern BC	M,T,Y	3.5 (2.4-5.2)	4.8 (3.4-6.7)	4.3 (3.1-6.0)
Vancouver General Hospital	L,T,Y	12.1 (10.7-13.6)	11.4 (10.1-12.9)	12.0 (10.7-13.5)
Vernon Jubilee Hospital	M,R,N	15.5 (12.4-19.4)	6.6 (4.7-9.2)	3.3 (2.1-5.3)
Victoria General Hospital	L,T,Y	3.0 (2.2-4.2)	2.9 (2.1-4.1)	2.1 (1.4-3.1)
West Coast General Hospital	M,C,N	3.2 (1.5-7.0)	4.7 (2.5-9.0)	1.6 (0.5-4.7)[E]
Wrinch Memorial Hospital	S,R,N	0.0	3.9 (0.7-21.9)[E]	3.0 (0.5-17.2)[E]

Notes:

a. Letter in the facility type represents: S: hospital with 1-50 beds, M: hospital with 21-250 beds, L: hospital with >250 beds, C: Community hospital, R: Regional hospital, T: Tertiary/Referral hospital, N: Non-teaching hospital, Y: Teaching hospital.
b. The data were not available from Q3 of FY 2010/2011 to Q2 of FY 2011/2012 due to information system upgrades in progress.
c. The data were not available for Q1 and Q2 of FY 2011/2012 due to information system upgrades in progress.
d. Formerly known as Masset Hospital
E. Indicates an estimated rate that the difference between the upper limit and lower limit of 95% CI was greater than twice the rate, thus the rate may not be reliable.

Relapse of healthcare-associated CDI

Of the 2,756 HCA CDI cases reported in FY 2011/2012, 255 cases were relapses (12.9%). There was no significant difference in the proportion of relapses among the hospital types by hospital size, by hospital category, or by teaching status.

Compared with FY 2010/2011 and FY 2009/2010, the proportion of relapses decreased significantly in FY 2011/2012 at the provincial level and in the community hospitals (Table 7). The proportion was significantly lower in FY 2011/2012 than in FY 2010/2011 for IHA, and than in FY 2009/2010 for VCHA. Continued decreases in the proportion of relapse of HCA CDI in the past three fiscal years were also observed in hospitals with 50 or fewer beds, hospitals with more 250 beds, tertiary/referral hospitals, and teaching hospitals, although the changes in proportions were not statistically significant.

Table 7. Proportion of relapses among healthcare-associated CDI cases and 95% confidence interval by health authority and facility type

	2009/2010	2010/2011	2011/2012
Total	**16.0% (14.7%-17.3%)**	**15.6% (14.3%-17.0%)**	**12.9% (11.7%-14.2%)**
By health authority			
IHA	21.6% (18.2%-25.5%)	24.4% (20.3%-29.1%)	12.7% (9.3%-17.3%)
FHA	10.4% (8.7%-12.3%)	11.7% (10.0%-13.6%)	11.7% (10.1%-13.5%)
VCHA	19.6% (17.1%-22.5%)	17.2% (14.8%-20.0%)	13.7% (11.4%-16.3%)
VIHA	16.4% (12.7%-20.8%)	16.5% (12.6%-21.3%)	15.6% (11.7%-20.6%)
NHA	15.9% (7.9%-29.4%)	14.8% (8.0%-25.7%)	15.4% (8.6%-26.1%)
PHSA	20.0% (10.5%-34.8%)	17.4% (7.0%-37.1%)	20.5% (11.2%-34.5%)
By hospital size			
1-50 beds	24.7% (19.0%-31.5%)	23.7% (18.2%-30.2%)	17.8% (12.6%-24.6%)
51-250 beds	16.1% (14.0%-18.4%)	16.7% (14.5%-19.2%)	11.9% (9.9%-14.4%)
>250 beds	14.9% (13.2%-16.7%)	13.9% (12.3%-15.7%)	12.9 (11.5%-14.6%)
By hospital category			
Community hospital	20.2% (16.6%-24.4%)	20.3% (16.6%-24.5%)	12.1% (9.1%-15.9%)
Regional Hospital	15.8% (13.6%-18.3%)	15.9% (13.6%-18.5%)	14.0% (11.8%-16.5%)
Tertiary/Referral Hospital	14.9% (13.2%-16.8%)	14.2% (12.5%-16.1%)	12.5% (11.0%-14.2%)
By teaching status			
Non-teaching hospital	16.2% (13.6%-19.1%)	20.0% (17.1%-23.2%)	12.9% (10.5%-15.7%)
Teaching hospital	15.8% (14.4%-17.5%)	14.3% (12.8%-15.9%)	12.9% (11.6%-14.2%)

Complications within 30 days of diagnosis

CDI cases are evaluated at 30 days post-diagnosis or up to the point of patient discharge or transfer (whichever comes first) for CDI-associated complications, which include admission to the intensive care unit (ICU), toxic megacolon, and total or partial colectomy. Among all 3,613 CDI cases reported in FY 2011/2012, 145 were admitted to ICU (4.0%), 40 developed toxic megacolon (1.1%), and 40 required total or partial colectomy (1.1%). The percentage of each complication was not significantly different from previous years, although the ICU admission decreased continually in the past three fiscal years (Table 8). Please note that CDI may not have been the sole reason for ICU admission.

Table 8. Percentage of CDI-associated complications within 30 days of diagnosis and 95% confidence interval

Complications	2009/2010	2010/2011	2011/2012
ICU admission	5.1% (4.4%-5.9%)	4.3% (3.7%-5.0%)	4.0% (3.4%-4.7%)
Toxic megacolon	1.1% (0.8%-1.5%)	1.3% (1.0%-1.8%)	1.1% (0.8%-1.5%)
Partial colectomy	1.3% (1.0%-1.8%)	0.9% (0.6%-1.3%)	1.1% (0.8%-1.5%)

Discussion

Since the provincial CDI surveillance program was expanded to all 80 acute care facilities in BC in April 2009, the provincial annual rate of new CDI associated with the reporting facility has been relatively stable, although the rate varied by HA and fiscal quarter. However, the rate over time and by HA should be interpreted with caution due to the changes in the laboratory testing for detection of *Clostridium difficile* and modifications in the criteria for CDI classification.

Diagnosis of CDI remains one of the most difficult challenges for hospital microbiology, and the optimal diagnostic algorithm is yet to be adequately defined[2,3,4,5,6]. Because there is no assay for the actual determination of CDI, the role of the laboratory testing is to accurately detect the presence of virulent *C. difficile* by recovering a toxin-producing strain using culture or via detection of toxin(s) or toxin gene(s) in the stool sample[2,6]. Conventional laboratory testing methods used to confirm the diagnosis of CDI include toxigenic culture, cell culture cytotoxicity, enzyme immunoassay (EIA) for toxins A and/or B and glutamate dehydrogenase (GDH), or a combination of two tests (two-step test)[2,7,8]. More recently, polymerase chain reaction (PCR) has been developed for detection of *C. difficile* toxin genes, with as much as twice the sensitivity of the toxin EIA[9]. Each of these tests has its own drawbacks[2-8]. A review of all tests by the Society for Healthcare Epidemiology of America (SHEA) and the Infection Disease Society of America (IDSA) concluded in the recently updated clinical practice guideline that "polymerase chain reaction testing appears to be rapid, sensitive and specific, and may ultimately address testing concerns" for diagnosis of CDI[2].

Various laboratory testing methods[10] have been used to confirm CDI diagnosis among BC healthcare facilities (for details, see "Limitations" in the "About CDI surveillance program" section of this report). PCR testing or a two-step testing algorithm was introduced by most HAs into their facilities during the past three years to enhance detection of toxigenic *C. difficile*. While improved testing clearly has positive implications for correct and rapid diagnosis of CDI, it would also likely result in increased CDI rates, which might be incorrectly intepreted as a decline in the effectiveness of infection control programs. Studies have found that changing laboratory testing from an EIA toxin to PCR-based assay could initially appear to double the number of *C. difficile* cases identified[6] or rate of CDI in the hospital[11] due to the high sensitivity of PCR testing. One study reported an increase of CDI rate from 4.9 per 10,000 inpatient days using EIA toxin to 10.3 per 10,000 inpatient days by PCR testing during a three-month period[12]. We observed a slight increase (which was not statistically significantly) in the CDI rate in the following quarter among only one of the HAs after the PCR testing was implemented or included as part of two-step algorithm. Because the PCR testing was implemented at different times by HAs in their facilities, localized increases in CDI rates may have been observed. However, those increases may not have been reflected at the provincial level when the data were aggregated by fiscal quarter and facility. An

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evaluation would be important to assist in understanding the impact of this change in laboratory best practice on CDI rates.

The CDI cases in this report were classified as either HCA or CA based on the patient's current and previous healthcare exposure. The look-back period was modified from eight weeks to four weeks in FY 2010/2011, in alignment with changes made by Canadian Nosocomial Infection Surveillance Program (CNISP). This change may result in a decrease in the number of cases classified as HCA CDI. Based on the data from one HA, a 2% reduction in the number of new HCA cases was observed when applying the four-week look-back period retrospectively to the cases in FY 2009/2010 and FY 2010/2011 (these data were not shown in this report). Variations also exist in the application of CDI case classification and definition among the HAs (see "Limitations" in "About CDI surveillance program" section), adding more layers of complexity to the interpretation of CDI rates in BC.

CDI is an evolving disease, and its epidemiology has changed dramatically[2,11,13,]. There has been a marked increase in CDI incidence and mortality across the United States (US), Canada, and Europe during the last decade, especially among those≥65 years of age. The incr easing incidence of CDI in the populations previously at low-risk, such as children and peri-partum women, and outbreaks of more severe disease than previously seen, have been observed[2,11]. The current rate of hospital-onset CDI in US hospitals is estimated to average 6-8 cases per 10,000 inpatient days[11], similar to our provincial rate (note: the CDI rates in this report also include the new cases of CDI that were community-onset and had an encounter with the reporting facility in the last four weeks). The surveillance results from BC acute care facilities were also consistent with a recent report from 28 community hospitals in the southern United States that found that *C. difficile* has overtaken Methicillin-resistant *Staphylococcus aureus* (MRSA) as the most common cause of healthcare-associated infection[14]. The rate of new CDI associated with the reporting facility was higher than that of new MRSA cases (including infection and colonization) in all HAs in BC.

CDI often occurs among patients in healthcare settings, which are considered ideal environments for *C. difficile* to persist, infect, and spread among vulnerable patients[15]. About 94% of CDI cases were reported to be related to various precedent and current healthcare exposures[9]. Advanced age, exposure to antimicrobial and chemotherapy agents, an extended stay in an acute care facility, or residence in a chronic care facility have been identified as the common risk factors for CDI[3].

Our surveillance results show that the rates of CDI were higher in large, tertiary/referral, or teaching hospitals. Because the large hospitals usually serve as regional or tertiary hospitals with specialty care to the patients, and may also provide teaching or training to the medical and nurse students, and other professionals, these hospitals are more likely to admit patients with greater severity of illness, which may in turn increase the risk of acquiring multidrug-resistant organisms. The higher proportion of patients with more severe underlying medical conditions, higher antibiotic use, and increased frequency of invasive procedures have been proposed as the main reasons for this difference[16].

On the other hand, data from England, where mandatory reporting of CDI and infection control programs were implemented in 2007, showed that the national rate of HCA CDI declined 47% during a

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3-year period (FY 2008/2009–FY 2010/2011)[17]. One investigation reported a 20% reduction in the incidence of hospital-onset CDI among 71 US hospitals participating in a CDI prevention program during an approximately 21-month period[9], suggesting that many cases of HCA CDI can be prevented.

It is increasingly being recognized that some CDI cases are acquired outside of healthcare facilities[13]. Data from the US, Canada, and Europe suggest that approximately 20%–27% of all CDI cases are community-associated[11]. Among the CDI cases reported to the National Healthcare Safety Network (NHSN) of the US in 2010, 52% were already present on hospital admission, although they were largely healthcare-related[9]. Recent research showed that CDI incidence is increasing in outpatient clinics and among persons living in the community, including healthy persons without recent healthcare encounters[2,13] or any known risk factors for CDI[18,19]. BC's surveillance data have demonstrated an increase in the proportion of CA CDI, from 15% in FY 2009/2010 to 21% in FY 2011/2012 (excluding unknown association. These data were not presented in this report).

Relapse of CDI, including recurrence from the same strain and re-infection with different strains, is still a concern for CDI prevention and treatment. Reported recurrence rates vary from 5% to 50% and typically are around 20%[20]. BC acute care facilities reported a lower and decreasing rate of relapse, from 16% in FY 2009/2010 to 13% in FY 2011/2012. This may be attributed to the improvement in CDI diagnosis and treatment, and infection control activities among the facilities, but needs further monitoring and assessment.

The surveillance results from the past three years appear consistent with progress in CDI prevention and control. The rate of CDI has decreased continually over the past three years in some acute care facilities. There was no significant increase in the CDI rate in the HAs after the laboratory testing for detection of *C. difficile* was changed to more sensitive PCR testing, which could result in more specimens being identified positive with *C. difficile* by the laboratory.

This report provides an overview of CDI incidence in BC acute care facilities in the past three fiscal years. Reliable and consistent surveillance data enable the effective monitoring of rate changes and trend analysis. A survey of Canadian hospitals demonstrated that the targeted surveillance and control activities had impacts on the rate of CDI and other infections caused by antibiotic-resistant organisms among those hospitals[21]. This provincial surveillance program and public reporting of the results also ensures transparency and accountability in prevention and control of healthcare-associated infections in BC hospitals.

The rates of CDI in this report were not adjusted by known risk factors, and therefore comparisons between health authorities and between healthcare facilities should not be made. As discussed above, laboratory testing methods can significantly affect identification of *C. difficile*, and thus the rate of CDI among the facilities. Furthermore, the population served by each healthcare facility differed in the risks for acquiring CDI. Facility type and size, and the complexity of the services offered, can also affect the rate of CDI of the facility. Other limitations of the data are described below in the "About CDI surveillance program" section. Due to unique challenges and different at-risk populations, each HA is in the best position to respond to the incidence of CDI in its region and its affiliated healthcare facilities.

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About the CDI surveillance program

Purpose of CDI surveillance

The provincial *Clostridium difficile* infection (CDI) surveillance program is a collaboration between PICNet and all the health authorities (HA) in BC, and involves the voluntary participation of all 80 acute care facilities across the province. The main purpose of this CDI surveillance program is to collect data on CDI incidence to monitor the rates and trends of healthcare-associated CDI in BC acute care facilities, and to provide the baseline information for CDI intervention programs in BC.

Population under surveillance

The population under CDI surveillance includes inpatients admitted to BC acute care facilities for acute care. This includes patients admitted to the emergency department awaiting placement (e.g. patients admitted to a service who are waiting for a bed), patients in alternative level of care beds, and patients in labour and delivery beds.

Outpatient visits to acute care facilities, patients in extended care and psychiatric beds housed in the acute care facilities, and short-term emergency room admissions are excluded. Patients under one year of age are also excluded from this surveillance.

Data collection and reporting

The definitions of CDI cases and core data elements for provincial surveillance were developed by PICNet's Surveillance Steering Committee (SSC) based on the surveillance protocol for CDI within healthcare institutes by the Canadian Nosocomial Infection Surveillance program (CNISP). Each HA incorporated the core data elements into their CDI surveillance form and database to standardize data collection. Data on individual cases of CDI are collected daily by infection control practitioners (ICP) and managed at the HA level. After the end of each fiscal quarter, HAs aggregate their CDI cases by facility and CDI classification, and submit the data to PICNet, along with facility-specific denominators. PICNet then consolidates the aggregated data for provincial analysis and reporting. At the end of each fiscal year (FY), the HAs provide updates on their quarterly data submission. The data are analyzed quarterly and annually for public reporting. Data updating after the data submission due dates may not be reflected in each quarterly report, but will be presented in the next one.

Limitations

Although the standard surveillance protocol was developed by SSC, variations exist in the methodologies of CDI identification and inclusion criteria for data collection among the acute care facilities and health authorities in BC.

Laboratory detection of *C. difficile*: Various laboratory testing methods have been used by BC laboratories to confirm CDI diagnosis, including enzyme immunoassay (EIA), cell culture cytotoxicity, toxigenic culture, and polymerase chain reaction (PCR). The sensitivity and specificity of these methods varies greatly, from <50% to >99%[6,10]. In particular, the recently developed PCR testing, which has sensitivity as much as twice the toxin EIA for detection of *C. difficile*, was introduced into BC laboratories by the HAs to enhance CDI diagnosis. The start date of implementing PCR testing or including PCR testing as part of a two-step testing algorithm varied by HA and facility: VCHA

implemented PCR testing on June 27, 2008; PHC on August 2, 2010; FHA on October 26, 2011 in four facilities and on March 19, 2012 for the remaining facilities; and PHSA in November 2011. IHA introduced PCR testing to one facility and the two-step algorithm to the remaining facilities in September 2009. VIHA introduced the two-step algorithm on April 1, 2011. Shifting to PCR testing or including PCR as part to two-step algorithm testing from conventional toxin EIA may result in more specimens being identified positive with *C. difficile* by the laboratory, and thus more CDI cases diagnosed.

Case definition and classification: Review of medical charts is required to confirm CDI cases and apply classification, which is based on the patient's healthcare encounter history. The quality of medical chart documentation varies by facility and by healthcare provider, and the ability to determine healthcare encounter history depends on the patient information system used in each hospital or HA. The "look-back" period was eight weeks in FY 2009/2010 by all HAs with the exception of PHC, which used a four-week period. In FY 2010/2011, the look-back period was modified to four weeks for all HAs, with the exception of IHA, which continues to use an eight-week period. FHA applied the four-week look-back period retrospectively to their cases in FY 2009/2010. The modification from eight weeks to four may result in a decrease in the number of cases classified as healthcare-associated infections.

There are variations among HAs in how the CDI cases are classified since the provincial CDI surveillance protocol has been developed. IHA assigns CDI cases of both new case and relapse that were associated with another facility within IHA to the appropriate facilities, and the cases that were associated with the facilities outside of IHA as "healthcare-associated with another facility". FHA includes CDI cases among psychiatric patients in acute care beds, while the other HAs exclude these. PHC classifies CDI cases as either "PHC-associated" or "Not-PHC-associated" for both new cases and relapses. "PHC-associated" cases include CDI that were associated with the reporting facility or another facility of PHC. The cases other than these are classified as "Not-PHC-associated", which were grouped into the category of "Community-associated/Unknown" in this report. Other facilities within VCHA include the cases of CDI that are associated with the facilities outside of VCHA into "healthcare-associated with another facility". PHSA classifies all CDI cases other than those associated with the reporting facility as "Community-associated" or "Unknown", including the cases which may be associated with another healthcare facility. In addition, the community-associated (termed as not-healthcare-associated in FY 2010/2011) CDI cases are no longer further classified as new cases or relapses in FY 2011/2012. In this report, all community-associated CDI were combined with unknown of association as "Community-associated/Unknown".

Denominator data: Acute care inpatient days are used as the denominator to calculate the CDI rates at the provincial, HA, and healthcare facility level. These data are collected by each HA from their information systems. There was some variation in what was included in the inpatient days due to the inability of some HAs to separate the patients under surveillance from other patients in their denominator dataset. In addition, FHA and VCHA (except PHC) include patients less than one year of age in their inpatient days, and FHA also includes psychiatric inpatient days in their denominator.

Variations may also exist in the clinical practice and healthcare services provided by each healthcare facility, as well as population served, which will affect the rate of CDI in the facility.

Glossary

Acute care facility

Acute care facilities are care facilities in which patients are treated for brief but severe episodes of illness, for the sequelae of an accident or other trauma, or during recovery from surgery. In this report, acute care facility refers to acute care hospitals in BC.

Clostridium *difficile* Infection (CDI)

CDI, under PICNet CDI surveillance, is defined as:

- Acute onset of diarrhea (three or more loose stools within a 24-hour period) without another etiology (loose stool is defined as that which takes the shape of the container that holds it).

  AND one or more of the following:

- Laboratory confirmation (positive toxin, or culture with evidence of toxin production, or detection of toxin genes)

  OR

- Diagnosis of typical pseudo-membranes on sigmoidoscopy or colonoscopy or histological/pathological diagnosis of CDI

  OR

- Diagnosis of toxic megacolon.

Note: It is assumed that any stool sent to the laboratory for *C. difficile* testing is from a patient that has had a least three episodes of loose stools in a 24-hour period. It is accepted that the surveillance protocol may overestimate the number of cases as some patients may have had only one or two loose stools prior to a specimen being collected.

Community-associated (CA) CDI

A CDI case (as defined above) with symptom onset in the community or three calendar days or less after admission to a healthcare facility, provided that symptom onset was more than four weeks after the last discharge from a healthcare facility.

Complications

Complications under PICNet's CDI surveillance include ICU admission, toxic megacolon, and total or partial colectomy. Other complications associated with CDI are excluded from the surveillance. Relapses are included in the CDI surveillance, but are reported separately.

Confidence Interval (CI)

A confidence interval gives an estimated range of values which is likely to include an unknown population parameter to indicate the reliability of an estimate. The 95% CI of the rate and proportion in this report are calculated using Wilson score intervals.[22]

[22] Agresti A and Coull BA (1998). The American Statistician 52:119-126

Fiscal and Calendar Quarter

Fiscal quarter (FQ) is a specified period within a budget or financial year. There are four FQs in a fiscal year. Start and end dates of each FQ vary from year to year. Calendar Quarter is a period of three consecutive months starting on the first day of January, April, July or October. Below is the start and end date of each quarter for the fiscal year from 2009/2010 to 2011/2012:

Start and end date of quarters for this report

Fiscal year	Quarter code	Fiscal quarter		Calendar quarter	
		Start date	End date	Start date	End date
2009/2010	**Q1**	01-Apr-2009	25-Jun-2009	01-Apr-2009	30-Jun-2009
	Q2	26-Jun-2009	17-Sep-2009	01-Jul-2009	30-Sep-2009
	Q3	18-Sep-2009	10-Dec-2009	01-Oct-2009	31-Dec-2009
	Q4	11-Dec-2009	31-Mar-2010	01-Jan-2010	31-Mar-2010
2010/2011	**Q1**	01-Apr-2010	24-Jun-2010	01-Apr-2010	30-Jun-2010
	Q2	25-Jun-2010	16-Sep-2010	01-Jul-2010	30-Sep-2010
	Q3	17-Sep-2010	09-Dec-2010	01-Oct-2010	31-Dec-2010
	Q4	10-Dec-2010	31-Mar-2011	01-Jan-2011	31-Mar-2011
2011/2012	**Q1**	01-Apr-2011	23-Jun-2011	01-Apr-2011	30-Jun-2011
	Q2	24-Jun-2011	15-Sep-2011	01-Jul-2011	30-Sep-2011
	Q3	16-Sep-2011	08-Dec-2011	01-Oct-2011	31-Dec-2011
	Q4	09-Dec-2011	31-Mar-2012	01-Jan-2012	31-Mar-2012

Fiscal Year (FY)

A term used to differentiate a budget or financial year from the calendar year. The Fiscal Year in BC runs from April 1 of the prior year through March 31 of the next year. For example, FY 2010/2011 is from April 1, 2010 to March 31, 2011.

Healthcare-associated (HCA) with reporting facility

- A CDI case occurring more than three calendar days after admission to an acute care facility, where the CDI was reported, AND the case has not had CDI in the past eight weeks,

  OR

- A *CDI* case with symptom onset in the community or three calendar days or less after admission to an acute care facility where the CDI was reported, provided that symptom onset was less than four weeks after the last discharge from that acute care facility.

Healthcare-associated (HCA) with another healthcare facility

A case with symptom onset three calendar days or less after admission to an acute care facility; AND the case had an encounter with another healthcare facility, either as an inpatient (including Acute Care and Long Term Care), or an outpatient (including emergency care and clinics), within the last four weeks; AND the case has not had CDI in the past eight weeks.

Health authority (HA)

A health authority manages and delivers health care services. There are five regional Health Authorities in BC which govern, plan, and coordinate services regionally within sixteen health service delivery areas, and a Provincial Health Services Authority which coordinates and/or provides provincial programs and specialized services.

The six HAs in BC are:

- Interior Health Authority (IHA)
- Fraser Health Authority (FHA)
- Northern Health Authority (NHA)
- Vancouver Coastal Health Authority (VCHA)
- Vancouver Island Health Authority (VIHA)
- Provincial Health Services Authority (PHSA)

Hospital category

The hospital category in this report is based on the healthcare services that the hospital provides and the population to be served, including:

- Tertiary/referral hospital refers to a major hospital that provides a wide range of acute in-patient and out-patient specialist services together with the necessary support systems for the patients across the health authority, and in some cases, across the province. Patients will often be referred from smaller hospitals for major operations, consultations with specialist and sub-specialists and when sophisticated intensive care facilities are required.
- Regional hospital typically provides health care services to the patients in its region, with large numbers of beds for intensive care and long-term care, providing specialist and sub-specialist services, such as surgery, plastic surgery, childbirth, bioassay laboratories, and so forth.
- Community hospital offers an appropriate range of integrated health and social care designed to meet the needs of local people. Medical care is predominantly provided by general practitioners working with consultant medical colleagues.

Inpatient day

An accounting unit used by healthcare facilities and healthcare planners. Each day represents a unit of time during which the services of the institution or facility are used by a patient; thus 50 patients in a hospital for 1 day would represent 50 inpatient days. The report uses the inpatient days as denominator to calculate the rate of CDI.

New cases of CDI

- A CDI case without previous history of CDI

  OR

- *A* CDI *case that has not had an episode of CDI in the previous eight weeks*

Nosocomial infection

Infection associated with admission to the reporting healthcare facility.

Polymerase chain reaction (PCR)

A laboratory testing method used to detect *C. difficile* toxin genes from the samples.

Rate per 10,000 inpatient days

$$\text{Rate per 10,000 inpatient days} = \frac{\text{Number of CDI cases in a defined period}}{\text{Total inpatient days during the same period}} \times 10{,}000$$

A defined period can be a quarter or several quarters, or a year (annual rate).

Relapse of CDI

A CDI case with recurrence of diarrhea within two to eight weeks of a previous CDI episode (as determined by the date of a previous lab test, chart note or diagnosis by endoscopy or pathological specimen) provided that CDI symptoms from the earlier episode resolved with or without treatment. A relapse is to be attributed to the association of the original infection (i.e., healthcare-associated or community-associated).

Note: a case with recurrence of diarrhea less than two weeks from the previous episode is considered to be a continuation of the previous episode, and not a relapse.

Statistical significance

In statistics, a result is called statistically significant if it is unlikely to have occurred by chance. In this report, the difference is considered as statistically significant if the 95% confidence intervals of the two rates, proportions, percentages, or means do not overlap (i.e., the lower limit of one confidence interval is greater than the upper limit of the other confidence interval).

Teaching hospital

A teaching hospital combines assistance to patients with the training/education of medical students, nursing students, and other healthcare professionals, and is often linked to a medical school, nursing school or university. A teaching hospital can be a community hospital, or regional hospital, or tertiary/referral hospital.

Trend test

A trend test is an aspect of statistical analysis that tries to determine whether there is a statistically significant trend upwards or downwards over a period of time or among specific ordinal categories. This report uses Mantel-Haenszel Chi-square test for linear trend at a statistically significant level of $p < 0.05$.

Unknown association

A CDI case where there is insufficient information on healthcare admission and/or discharge to classify whether it is healthcare-associated or not.

Surveillance Steering Committee

The Provincial Infection Control Network of British Columbia (PICNet) is a provincially supported professional collaborative that provides guidance and advice on healthcare-associated infection prevention and control in British Columbia. Under the aegis and accountability framework of the Provincial Health Services Authority, PICNet connects health care professionals from across the province to develop and create guidelines and tools, with a focus on surveillance, education, and evidence-based practice.

PICNet's **Surveillance Steering Committee** provides guidance to PICNet's surveillance programs and assists the PICNet Management Office in implementation within the participating Health Authorities.

- Dr. Ghada Al-Rawahi, BC Association of Medical Microbiologists
- Anne Marie Locas, Interior Health Authority
- Jun Chen Collet, Provincial Health Services Authority
- Tara Donovan, Fraser Health Authority
- Leslie Forrester, Vancouver Coastal Health Authority
- Bruce Gamage (Co-Chair), Provincial Infection Control Network of BC
- Dr. Guanghong Han(Co-chair), Provincial Infection Control Network of BC
- Deanna Hembroff, Northern Health Authority
- Dr. Bonnie Henry, Provincial Health Services Authority
- Anthony Leamon, Vancouver Island Health Authority
- Dr. Elisa Lloyd-Smith, Providence Health Care

PICNet
PROVINCIAL INFECTION CONTROL NETWORK OF BRITISH COLUMBIA
A program of the Provincial Health Services Authority

Provincial Health Services Authority
Province-wide solutions. Better health.