Antibiotic Resistant Bacteria

The Bugs Strike Back

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Conflict of Interest Declaration

Presenter: David Gregory Gamble MDCM

Antibiotic Resistant Bacteria

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I have no financial or personal relationship related to this presentation to disclose.

Learning Objectives

At the end of this presentation, participants will:

1. Be familiar with some of the antibiotic resistant bacteria of concern in Thunder Bay and area
2. Know more about the emerging antibiotic resistant bacteria that will be of concern here in the near future
3. Identify strategies to avoid and manage infections with these bacteria

Session Evaluation and Outcome Assessment

These short forms serve important functions!

- For MYSELF, responses will help me improve the session to better meet future participant learning needs, and teaching outcomes
- For YOU, responses allow reflection on what you've learned and how to apply it to enact change as you return to your professional duties
- For the CEPD office:
  - To plan future programs
  - For quality assurance and improvement
  - To demonstrate compliance with national accreditation requirements

Please take 3-5 minutes to fill the evaluation form out. Thank you!

The Rogues Gallery

- Clostridium difficile
- Methicillin Resistant Staphylococcus aureus
- Vancomycin Resistant Enterococcus
- ESBL Gram Negative Rods
- CP Gram Negative Rods

Questions to Ponder

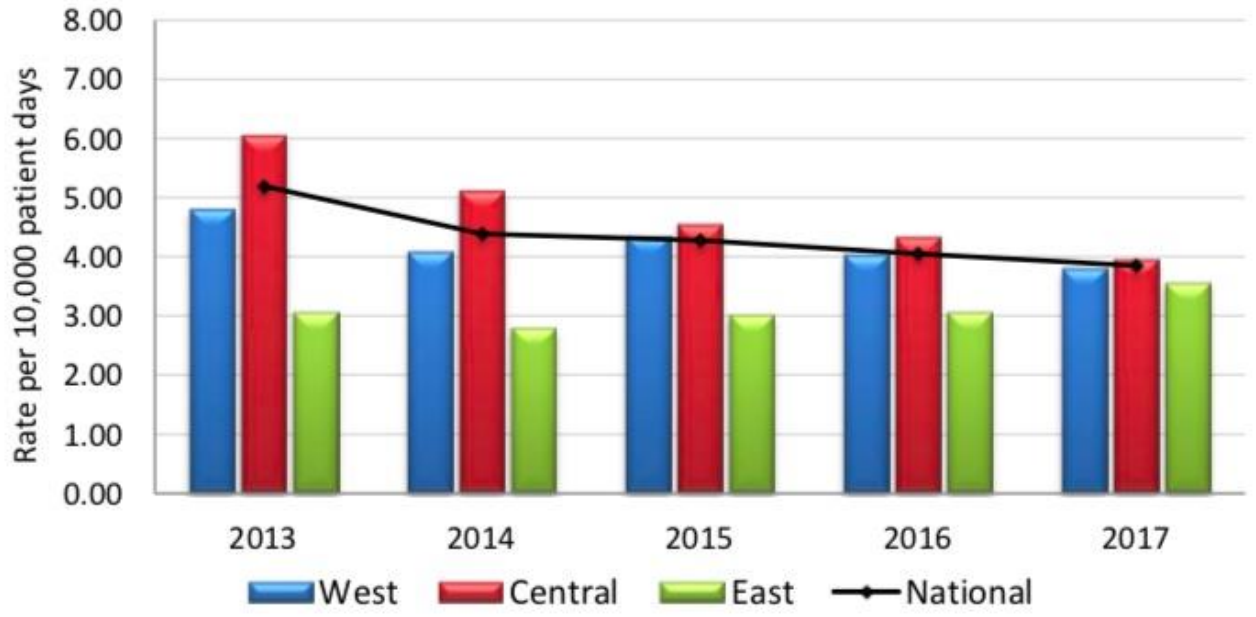
- Drug resistance isn't a concern for C.difficile
- Most MRSA infections are hospital acquired
- Clindamycin is more reliable than TMP/SMX for treatment of MRSA infection in Thunder Bay
- VRE bacteremia is treatable and is associated with low mortality
- CPE infections have occurred in Thunder Bay already

Canadian Nosocomial Infection Surveillance Program (CNISP)

- Collaboration between AMMI and PHAC
- Established in 1994 to provide rates and trends of healthcare associated infection, thus enabling benchmarking
- 54 sentinel hospitals from 10 provinces
- CNISP Summary Report of HAI, AMR and AMU Surveillance Data from Jan 1, 2013 to December 31, 2017
  - PHAC Website

CNISP HA-C. Difficile Rates 2013 -2017

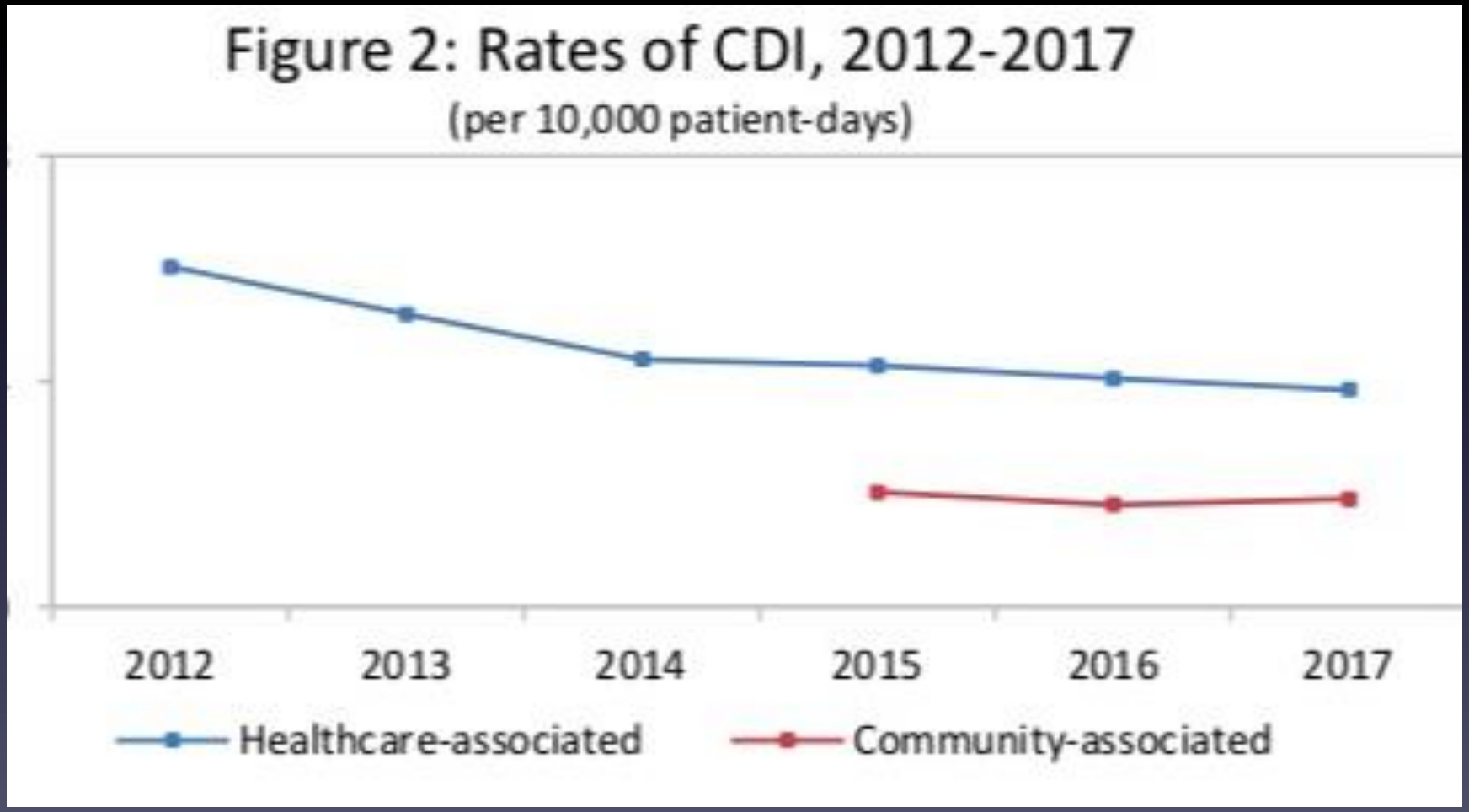
Graph 1.1 HA-CDI from CNISP reporting hospitals only[‡], national and regional incidence rates per 10,000 patient days



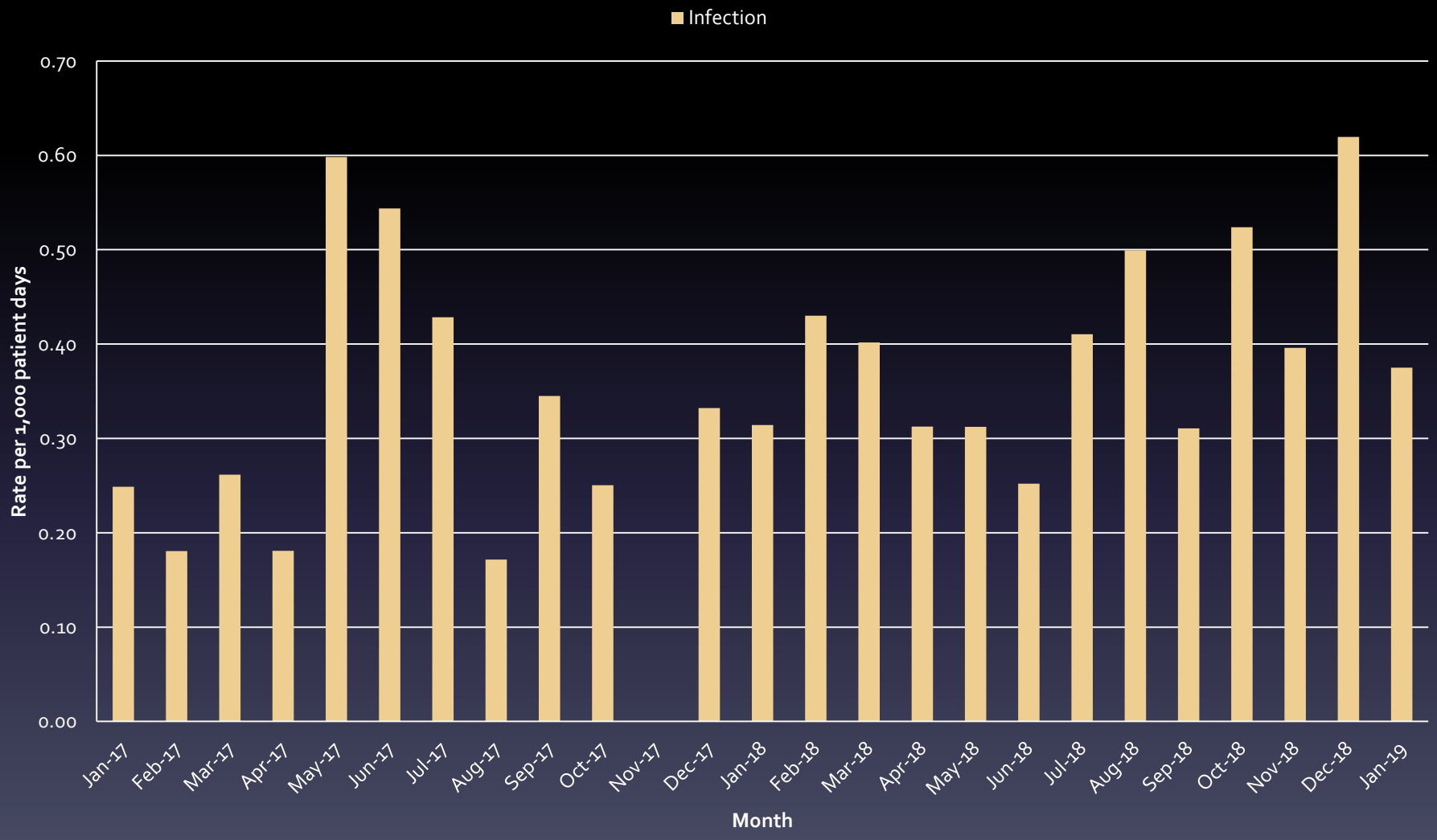
[‡] *HA-CDI from CNISP reporting hospitals only: includes all cases identified and have been acquired only within a CNISP hospital as per the case definition in Appendix C.*

HA versus CA CDI (CNISP)

2012 - 2017



Monthly TBRHSC Acquired C. difficile Infection Rates
January 2017 to January 2019



HA-C. difficile Antibiotic Resistance (CNISP)

2013 - 2017

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*

C. difficile Strains (CNISP) 2013 - 2017

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.*

Canadian CDI Treatment Guidelines 2018

Table 2: Treatment recommendations for *Clostridium difficile* infection (CDI) in adults

Clinical definition	Parameters	Treatment recommendations
Initial episode		
Mild to moderate	• WBC* $\leq 15.0 \times 10^9$/L, and • Serum creatinine $\leq 1.5 \times$ baseline	First line: • Vancomycin 125 mg po QID for 10–14 days Alternative Choices: • Fidaxomicin 200 mg po BID for 10 days • Metronidazole 500 mg po TID for 10–14 days can be used in patients with mild diarrhea when the costs of vancomycin or fidaxomicin may be prohibitive for their use.
Severe, uncomplicated†	• WBC* $> 15.0 \times 10^9$/L or • Serum creatinine $> 1.5 \times$ baseline • Hypoalbuminemia	• Vancomycin 125 mg po QID for 10–14 days, or • Fidaxomicin 200 mg po BID for 10 days
Severe, complicated	• Hypotension or shock, ileus, megacolon	• Vancomycin 125–500 mg po QID for 10–14 days or via nasogastric tube in conjunction with intravenous metronidazole 500 mg Q 8 H • Alternative: Fidaxomicin 200 mg po BID for 10 days with intravenous metronidazole 500 mg Q 8 H if severe allergy to oral vancomycin • If paralytic ileus is present, consider administering vancomycin rectally 500 mg in approximately 100 mL normal saline per rectum every 6 hours as a retention enema, in conjunction with intravenous metronidazole 500 mg Q 8 H and oral vancomycin
Recurrent episodes		
First recurrence, mild to moderate	• WBC* $\leq 15.0 \times 10^9$/L, and • Serum creatinine ≤ 1.5 baseline	First line: • Vancomycin 125 mg po QID for 14 days Alternative choices: • Fidaxomicin 200 mg po BID for 10 days • Metronidazole 500 mg po TID for 10–14 days if vancomycin or fidaxomicin cannot be used.
First recurrence, severe, uncomplicated†	• WBC* $> 15.0 \times 10^9$/L, or • Serum creatinine $> 1.5 \times$ baseline • Hypoalbuminemia	• Vancomycin 125 mg po QID for 14 days, or • Fidaxomicin 200 mg po BID for 10 days
Second or subsequent recurrences		• Vancomycin as a prolonged tapered and/or pulsed regimen (e.g., 125 mg po QID for 14 days; 125 mg po TID for 7 days; 125 mg po BID for 7 days; 125 mg po once daily for 7 days, and then every 2 or 3 days for 2–8 weeks) • Consider fecal microbiota transplantation for recurrence following a vancomycin taper

* WBC refers to peripheral white blood cell count
† Criteria to define severe CDI based on expert opinion

Loo,V et al JAMMI-C, 3.2,2018, 71-92

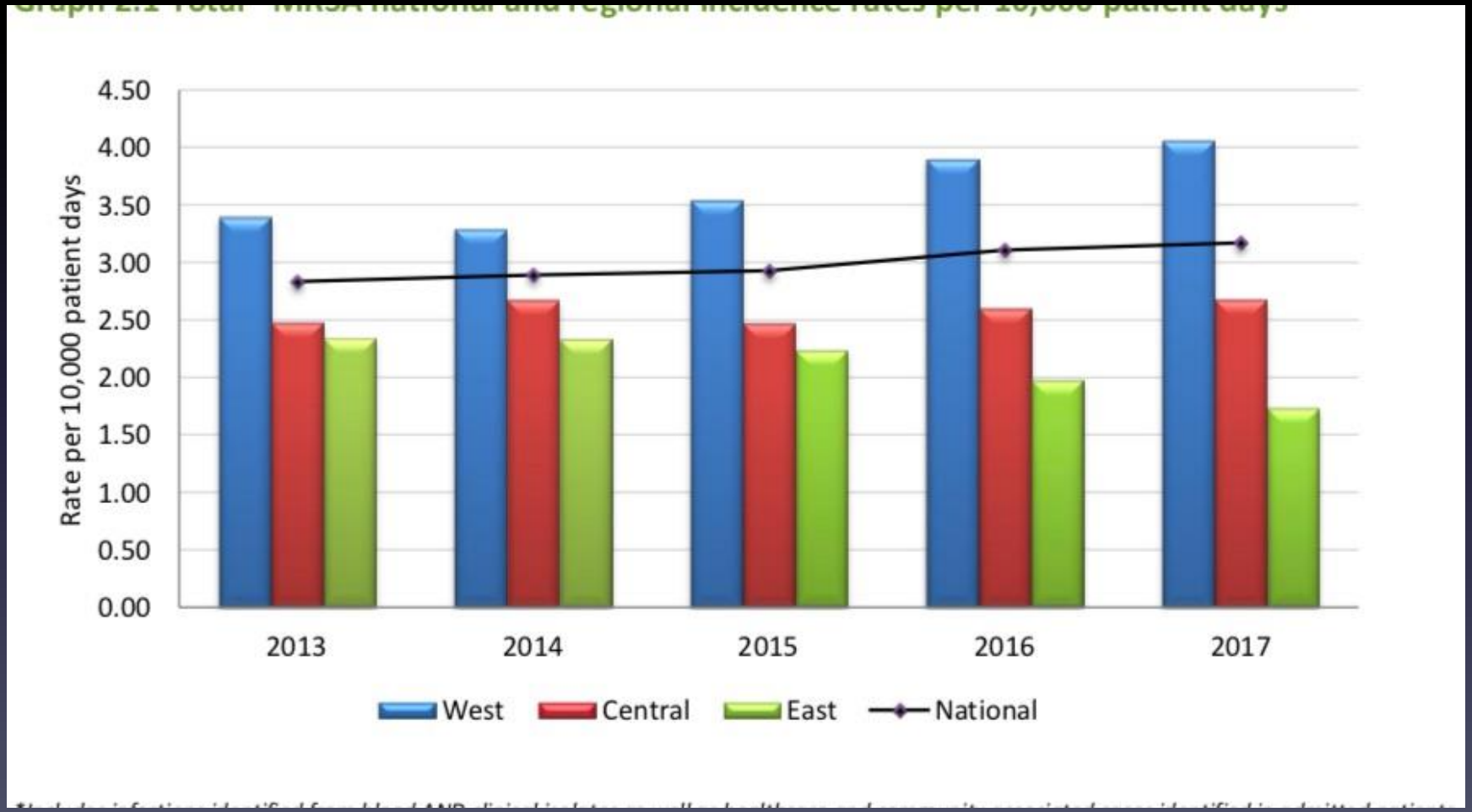
Fidaxomicin

- Bactericidal agent, minimally absorbed from the gut
- Gram positive activity
- Inhibits RNA polymerase
- Lower relapse rates at 30 days

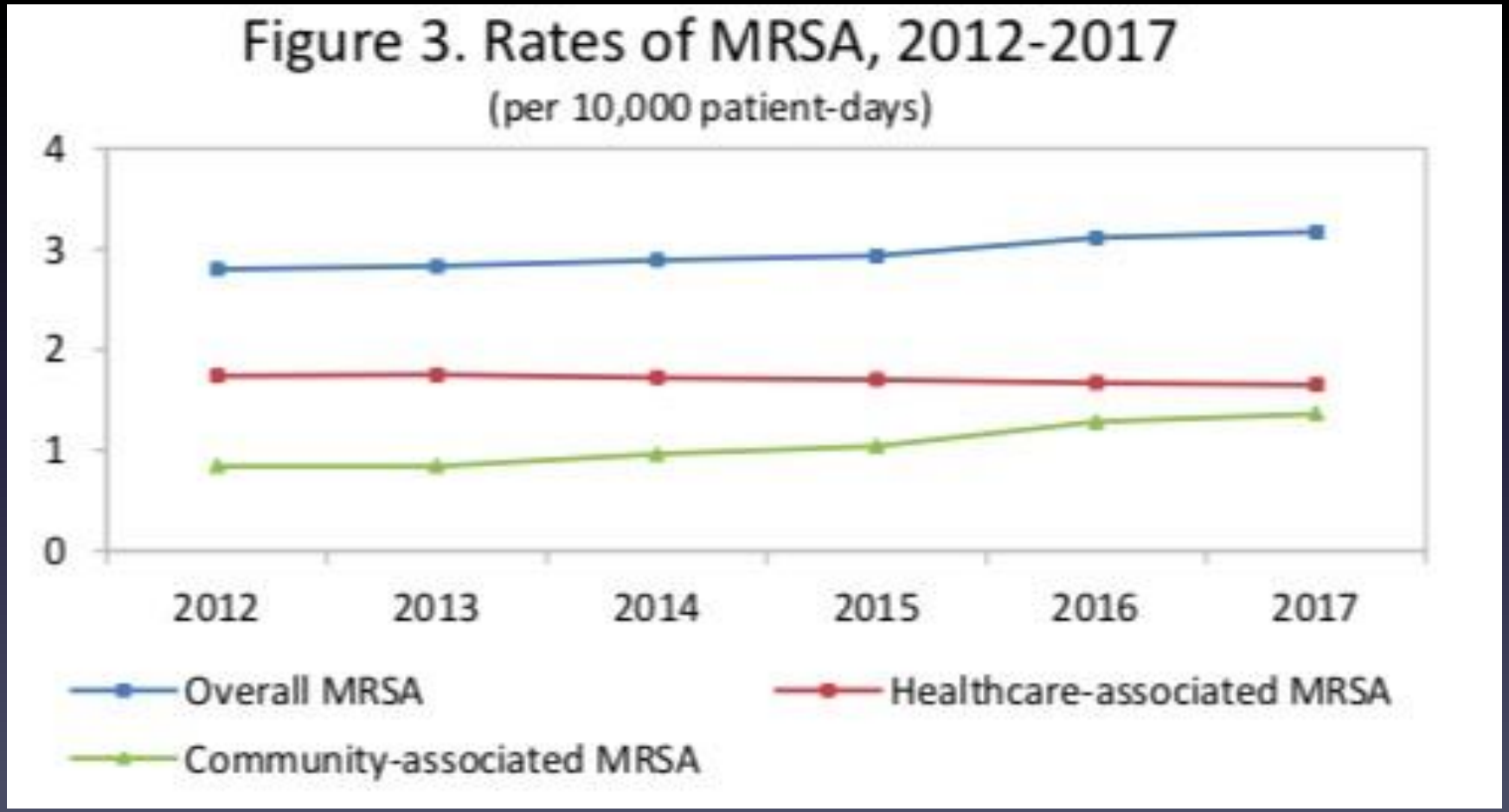
C. difficile Management Strategies

- Early detection and treatment
- Avoiding colonization
  - Antibiotic stewardship
  - Isolation protocols
  - Environmental cleaning
  - Modern physical plant

Total MRSA Infection Rates (CNISP) 2013-2017



MRSA Infection Rate by Origin (CNISP)
2012-2017



Circulating MRSA Strains (CNISP) 2013-2017

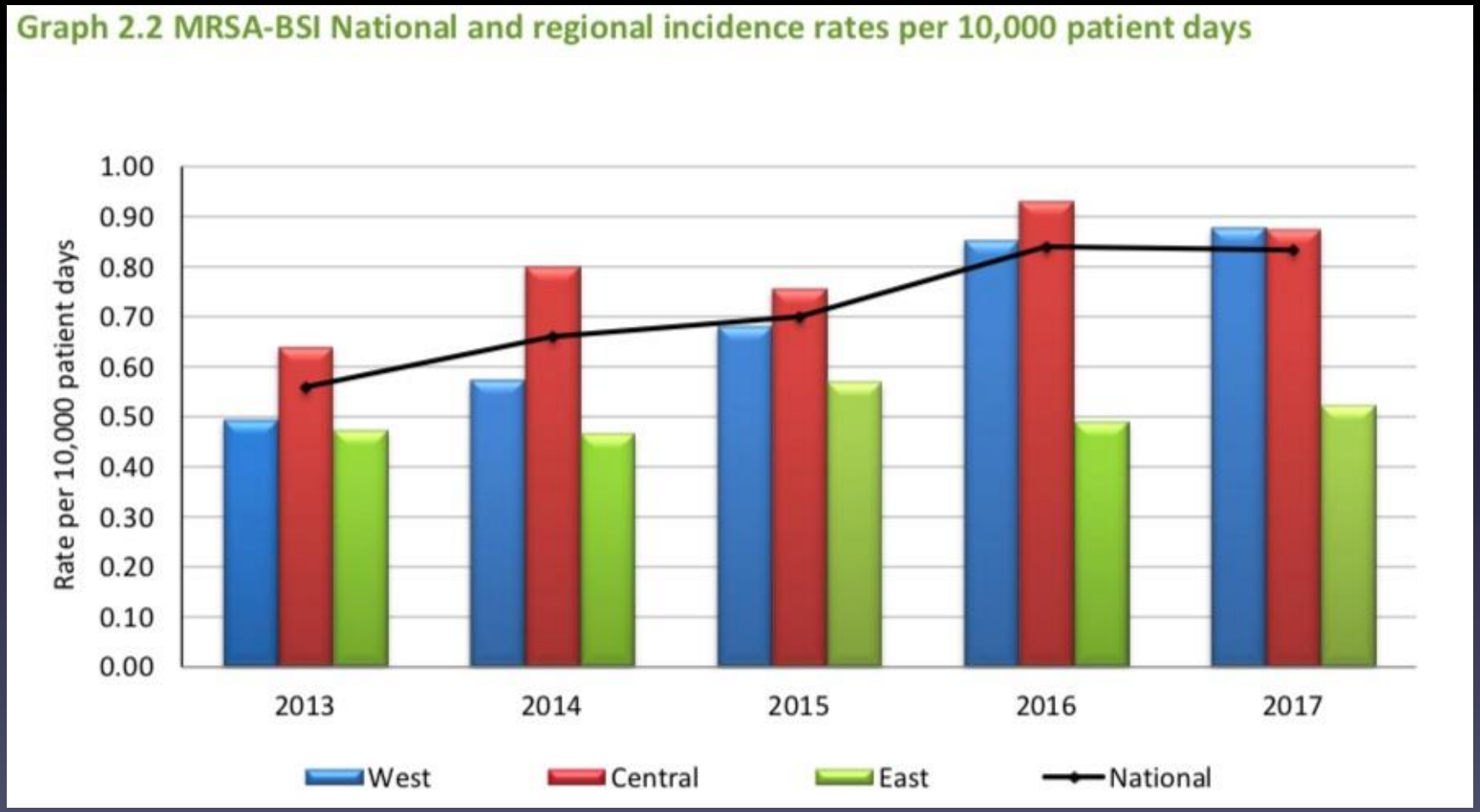
Table 2.6 Number and proportion of select MRSA strain types identified

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.

MRSA BSI Rates (CNISP)
2013-2017



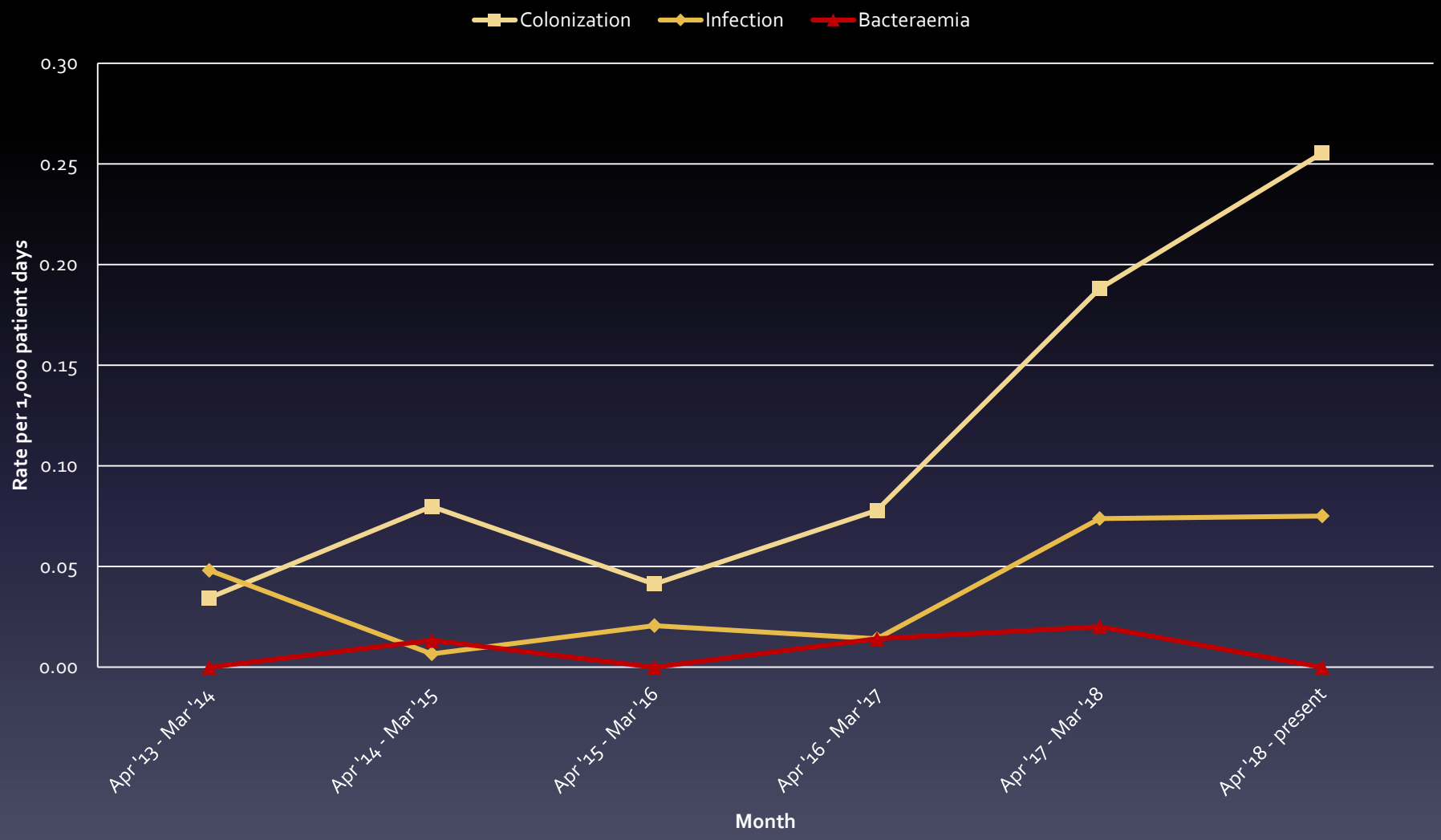
All-cause MRSA BSI Mortality (CNISP) 2013-2017

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.*

Annual TBRHSC Acquired MRSA Rates 2013-Present



MRSA Antibiogram (CNISP) 2013-2017

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)[T]	85 (81.7)[T]	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)*

[T] 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

TBRHSC Gram Positive Antibiogram 2017-2018

Antimicrobial Susceptibilities* for Selected Important Pathogens Against Various Antimicrobial Agents
Thunder Bay Regional Health Sciences Centre
21 March 2017 – 20 March 2018

Gram-Positive Organisms (% Susceptible) ≥80% Susceptible 70-79% Susceptible ≤69% Susceptible	*E. faecalis*	*E. faecium*	*S. aureus*	*S. epidermidis*	*S. pneumonia*
Penicillin	-	-	-	-	94 (M) 100 (NM)
Ampicillin	99	5	-	-	-
Oxacillin (Cloxacillin)	-	-	59	37	-
Ceftriaxone	-	-	-	-	100 (M) 100 (NM)
Ciprofloxacin	78	3	72	59	-
Levofloxacin	79	3	73	59	100
Norfloxacin (UTI only)	52	2	73	-	-
Clindamycin	-	-	77	47	96
Erythromycin	-	-	50	28	93
Meropenem	-	-	-	-	100
Nitrofurantoin (UTI only)	99	26	99	99	-
Tetracycline	24	35	96	82	96
TMP/SMX	-	-	100	69	99
Vancomycin	100	70	100	100	100

*% Susceptible for each organism/antimicrobial combination was generated by including species with testing data for ≥ 30 isolates (excludes surveillance isolates).
(-) Drug not tested/not enough isolates or drug not indicated.
(M) Meningitis breakpoint
(NM) Non-Meningitis breakpoint

Management of MRSA Infection

- Antibiotic Treatment
  - Vancomycin
  - Second line agents
    - Daptomycin, linezolid
    - TMP/SMX, doxycycline, clindamycin
- Source Control
- Avoiding colonization

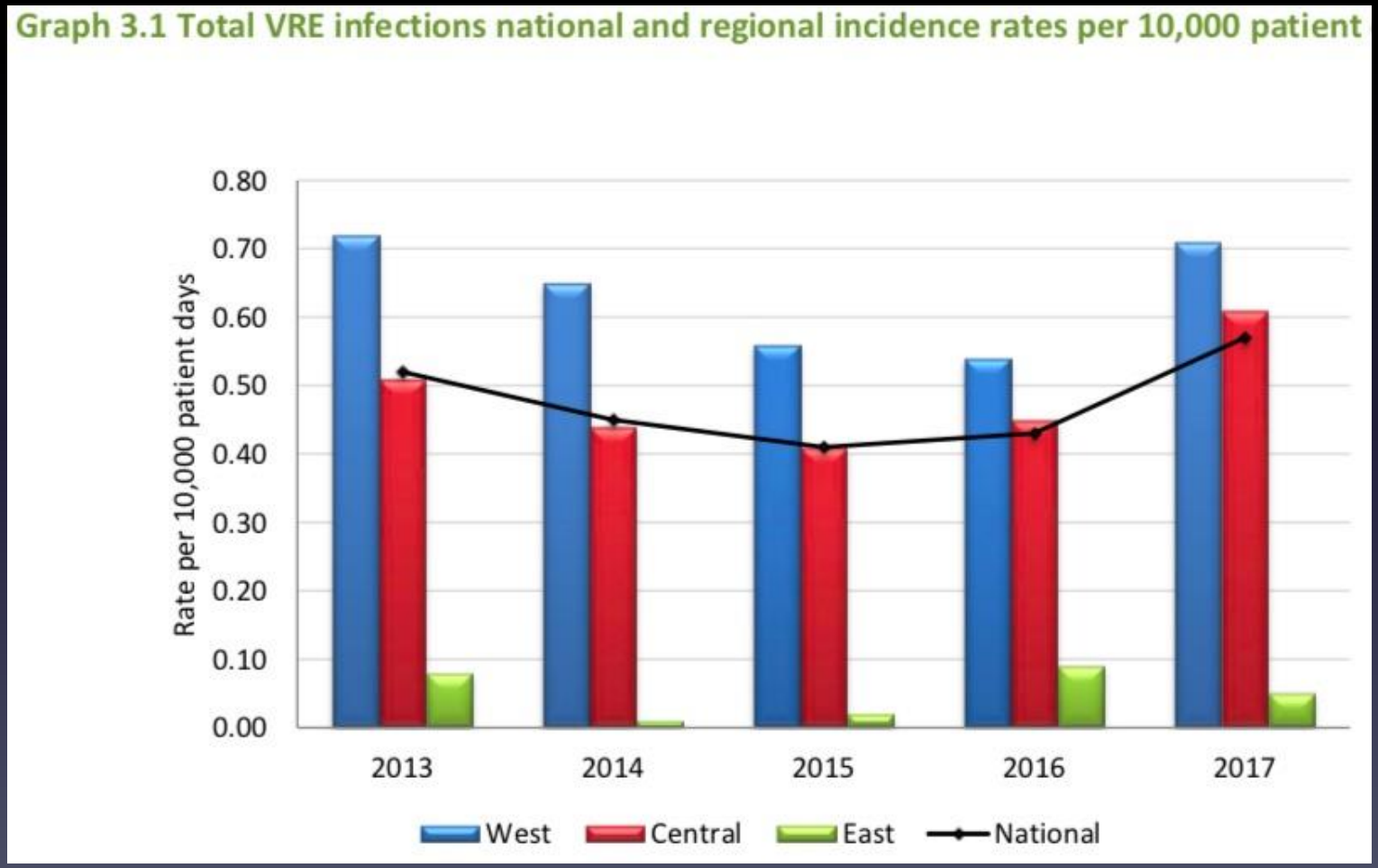
Daptomycin

- Lipopeptide
- Depolarizes bacterial membranes
- Bactericidal, activity includes MRSA, VRE
- Inactivated in lungs, only IV
- Issues
  - Myositis
  - Eosinophilic pneumonitis

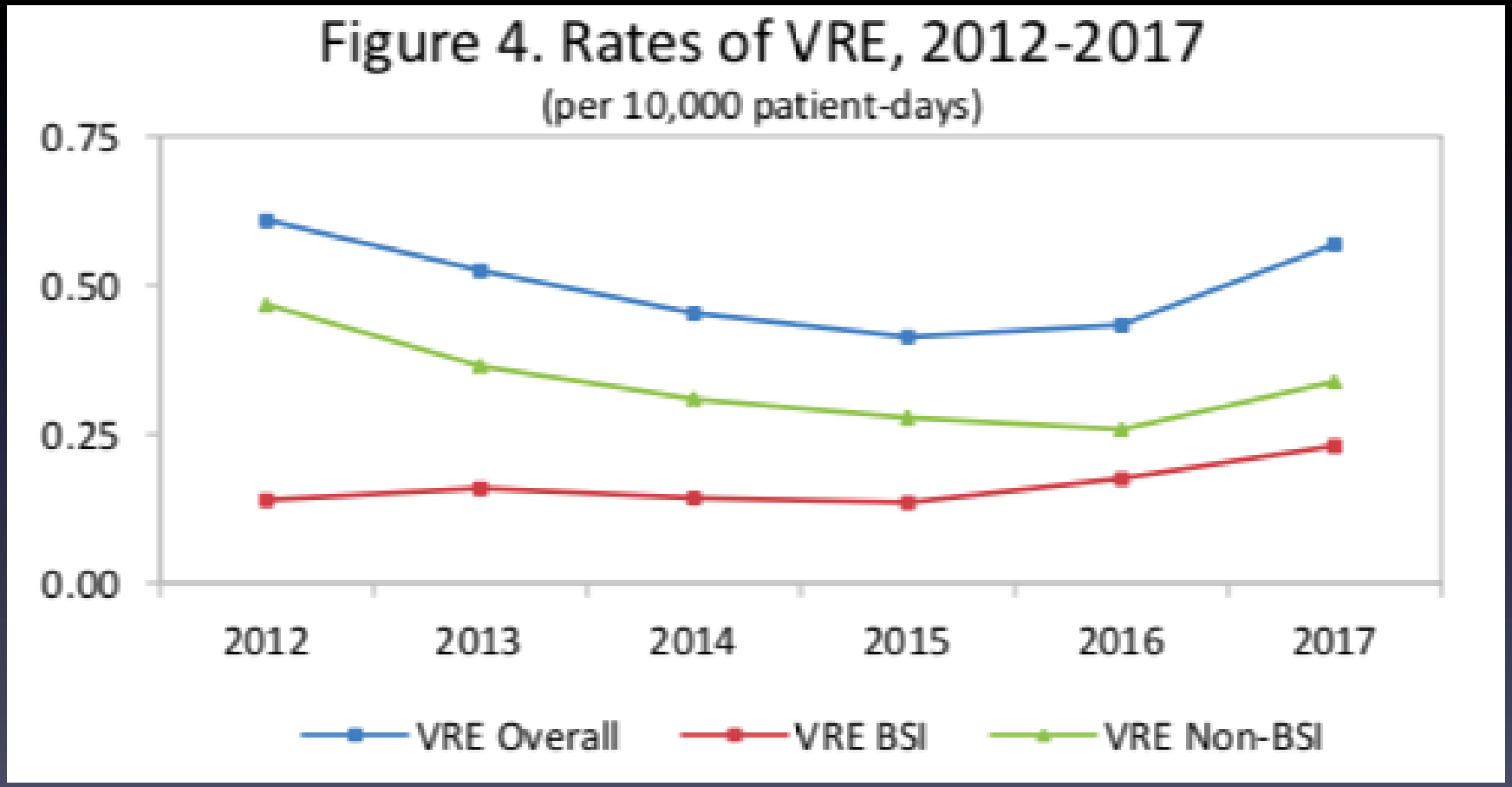
Linezolid

- Oxazolidinone (synthetic antibiotic)
  - Blocks ribosomal synthesis of protein
  - Bacteriostatic
  - Excellent tissue penetration IV, po
  - Activity includes MRSA, VRE
  - Issues
    - Serotonergic syndrome/hypertension
    - Pancytopenia
    - Optic neuritis

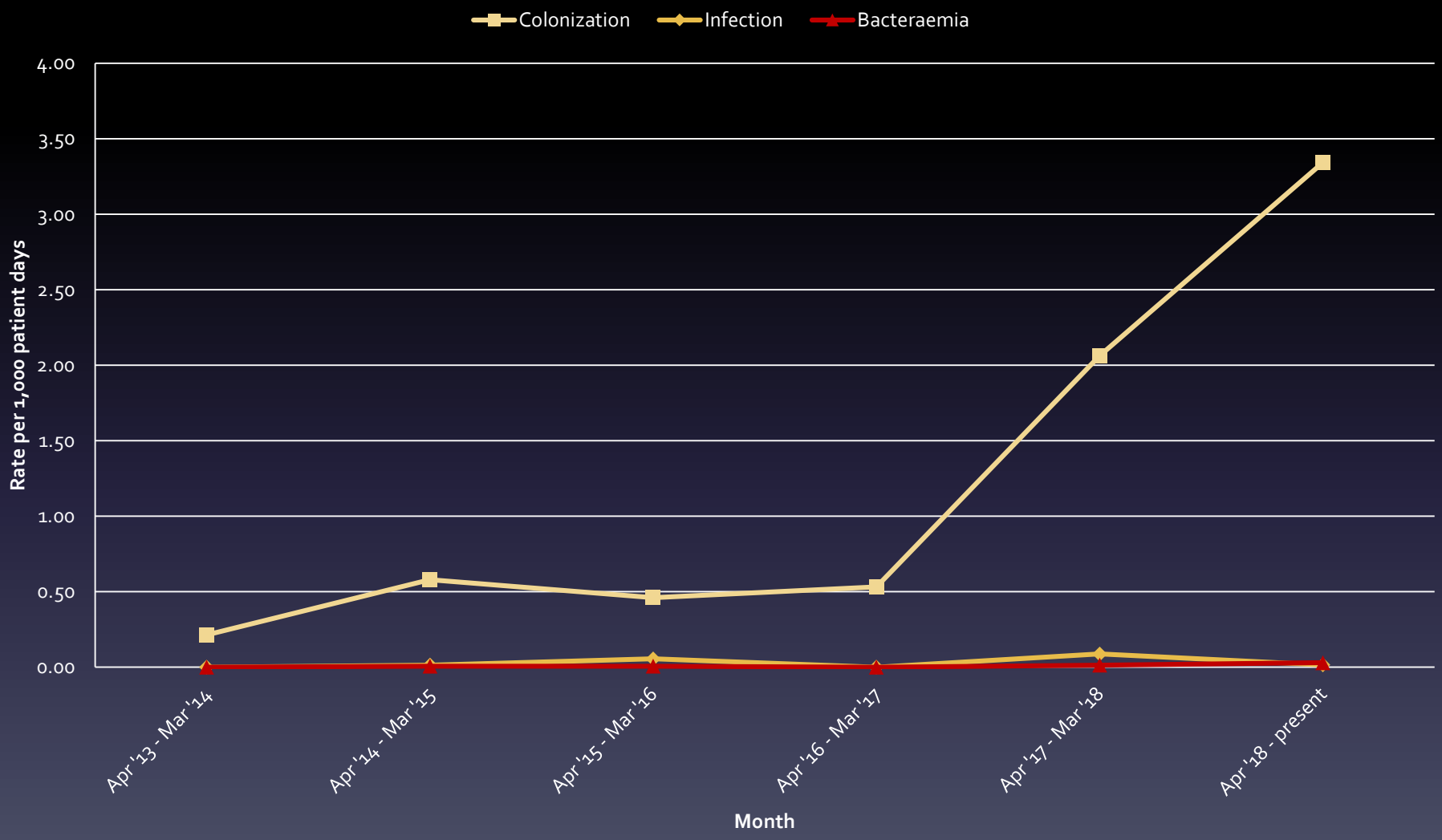
VRE Infection Rates (CNISP) 2013 -2017



VRE Infection Rates By Type (CNISP) 2012 -2017



Annual TBRHSC Acquired VRE Rates
FY2013 - Present



VRE Strains (CNISP) 2013 -2017

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.*

VRE Sensitivities (CNISP) 2013-2017

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*

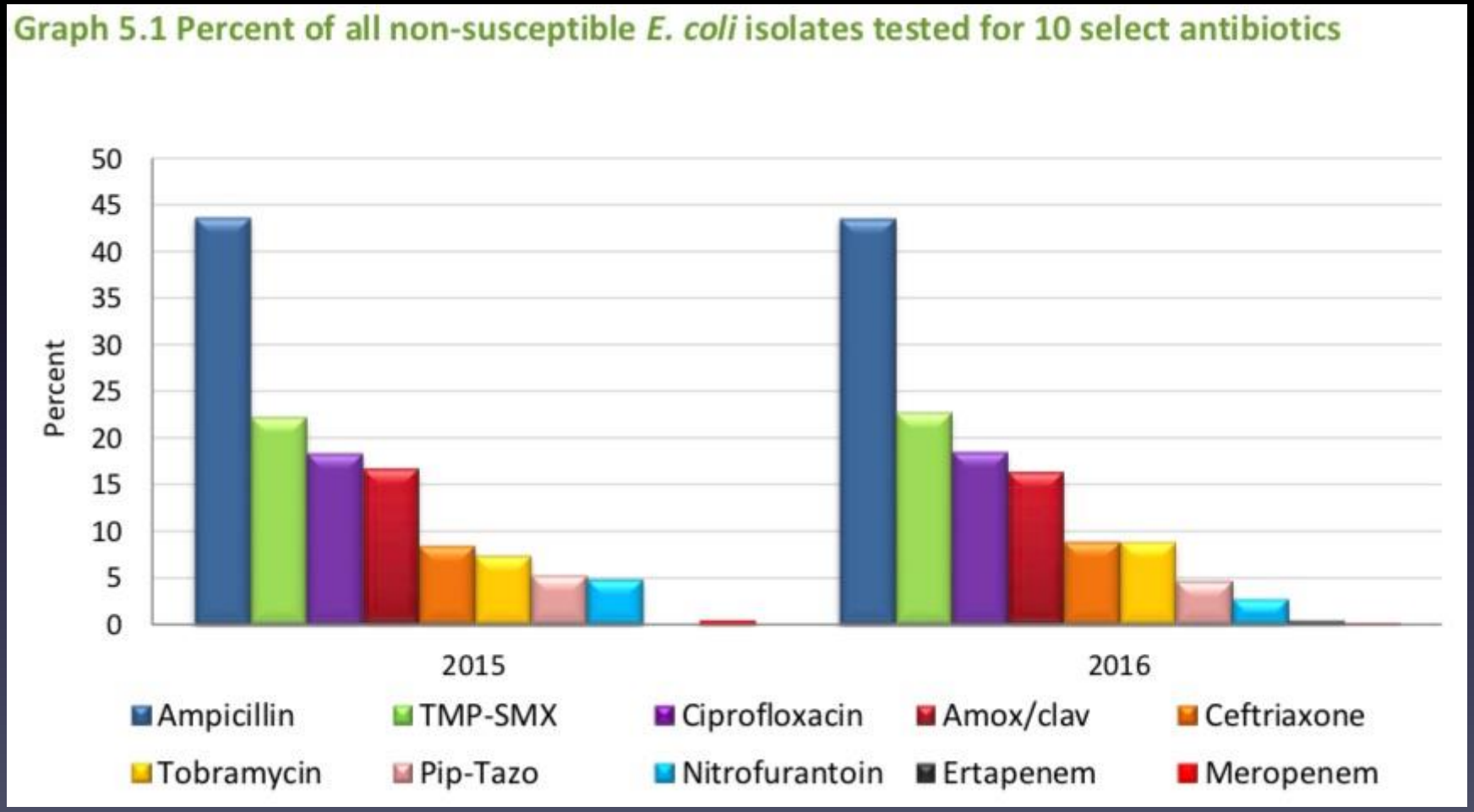
VRE Treatment

- Antibiotics
  - linezolid
  - daptomycin
  - ?tigecycline
- Source control
- Prevention of colonization

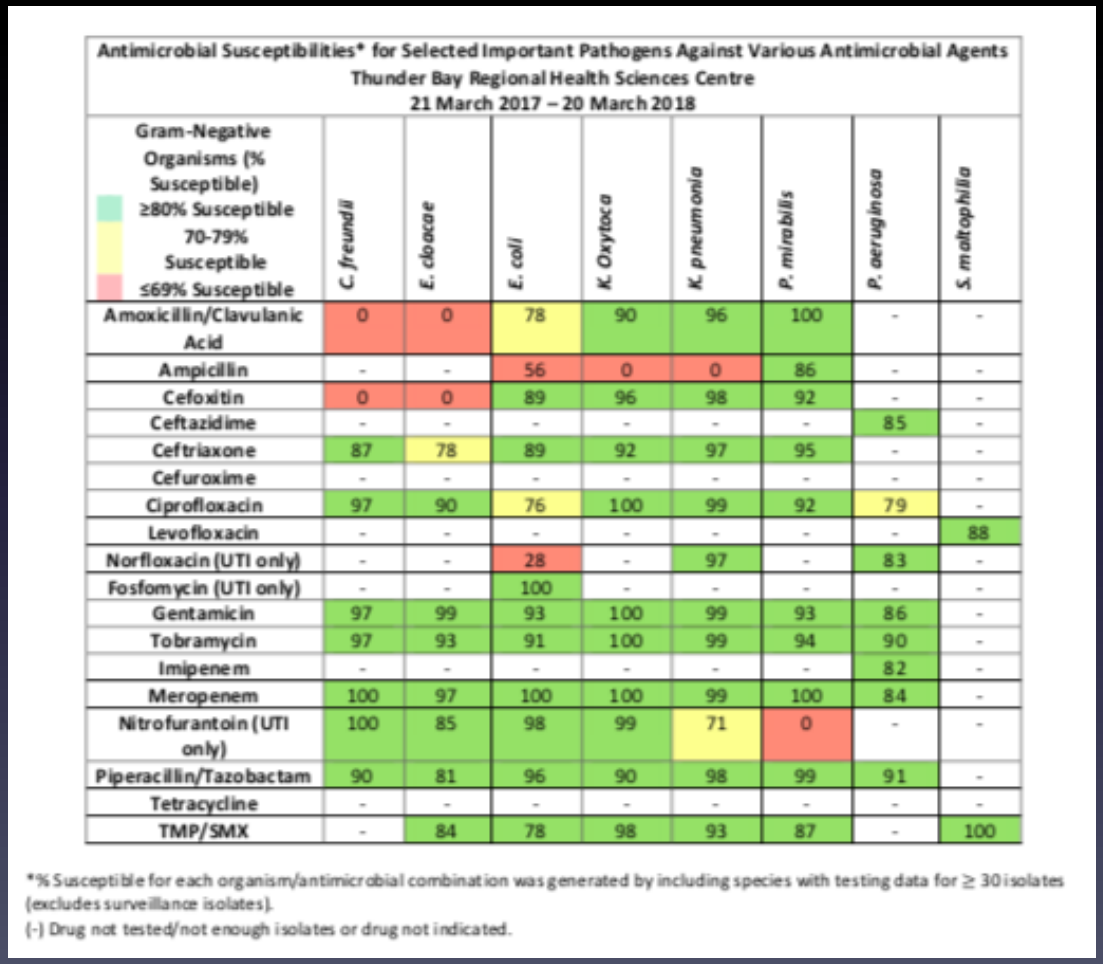
Gram Negative AROs

- Extended spectrum B-Lactamase producing Enterobacteriacae (ESBL)
- Carbapenemase producing Enterobacteriacae (CPE)
- Carbapenemase producing Acinetobacter (CPA)
- Multidrug resistant Pseudomonas aeruginosa (MDR-PA)

Antibiotic Resistance E.Coli (CNISP) 2015 - 2016



TBRHSC Gram Negative Antibiogram 2017-2018

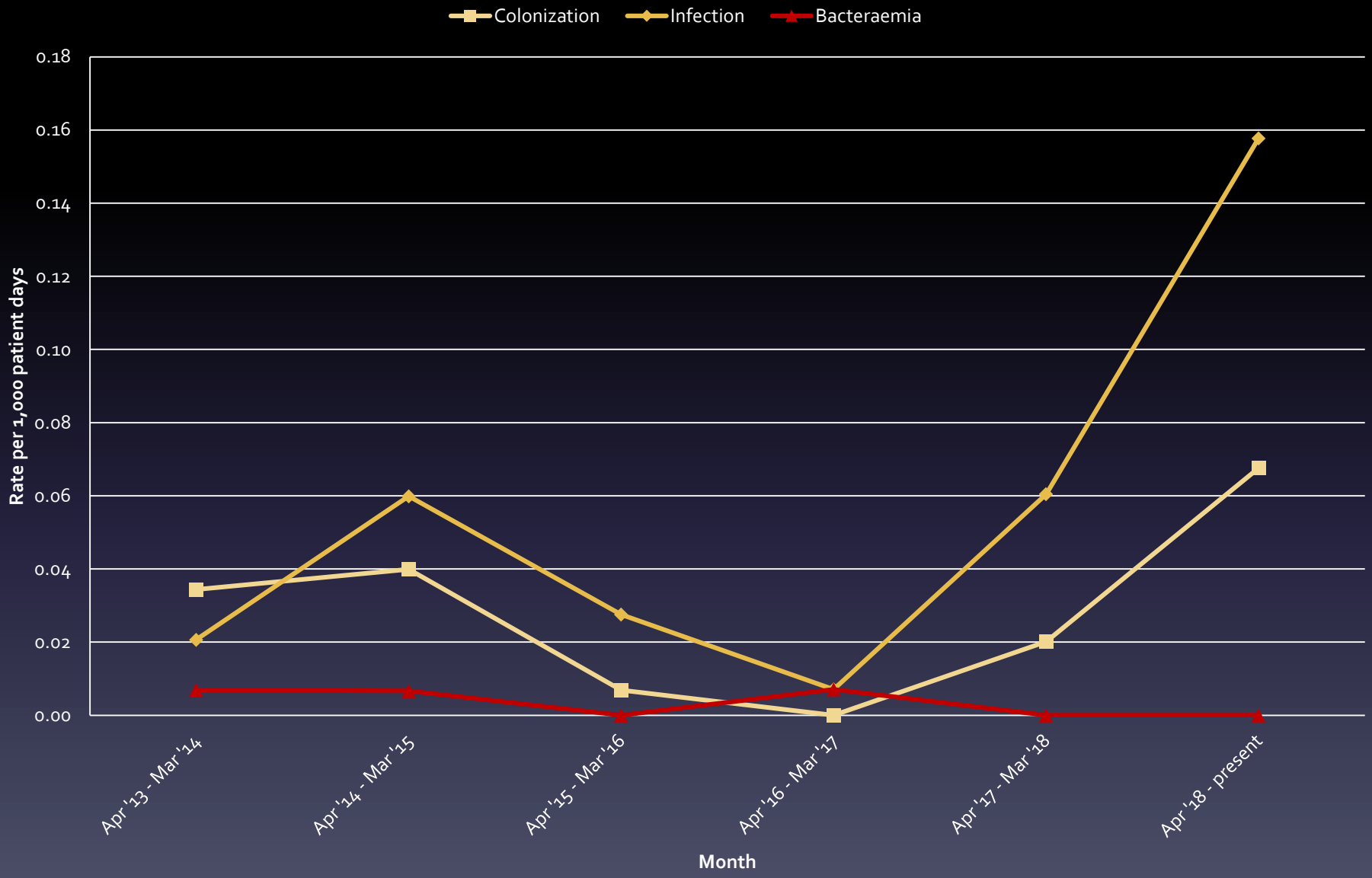


Antimicrobial Susceptibilities* for Selected Important Pathogens Against Various Antimicrobial Agents
Thunder Bay Regional Health Sciences Centre
21 March 2017 – 20 March 2018

Gram-Negative Organisms (% Susceptible) ≥80% Susceptible 70-79% Susceptible ≤69% Susceptible	*C. freundii*	*E. cloacae*	*E. coli*	*K. Oxytoca*	*K. pneumonia*	*P. mirabilis*	*P. aeruginosa*	*S. maltophilia*
Amoxicillin/Clavulanic Acid	0	0	78	90	96	100	-	-
Ampicillin	-	-	56	0	0	86	-	-
Cefoxitin	0	0	89	96	98	92	-	-
Ceftazidime	-	-	-	-	-	-	85	-
Ceftriaxone	87	78	89	92	97	95	-	-
Cefuroxime	-	-	-	-	-	-	-	-
Ciprofloxacin	97	90	76	100	99	92	79	-
Levofloxacin	-	-	-	-	-	-	-	88
Norfloxacin (UTI only)	-	-	28	-	97	-	83	-
Fosfomycin (UTI only)	-	-	100	-	-	-	-	-
Gentamicin	97	99	93	100	99	93	86	-
Tobramycin	97	93	91	100	99	94	90	-
Imipenem	-	-	-	-	-	-	82	-
Meropenem	100	97	100	100	99	100	84	-
Nitrofurantoin (UTI only)	100	85	98	99	71	0	-	-
Piperacillin/Tazobactam	90	81	96	90	98	99	91	-
Tetracycline	-	-	-	-	-	-	-	-
TMP/SMX	-	84	78	98	93	87	-	100

*% Susceptible for each organism/antimicrobial combination was generated by including species with testing data for ≥ 30 isolates (excludes surveillance isolates).
(-) Drug not tested/not enough isolates or drug not indicated.

TBRHSC Acquired ESBL Gram Negative Rates
FY2013 - Present



CPE/CPA Isolates (CNISP) 2013-2017

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.*

CPE Carbapenemases (CNISP)

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

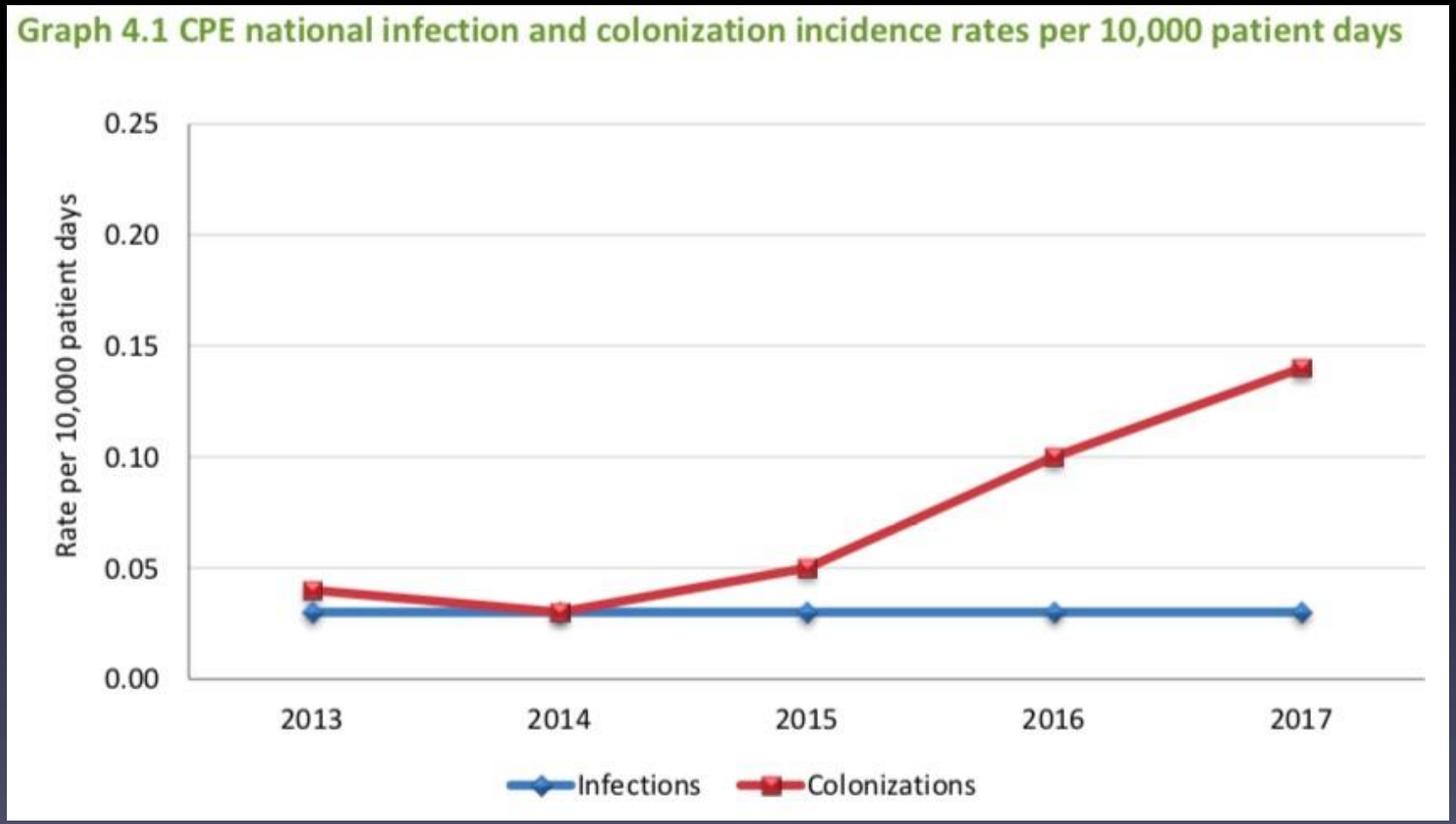
Carbapenemase	2013	2014	2015	2016	2017
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
KPC	30 (52.6)	31 (49.2)	26 (34.7)	62 (52.1)	69 (45.7)
NDM	14 (24.6)	17 (27.0)	29 (38.7)	38 (31.9)	55 (36.4)
OXA-48	6 (10.5)	7 (11.1)	14 (18.7)	17 (14.3)	23 (15.2)
NMC/IMI	1 (1.8)	2 (3.2)	0 (0)	2 (1.6)	4 (2.6)
VIM	0 (0)	1 (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*

CPE Colonization and Infection Rates (CNISP) 2013 -2017



All-Cause Mortality CPE (CNISP) 2013-2017

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.*

Antibiotic Resistance CPE (CNISP) 2013 - 2017

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*

CPE Treatment Strategies

- Antibiotics
  - Old antibiotics
    - Colistin alone or in combination
  - Under development
    - Plazomycin (new aminoglycoside)
    - Ceftazidime/avibactam (and similar BLI combos)
    - Novel tetracyclines and fluoroquinolones
    - Phage therapy
- Source control
- Prevention of colonization

Questions to Ponder

- Drug resistance isn't a concern for C.difficile
- Most MRSA infections are hospital acquired
- Clindamycin is more reliable than TMP/SMX for treatment of MRSA infection in Thunder Bay
- VRE bacteremia is treatable and is associated with low mortality
- CPE infections have occurred in Thunder Bay already

Questions