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Antimicrobial Susceptibility of 27,123 Pathogens Isolated from Patients in Canadian Hospitals: CANWARD Study 2007 - 2011

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UPDATED ABSTRACT

Background: CANWARD is a national, annual, ongoing study assessing pathogens causing infections in Canadian hospitals and their antimicrobial resistance patterns.

Methods: From 2007 through 2011, 27,123 pathogens were collected from tertiary-care centres from across Canada. Susceptibility testing was performed using CLSI broth microdilution methods.

Results: Of the 27,123 isolates collected in total, 45.2%, 29.6%, 14.8% and 10.4% were from blood, respiratory, urine and wound specimens, respectively. Patient demographics were as follows: 54.4/45.6% male/female, 12.8% ≤17yrs, 45.1% 18-64yrs and 42.1% ≥65yrs. Isolates were obtained from patients in medical and surgical wards 37.8%, emergency rooms 25.7%, clinics 18.0% and ICUs 18.5%. The most common pathogens were: *E. coli* 20.1%, *S. aureus* (MSSA) 15.4%, *P. aeruginosa* 8.0%, *S. pneumoniae* (SPN) 6.9%, *K. pneumoniae* 6.1%, *Enterococcus* spp. 5.9%, MRSA 4.7%, *H. influenzae* 3.8%, and *Enterobacter cloacae* 2.3%. Susceptibility rates (SR) for *E. coli* were: 100% meropenem (MER), 99.7% ertapenem (ERT), 97.7% piperacillin/tazobactam (P/T), 99.9% tigecycline (TGC), 93.7% ceftriaxone (CTR), 90.5% gentamicin (Gent), 77.9% ciprofloxacin (CIP) and 73.4% cotrimoxazole (T/S). SR for *P. aeruginosa* were: 93.1% colistin, 82.6% MER, 84.0% P/T, 83.5% ceftazidime (CAZ), 72.0% Gent and 71.9% CIP. SR for MRSA were: 100% daptomycin (DAP), 100% linezolid (LZD), 100% telavancin (TLV), 99.8% TGC, 99.9% vancomycin, 92.2% T/S and 48.2% clindamycin. Statistical analysis revealed that ESBL rates among *E. coli* and *K. pneumoniae* and VRE rates increased while MRSA rates declined over time. Fluoroquinolone resistance rates in *E. coli* also increased over time.

Conclusions: *E. coli*, MSSA, *P. aeruginosa*, SPN, *K. pneumoniae,* MRSA and *Enterococcus* spp. are the most common pathogens in Canadian hospitals. SR for *E. coli* were highest with MER, ERT P/T and TGC. SR for *P. aeruginosa* were highest with colistin, MER, P/T and CAZ. 100% susceptibility occurred in MRSA to DAP, LZD and TLV with 99.9% with vancomycin.

INTRODUCTION

Pathogens causing antibiotic resistant infections is a Canadian and global crisis (1,2). Antibiotic resistant pathogens including methicillin-resistant *Staphylococcus aureus* (MRSA, community-associated and healthcare-associated), vancomycin-resistant *Enterococcus* species (VRE), penicillin-resistant *Streptococcus pneumoniae* (PRSP), extended spectrum ß-lactamase (ESBL) producing *Escherichia coli* and *Klebsiella* species and fluoroquinolone-resistant and carbapenem-resistant *Enterobacteriaceae* and *Pseudomonas aeruginosa* are increasing in prevalence in Canada and around the world (1,2). Available therapeutic options for the treatment of these antibiotic resistant organisms are severely limited as these organisms frequently display a multidrug resistant (MDR) phenotype.

PURPOSE

- To determine the pathogens associated with respiratory, urinary, bacteremic and wound/IV site infections in Canadian patients affiliated with hospitals from 2007-2011, inclusive.
- To determine the prevalence of antimicrobial resistance in pathogens associated with respiratory, urinary, bacteremic and wound/IV site infections in Canadian patients affiliated with hospitals from 2007-2011, inclusive.
- To assess the activity of antimicrobials against respiratory, urinary, bacteremic and wound/IV site pathogens in Canadian patients affiliated with hospitals from 2007-2011, inclusive.

MATERIALS & METHODS

Participating Sites: From January 2007 to December 2011, sentinel hospital sites (12 in 2007, 10 in 2008, 15 in 2009, 14 in 2010 and 15 in 2011) in major population centres in 8 of the 10 provinces in Canada were recruited (1,2). These sites were geographically distributed in a population based fashion.

Bacterial Isolates: Tertiary-care medical centres submitted pathogens from patients attending hospital clinics, emergency rooms, medical and surgical wards, and intensive care units. From January 2007 through December 2011, inclusive, each study site was asked to submit clinical isolates (consecutive, one per patient, per infection site) from inpatients and outpatients with respiratory, urine, wound, and bloodstream infections. The medical centres submitted "clinically significant" isolates from patients with a presumed infectious disease. Surveillance swabs, eye, ear, nose and throat swabs were excluded. We also excluded anaerobic organisms. Isolate identification was performed by the submitting site and confirmed at the reference site as required, based on morphological characteristics and antimicrobial susceptibility patterns. Isolates were shipped on Amies semi-solid transport media to the coordinating laboratory (Health Sciences Centre, Winnipeg, Canada), subcultured onto appropriate media, and stocked in skim milk at -80°C until minimum inhibitory concentration (MIC) testing was carried out. In 2007, 2008, 2009, 2010 and 2011; 7714, 5283, 5372, 4960 and 3794 isolates were collected, respectively (1,2).

Antimicrobial Susceptibilities: Following 2 subcultures from frozen stock, the *in vitro* activity of selected antimicrobials was determined by broth microdilution in accordance with the Clinical and Laboratory Standards Institute (CLSI) guidelines (CLSI, 2009 M7-A8). Antimicrobial minimum inhibitory concentration (MIC) interpretive standards were defined according to CLSI breakpoints (M100-S21, 2011). Susceptibility testing could not be performed with all agents due to lack of space on the susceptibility panels. Antimicrobial agents were obtained as laboratory grade powders from their respective manufacturers. Stock solutions were prepared and dilutions made as described by CLSI (M7-A8, 2009). The MICs of the antimicrobial agents for the isolates were determined using 96-well custom designed microtitre plates. These plates contained doubling antimicrobial dilutions in 100µl/well of cation adjusted Mueller-Hinton broth and inoculated to achieve a final concentration of approximately 5 x 10^5 CFU/ml then incubated in ambient air for 24 hours prior to reading. Colony counts were performed periodically to confirm inocula. Quality control was performed using ATCC QC organisms including; *S. pneumoniae* 49619, *S. aureus* 29213, *E. faecalis* 29212, *E. coli* 25922, and *P. aeruginosa* 27853.

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RESULTS

Table 1. Antimicrobial activity against the most common Gram-positive cocci isolated from Canadian hospitals

Organism (no. tested) / Antimicrobial Agent	% S	% I	% R	MIC (µg/mL) MIC50	MIC90	Range
Staphylococcus aureus, MSSA (n=4177)						
Cefazolin	99.9		0.1	≤0.5	1	≤0.5 - 32
Ciprofloxacin	85.9	3.0	11.1	0.5	8	≤0.06 - >16
Clarithromycin	74.8	0.3	24.9	0.25	>32	≤0.12 - >16
Clindamycin	92.5	0.4	7.1	≤0.12	0.25	≤0.12 - >8
Daptomycin	100.0			0.12	0.25	≤0.03 - 1
Gentamicin	97.8	0.1	2.1	≤0.5	1	≤0.5 - >32
Linezolid	100.0			2	2	≤0.12 - 4
Moxifloxacin	90.1	0.6	9.3	≤0.06	0.25	≤0.06 - >16
Telavancin	100.0			0.25	0.5	≤0.06 - 1
Tigecycline	99.9			0.25	0.25	≤0.03 - 1
SXT	99.5		0.5	≤0.12	0.12	≤0.12 - >8
Vancomycin	100.0			1	1	≤0.12 - 2
Staphylococcus aureus, MRSA (n=1266)						
Cefazolin			100.0[a]	64	>128	1 - >128
Ciprofloxacin	13.7	0.3	85.9	>16	>16	0.12 - >16
Clarithromycin	12.2	0.1	87.7	>32	>32	≤0.03 - >32
Clindamycin	48.2	0.1	51.7	>8	>8	≤0.12 - >8
Daptomycin	100.0			0.25	0.25	0.06 - 1
Gentamicin	91.0	0.1	8.9	≤0.5	1	≤0.5 - >32
Linezolid	100.0			2	2	≤0.12 - 4
Moxifloxacin	14.4	2.1	83.6	8	>16	≤0.06 - >16
Telavancin	100.0			0.25	0.5	≤0.06 - 1
Tigecycline	99.8			0.25	0.5	0.06 - 2
SXT	92.2		7.8	≤0.12	0.5	≤0.12 - >8
Vancomycin	99.9	0.1		1	1	≤0.25 - 4
Staphylococcus epidermidis (n=568)						
AMC	82.0		18.0	1	8	≤0.06 - 32
Cefazolin	84.1	0.9	15.0	1	64	≤0.5 - >128
Cefepime	71.5	8.0	20.5	4	>32	≤1 - >32
Cefoxitin				8	>32	≤0.06 - >32
Ceftriaxone	57.0	23.2	19.7	>4	>4	≤1 - >4
Ciprofloxacin	43.7	1.4	54.9	4	>16	≤0.06 - >16
Clarithromycin	31.2	1.2	67.6	>16	>16	≤0.25 - >16
Clindamycin	54.7	0.7	44.6	≤0.25	>8	≤0.25 - >8
Daptomycin	100.0			0.12	0.25	≤0.06 - 1
Doripenem				1	16	≤0.12 - 32
Ertapenem	45.7	10.6	43.7	4	>32	≤0.06 - >32
Gentamicin	53.6	5.0	41.4	1	>32	≤0.5 - >32
Linezolid	100.0			0.5	1	≤0.12 - 4
Meropenem	68.0	10.0	22.0	2	32	≤0.12 - >32
Moxifloxacin	45.4	7.0	47.5	1	>16	≤0.06 - >16
TZP	84.0		16.1	≤1	32	≤1 - 128
Telavancin				0.25	0.5	≤0.06 - 1
Tigecycline				0.12	0.5	≤0.03 - 1
SXT	58.8		41.2	1	8	≤0.12 - >8
Vancomycin	100.0			1	2	≤0.25 - 4
Streptococcus pneumoniae (n=1881)						
AMC	98.2	1.0	0.9	≤0.06	0.12	≤0.06 - 16
Ceftriaxone[b]	99.3	0.5	0.2	≤0.06	0.12	≤0.06 - 4
Cefuroxime	93.7	2.0	4.3	≤0.25	0.5	≤0.25 - >16
Ciprofloxacin				1	2	≤0.06 - >16
Clarithromycin	80.3	3.7	16.0	≤0.03	4	≤0.03 - >32
Clindamycin	93.1	0.6	6.2	≤0.12	≤0.12	≤0.12 - >64
Doripenem	99.9		0.1	≤0.03	0.06	≤0.03 - 2
Doxycycline[c]	93.1	3.1	3.8	≤0.25	1	≤0.25 - >16
Ertapenem	99.3	0.7	0.1	≤0.06	0.12	≤0.06 - 4
Levofloxacin	99.1	0.2	0.7	0.5	1	≤0.06 - 32
Linezolid	100.0			0.5	1	≤0.12 - 2
Meropenem	95.6	2.8	1.6	≤0.06	≤0.06	≤0.06 - 2
Moxifloxacin	99.1	0.4	0.6	0.12	0.25	≤0.06 - 8
Penicillin[d]	81.7	13.9	4.5	≤0.03	0.25	≤0.03 - >8
TZP				≤1	≤1	≤1 - 8
Telavancin				≤0.03	≤0.06	≤0.03 - 0.12
Telithromycin	99.9	0.1		0.008	0.03	≤0.008 - 2
Tigecycline	99.7			0.03	0.06	≤0.015 - 0.25
SXT	84.8	6.5	8.7	≤0.12	2	≤0.12 - >8
Vancomycin	100.0			≤0.25	0.25	≤0.12 - 1
Streptococcus agalactiae (n=432)						
AMC				≤0.06	≤0.06	≤0.06 - 0.25
Ceftriaxone	100.0			≤0.06	0.12	≤0.06 - 0.25
Cefuroxime				≤0.25	≤0.25	≤0.25 - 0.5
Clarithromycin	69.6	5.1	25.4	≤0.03	>32	≤0.03 - >32
Clindamycin	83.3	1.5	15.2	≤0.12	>8	≤0.12 - >64
Daptomycin	100.0			0.12	0.25	≤0.03 - 0.5
Doripenem	100.0			≤0.06	≤0.06	≤0.03 - ≤0.06
Doxycycline				8	16	≤0.25 - >16
Ertapenem	100.0			≤0.06	≤0.06	≤0.06 - 0.12
Levofloxacin	97.8		2.2	1	1	0.25 - >32
Linezolid	100.0			1	1	≤0.12 - 2
Meropenem	100.0			≤0.06	≤0.06	≤0.06 - ≤0.06
Moxifloxacin				0.12	0.25	≤0.06 - 4
Penicillin	99.3		0.7	0.12	0.12	≤0.03 - 0.25
TZP				≤1	≤1	≤1 - ≤1
Telavancin	100.0			≤0.06	0.12	≤0.03 - 0.12
Telithromycin				0.015	0.12	≤0.002 - 0.25
Tigecycline	100.0			0.06	0.12	≤0.015 - 0.12
SXT				≤0.12	≤0.12	≤0.12 - 0.5
Vancomycin	100.0			0.5	0.5	≤0.25 - 0.5
Streptococcus pyogenes (n=424)						
AMC				≤0.06	≤0.06	≤0.06 - 0.12
Ceftriaxone	100.0			≤0.12	≤0.12	≤0.06 - 0.25
Cefuroxime				≤0.25	≤0.25	≤0.25 - ≤0.25
Clarithromycin	84.5	2.8	9.7	≤0.03	0.5	≤0.03 - >32
Clindamycin	98.2		1.8	≤0.12	≤0.12	≤0.12 - >64
Daptomycin	100.0			≤0.03	0.06	≤0.03 - 0.25
Doripenem				≤0.03	≤0.06	≤0.03 - 0.06
Doxycycline				≤0.25	0.5	≤0.25 - 16
Ertapenem	100.0			≤0.06	≤0.06	≤0.06 - 0.12
Levofloxacin	99.7	0.3		0.5	1	≤0.06 - 4
Linezolid	100.0			1	1	≤0.12 - 2
Meropenem	100.0			≤0.06	≤0.06	≤0.06 - 0.12
Moxifloxacin				0.12	0.25	≤0.06 - 0.5
Penicillin	100.0			≤0.03	≤0.03	≤0.03 - 0.12
TZP				≤1	≤1	≤1 - ≤1
Telavancin	100.0			0.06	0.06	≤0.03 - 0.12
Telithromycin				0.008	0.015	≤0.002 - 2
Tigecycline	100.0			0.03	0.06	≤0.015 - 0.25
SXT				≤0.12	≤0.12	≤0.12 - 8
Vancomycin	100.0			0.5	0.5	≤0.12 - 1
Enterococcus faecalis (n=753)						
AMC				0.5	1	≤0.06 - >32
Ciprofloxacin	54.2	12.3	33.6	1	>16	0.25 - >16
Clarithromycin				2	>32	≤0.03 - >32
Daptomycin	100.0			0.5	1	≤0.03 - 4
Doripenem				4	8	≤0.06 - >32
Ertapenem				8	16	0.25 - >32
Levofloxacin	65.5	1.1	33.5	2	>32	0.25 - >32
Linezolid	99.5	4.5		2	2	0.5 - 4
Meropenem				4	8	≤0.06 - >32
Moxifloxacin				0.5	16	≤0.06 - >16
Nitrofurantoin	99.5	0.6		8	8	2 - 64
TZP				4	8	≤1 - >512
Tigecycline	97.4			0.12	0.25	≤0.03 - 0.5
Vancomycin	99.9		0.1	1	2	0.25 - >32
Enterococcus faecium (n=271)						
AMC				>32	>32	0.12 - >32
Ciprofloxacin	6.7	2.6	90.6	>16	>16	0.25 - >16
Clarithromycin				>32	>32	≤0.03 - >32
Daptomycin	100.0			1	2	≤0.03 - 4
Doripenem				>32	>32	1 - >64
Ertapenem				>32	>32	4 - >32
Levofloxacin	9.6	1.3	89.2	>32	>32	1 - >32
Linezolid	88.8	11.2		2	4	≤0.12 - 4
Meropenem				>32	>32	2 - >64
Moxifloxacin				>16	>16	0.12 - >16
Nitrofurantoin	41.2	28.2	30.6	64	128	4 - 256
TZP				>512	>512	2 - >512
Tigecycline				0.12	0.12	≤0.03 - 2
Vancomycin	77.6		22.4	1	>32	≤0.12 - >32

[a] based upon oxacillin susceptibility; [b]CLSI, non-meningitis breakpoints used; [c] tetracycline breakpoints used; [d]penicillin-v breakpoints used; for tigecycline, FDA approved breakpoints used; S, susceptible; I, intermediate; R, resistant; AMC, amoxicillin clavulanic acid; TZP, piperacillin/tazobactam; SXT, trimethoprim/sulfamethoxazole

Table 2. Antimicrobial activity against the most common Gram-negative bacilli isolated from Canadian hospitals

Organism (no. tested) / Antimicrobial Agent	% S	% I	% R	MIC (µg/mL) MIC50	MIC90	Range
Escherichia coli (n=5451)						
Amikacin	99.6	0.3	0.1	≤2	4	≤1 - >64
AMC	89.0	7.7	3.3	4	16	≤0.06 - >32
Cefazolin	70.2	13.1	16.7	2	16	≤0.5 - >128
Cefepime	97.7	1.2	1.1	≤0.25	1	≤0.25 - >64
Cefoxitin	91.9	4.1	4.0	4	8	≤0.06 - >32
Ceftazidime	95.2	0.6	4.2	≤0.25	1	≤0.25 - >32
Ceftriaxone	93.7	0.3	6.0	≤0.25	1	≤0.25 - >256
Ciprofloxacin	77.9	0.3	21.8	≤0.06	>16	≤0.06 - >16
Colistin				0.25	0.5	≤0.06 - >16
Doripenem	99.9	0.1		≤0.06	0.12	≤0.03 - 2
Ertapenem	99.7	0.2	0.1	≤0.03	0.06	≤0.03 - 8
Gentamicin	90.5	0.4	9.1	≤0.5	4	≤0.5 - >32
Meropenem	100.0			≤0.06	0.12	≤0.03 - 1
Moxifloxacin	78.0	0.4	21.6	≤0.06	>16	≤0.06 - >16
Nitrofurantoin	96.7	2.3	1.1	16	32	≤0.5 - >256
TZP	97.7	1.2	1.1	2	4	≤1 - >512
Tigecycline	99.9	0.1		0.25	0.5	0.06 - 4
SXT	73.4		26.7	≤0.12	>8	≤0.12 - >8
Pseudomonas aeruginosa (n=2183)						
Amikacin	90.1	4.5	5.4	4	16	≤1 - >64
AMC				>32	>32	0.5 - >32
Cefazolin				>128	>128	16 - >128
Cefepime	77.2	15.2	7.6	4	16	≤0.25 - >128
Cefoxitin				>32	>32	2 - >32
Ceftazidime	83.5	5.1	11.4	4	32	≤0.25 - >32
Ceftriaxone	25.3	43.2	31.6	16	>64	≤0.25 - >32
Ciprofloxacin	71.9	8.8	19.4	0.25	8	≤0.06 - >16
Colistin	93.1	5.9	1.1	2	2	≤0.06 - >16
Doripenem	84.2	6.3	9.5	0.5	4	≤0.03 - >64
Ertapenem				8	>32	0.06 - >32
Gentamicin	72.0	13.2	14.9	4	16	≤0.5 - >32
Meropenem	82.6	6.3	11.1	0.5	8	≤0.03 - >64
Moxifloxacin				4	>16	≤0.06 - >16
Nitrofurantoin				>256	>256	16 - >256
TZP	84.0	8.6	7.4	4	64	≤1 - >512
Tigecycline				>16	>16	0.25 - >16
SXT				8	>8	≤0.12 - >8
Klebsiella pneumoniae (n=1659)						
Amikacin	99.6	0.1	0.3	≤2	≤2	≤1 - >64
AMC	94.8	3.1	2.1	2	8	0.5 - >32
Cefazolin	82.3	6.7	11.0	2	8	≤0.5 - >128
Cefepime	98.2	0.4	1.4	≤0.25	1	≤0.25 - 128
Cefoxitin	91.9	4.5	3.6	4	8	0.12 - >32
Ceftazidime	96.8	0.3	3.0	≤0.25	1	≤0.25 - >32
Ceftriaxone	95.7	1.3	6.5	≤0.25	0.5	≤0.25 - >256
Ciprofloxacin	92.2	1.3	6.5	≤0.06	0.5	≤0.06 - >16
Colistin				0.5	1	≤0.06 - >16
Doripenem	99.9		0.1	≤0.06	0.12	≤0.03 - 4
Ertapenem	99.6	0.3	0.1	≤0.03	0.06	≤0.03 - 16
Gentamicin	97.0	0.3	2.7	≤0.5	≤0.5	≤0.5 - >32
Meropenem	99.9		0.1	≤0.06	0.12	≤0.03 - 4
Moxifloxacin	92.8	2.5	4.8	0.12	1	≤0.06 - >16
Nitrofurantoin	36.1	32.0	31.8	64	128	2 - >256
TZP	96.9	1.2	1.9	2	8	≤1 - >512
Tigecycline	95.3	3.9	0.8	1	2	0.06 - 16
SXT	90.8		9.2	≤0.12	2	≤0.12 - >8
Haemophilus influenzae (n=1038)						
AMC	99.9		0.1	0.5	2	≤0.06 - 8
Ampicillin	81.2	1.6	17.2	≤0.25	8	≤0.25 - >128
Cefepime	100.0			≤0.25	≤0.25	≤0.25 - 2
Ceftriaxone	99.7		0.3	≤0.06	≤0.06	≤0.06 - >4
Cefuroxime	96.5	2.7	0.9	1	4	≤0.25 - >16
Ciprofloxacin	100.0			≤0.015	≤0.015	≤0.015 - >0.5
Clarithromycin	86.8	11.2	2.0	4	16	≤0.03 - >32
Doripenem	98.1		1.9	≤0.06	0.25	≤0.06 - 2
Doxycycline				0.5	1	≤0.25 - 8
Ertapenem	99.7		0.3	≤0.03	0.12	≤0.03 - >4
Gentamicin				1	2	≤0.5 - 16
Meropenem	99.6		0.4	≤0.06	0.12	≤0.06 - 2
Moxifloxacin	100.0			≤0.015	0.03	≤0.015 - 0.5
TZP	99.5		0.5	≤1	≤1	≤1 - 8
Telithromycin	98.2	1.2	0.7	1	4	≤0.03 - >32
SXT	83.3	3.5	13.1	≤0.12	4	≤0.12 - >8
Enterobacter cloacae (n=637)						
Amikacin	100.0			≤ 2	2	≤2 - 16
AMC	12.7	18.1	69.2	32	>32	2 - >32
Cefazolin	2.0	1.1	96.9	128	>128	1 - >128
Cefepime	99.8	0.2		≤0.25	2	≤0.25 - 16
Cefoxitin	11.4	6.5	82.1	>32	>32	2 - >32
Ceftazidime	80.7	1.1	18.3	0.5	>32	≤0.25 - >32
Ceftriaxone	74.3	2.0	23.7	≤0.25	64	≤0.25 - >256
Ciprofloxacin	93.9	1.6	4.6	≤0.06	0.25	≤0.06 - >16
Colistin				0.5	>16	≤0.06 - >16
Doripenem	99.7	0.2	0.2	≤0.06	0.12	≤0.03 - 8
Ertapenem	92.6	4.2	3.1	≤0.06	0.5	≤0.06 - 16
Gentamicin	97.3	0.2	2.5	≤0.5	≤0.5	≤0.5 - >32
Meropenem	99.7	0.3		≤0.06	0.12	≤0.03 - 2
Moxifloxacin	94.5	2.4	3.1	≤0.06	0.5	≤0.06 - >16
Nitrofurantoin	47.9	39.8	12.4	64	128	2 - >256
TZP	85.7	8.0	6.3	2	64	≤1 - 512
Tigecycline	94.4	4.1	1.6	1	1	0.25 - 16
SXT	92.5		7.5	≤0.12	1	≤0.12 - >8
Proteus mirabilis (n=415)						
Amikacin	99.8	0.2		2	4	≤1 - 32
AMC	96.4	2.1	1.5	1	4	0.5 - >32
Cefazolin	3.4	50.7	45.9	4	8	1 - >128
Cefepime	100.0			≤0.25	1	≤0.25 - 2
Cefoxitin	97.0	2.1	0.9	4	4	1 - >32
Ceftazidime	99.0		1.0	≤0.25	0.5	≤0.25 - 32
Ceftriaxone	98.3	0.5	1.2	≤0.25	1	≤0.25 - 16
Ciprofloxacin	85.5	6.5	8.0	≤0.06	2	≤0.06 - >16
Colistin				>16	>16	0.5 - >16
Doripenem	100.0			0.12	0.25	≤0.03 - 1
Ertapenem	100.0			≤0.03	0.06	≤0.03 - 0.25
Gentamicin	95.2	1.0	3.9	1	2	≤0.5 - >32
Meropenem	100.0			0.06	0.12	≤0.03 - 0.5
Moxifloxacin	81.9	1.7	16.4	0.5	16	≤0.06 - >16
Nitrofurantoin		7.6	92.4	128	256	64 - >256
TZP	100.0			≤1	≤1	≤1 - 8
Tigecycline	8.2	32.1	59.7	8	16	1 - >16
SXT	84.1		15.9	≤0.12	>8	≤0.12 - >8
Klebsiella oxytoca (n=411)						
Amikacin	99.8		0.2	≤2	2	≤1 - >64
AMC	91.5	4.1	4.4	2	8	1 - >32
Cefazolin	25.4	18.5	56.1	8	128	≤0.5 - >128
Cefepime	99.7	0.3		≤0.25	1	≤0.25 - 16
Cefoxitin	97.1	1.8	1.2	2	4	1 - >32
Ceftazidime	98.7		1.3	≤0.25	0.5	≤0.25 - >32
Ceftriaxone	92.0	1.2	6.8	≤0.25	≤1	≤0.25 - 64
Ciprofloxacin	96.6	1.2	2.2	≤0.06	0.12	≤0.06 - >16
Colistin				0.5	1	0.12 - >16
Doripenem	100.0			≤0.06	0.12	≤0.03 - 1
Ertapenem	99.7		0.3	≤0.03	0.06	≤0.03 - 2
Gentamicin	98.1	0.5	1.5	≤0.5	≤0.5	≤0.5 - >32
Meropenem	100.0			≤0.03	0.12	≤0.03 - 1
Moxifloxacin	96.8	1.2	2.0	0.12	0.25	≤0.06 - >16
Nitrofurantoin	77.8	20.4	1.9	32	64	4 - 128
TZP	89.8	0.5	9.8	2	32	≤1 - >512
Tigecycline	99.3	0.5	0.2	0.5	1	0.06 - 8
SXT	94.9		5.1	≤0.12	0.25	≤0.12 - >8
Serratia marcescens (n=412)						
Amikacin	99.5	0.2	0.2	≤2	4	≤1 - >64
AMC	2.6	21.1	76.3	>32	>32	≤0.06 - >32
Cefazolin	0.7		99.3	>128	>128	2 - >128
Cefepime	100.0			≤0.25	1	≤0.25 - 8
Cefoxitin	21.9	48.3	29.8	16	>32	4 - >32
Ceftazidime	99.3		0.7	≤0.5	1	≤0.25 - >32
Ceftriaxone	93.7	1.0	5.4	≤0.25	1	≤0.25 - >64
Ciprofloxacin	89.8	4.1	6.1	≤0.06	2	≤0.06 - >16
Colistin				>16	>16	0.5 - >16
Doripenem	99.5	0.2	0.2	≤0.12	0.12	≤0.03 - >32
Ertapenem	99.1	0.3	0.6	≤0.06	0.06	≤0.03 - 4
Gentamicin	95.1	2.4	2.4	≤0.5	1	≤0.5 - >32
Meropenem	99.5	0.5		≤0.06	0.12	≤0.06 - 2
Moxifloxacin	87.8	5.8	6.3	0.5	4	≤0.06 - >16
Nitrofurantoin		1.8	98.2	256	>256	64 - >256
TZP	95.9	3.2	1.0	≤1	4	≤1 - 256
Tigecycline	71.0	24.9	4.2	2	4	0.12 - >16
SXT	95.6		4.4	0.5	1	≤0.12 - >8
Stenotrophomonas maltophilia (n=378)						
Amikacin				>64	>64	≤2 - >64
AMC				>32	>32	2 - >32
Cefazolin				>128	>128	128 - >128
Cefepime				>32	>32	≤0.25 - >128
Cefoxitin				>32	>32	8 - >32
Ceftazidime	25.8	9.0	65.3	>32	>32	1 - >32
Ceftriaxone				64	256	8 - >256
Ciprofloxacin				2	16	≤0.06 - >16
Colistin				8	>16	0.25 - >16
Doripenem				>32	64	≤0.12 - >64
Ertapenem				>32	>32	0.12 - >32
Gentamicin				32	>32	≤0.5 - >32
Meropenem				>32	64	≤0.06 - >64
Moxifloxacin				1	4	≤0.06 - >16
Nitrofurantoin				>256	>256	32 - >256
TZP				256	>512	16 - >512
Tigecycline				2	8	0.25 - 16
SXT	86.6		13.4	0.5	4	≤0.12 - >8

For tigecycline, FDA approved breakpoints used; S, susceptible; I, intermediate; R, resistant; colistin (Polymyxin E); AMC, amoxicillin clavulanic acid; TZP, piperacillin/tazobactam; SXT, trimethoprim/sulfamethoxazole

Bacterial Isolates Collected

27,123 clinical isolates were collected for CANWARD 2007-2011.

- 12,261 (45.2%) were from blood, 8,020 (29.6%) from respiratory sources, 4,012 (14.8%) were from urine and 2,830 (10.4%) were from wounds
- 14,744 (54.4%) collected from male patients; 12,379 (45.6%) female patients
- 3,465 (12.8%) from patients ≤ 17 years of age, 12,234 (45.1%) 18-64 years, and 11,424 (42.1%) ≥ 65 years
- 7,819 (28.8%) were from patients on medical wards, 6,963 (25.7%) from emergency rooms, 5,010 (18.5%) from intensive care units, 4,879 (18.0%) from hospital clinics, and 2,452 (9.0%) from surgical wards

Table 3. The 20 most common organisms isolated from Canadian hospitals

Rank	Organism	n	% of Total
1	*E. coli*	5451	20.1
2	*S. aureus* - MSSA	4177	15.4
3	*P. aeruginosa*	2183	8.0
4	*S. pneumoniae*	1881	6.9
5	*K. pneumoniae*	1659	6.1
6	*S. aureus* - MRSA	1266	4.7
7	CNS / *S. epidermidis*	1180	4.4
8	*H. influenzae*	1038	3.8
9	*E. faecalis*	753	2.8
10	*E. cloacae*	637	2.3
11	*Enterococcus* spp	578	2.1
12	*S. agalactiae*	432	1.6
13	*S. pyogenes*	424	1.6
14	*P. mirabilis*	415	1.5
15	*S. marcescens*	412	1.5
16	*K. oxytoca*	411	1.5
17	*S. maltophilia*	378	1.4
18	*M. catarrhalis*	293	1.1
19	*E. faecium*	271	1.0
20	Viridans gp. Streptococci	231	0.9
	Other	3053	11.3
		27,123	

MSSA, methicillin-susceptible staphylococcus; CNS, coagulase-negative staphylococci; MRSA, methicillin-resistant *Staphylococcus aureus*.

CONCLUSIONS

- Of the 27,123 pathogens obtained, the most common were: *E. coli* 20.1%, *S. aureus* (MSSA) 15.4%, *P. aeruginosa* 8.0%, *S. pneumoniae* 6.9%, *K. pneumoniae* 6.1%, MRSA 4.7%, *H. influenzae* 3.8% and *Enterococcus* spp. 5.9%.
- Isolates were obtained from blood (45.2%), respiratory (29.6%), urine (14.8%) and wound specimens (10.4%), and from patients on medical wards 28.8%, surgical 9.0%, ER 25.7%, clinics 18.0% and ICU 18.5%.
- Susceptibility rates for *E. coli* were: 100% meropenem, 99.9% doripenem and tigecycline, 99.7% ertapenem, 99.6% amikacin, 97.7% piperacillin/tazobactam, 97.7% cefepime, 95.2% ceftazidime, 93.7 ceftriaxone, 90.5% gentamicin, 77.9% ciprofloxacin and 73.4% trimethoprim/sulfamethoxazole.
- Susceptibility rates for *P. aeruginosa* were: 93.1% colistin, 90.1% amikacin, 84.2% doripenem, 84.0% piperacillin/tazobactam, 83.5% ceftazidime, 82.6% meropenem, 72.0% gentamicin and 71.9% ciprofloxacin.
- Susceptibility rates for MRSA were: 100% daptomycin, linezolid and telavancin, 99.9% vancomycin, 99.8% tigecycline, 92.2% trimethoprim/sulfamethoxazole, 48.2% clindamycin, 13.7% ciprofloxacin and 12.2% for clarithromycin.
- Statistical analysis revealed that ESBL rates among *E. coli* and *K. pneumoniae* and VRE rates increased while MRSA rates declined over time. Fluoroquinolone resistance rates in *E. coli* also increased over time.

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