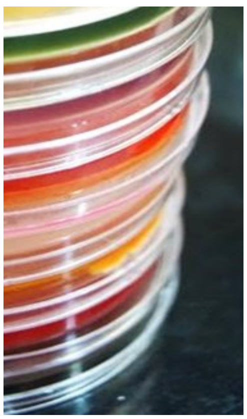

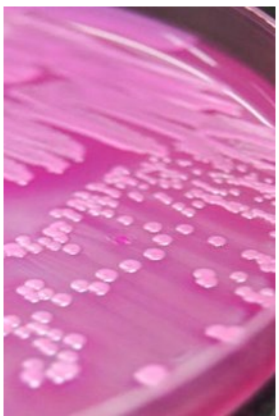

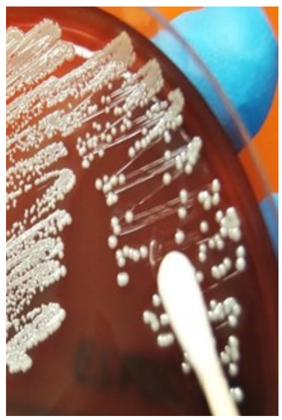

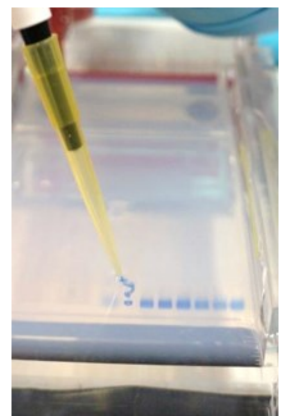

ANTIMICROBIAL RESISTANCE SURVEILLANCE PROGRAM

2015 Data Summary Report

Antimicrobial Resistance Surveillance Reference Laboratory

Research Institute for Tropical Medicine

Department of Health

Philippines

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Executive Summary

Resistance data for **50,895 bacterial isolates** coming from 22 hospital bacteriology laboratories located in 14 regions of the Philippines were analyzed for 2015.

Streptococcus pneumoniae

- Cumulative resistance rate of *S. pneumoniae* isolates from all specimen types reported for 2014 against penicillin, using meningitis breakpoints, was at 7.6% (n=369). When the pneumococcal isolates were analyzed by specimen type, penicillin resistance was at 9% for invasive (blood and CSF) isolates when analyzed using meningitis breakpoints but only 1% penicillin resistance rate for non-invasive isolates (non-CSF and non-blood) when analyzed using non-meningitis breakpoints.
- There was no ceftriaxone-resistant S. *pneumoniae* reported for 2015.
- The most common invasive *S. pneumoniae* serogroups/serotypes identified for 2015 were 1, 4, 6 and 18.
- The most common non-invasive *S. pneumoniae* serogroups/serotypes identified for 2015 were 3,6 and 18.

Haemophilus influenzae

- For 2015, 8.9% of *H. influenzae* isolates were resistant to ampicillin (n= 361) and 3.4% were resistant to ampicillin-sulbactam (n=314). These rates did not differ significantly when compared to data from 2014 (*p* value > 0.05).
- All ampicillin-resistant *H. influenzae* isolates tested at the reference laboratory were positive for β-lactamase production.
- Resistance rates for 2015 isolates of *H. influenzae* are at 32.5% for co-trimoxazole (n= 366) and 5.7% for chloramphenicol (n=332).
- There were no reports of levofloxacin or azithromycin resistant *H. influenzae* for 2015.

Salmonella enterica serotype Typhi

- *S. enterica* ser. Typhi isolates have remained susceptible to first line antibiotics, with resistance rates against ampicillin, co-trimoxazole and chloramphenicol remaining at less than 5% for 2015 as they have been for the past 10 years.
- Emerging resistance against fluoroquinolones is noted with resistance rates against nalidixic acid at 4.3% (n=117) and ciprofloxacin at 0.8% (n=120).

Nontyphoidal *Salmonella*

- Increasing resistance of nontyphoid salmonella to ciprofloxacin (n= 155) is noted with rate at 10.3% for 2015.
- The commonest nontyphoidal *Salmonella* species serovar identified for 2015 are *S. enterica* serotype Typhimurium and *S. enterica* serotype Enteritidis.

Shigella species

- Combined 2012-2015 data reveals emerging resistance of *Shigella* species against the fluoroquinolones as seen with cumulative rate of resistance at 16.3% against ciprofloxacin (n=49).

Vibrio cholerae

- *Vibrio cholerae* isolates remain susceptible to first line agents: chloramphenicol, co-trimoxazole and tetracycline with resistance rates at <2% for the combined 2013-2015 data.

Neisseria gonorrhoeae

- The 2015 *Neisseria gonorrhoeae* isolates have high rates of resistance against penicillin at 93.6% (n= 78); tetracycline at 65% (n=80); and ciprofloxacin at 83.1% (n=77).
- There was no reported streptomycin, ceftriaxone and cefixime resistant isolates for the 2015 data.

Staphylococcus aureus

- MRSA rate for 2015 is at 62.6% (n= 3,555). This did not differ statistically from the reported MRSA rate of 60.3% in 2014.
- There was not confirmed vancomycin-resistant *S. aureus* for 2015.

Enterococcus species

- For 2015, we continue to report higher rates of ampicillin resistance in enterococci with rates at

10.9% for *E. faecalis* (n=817) and 78.1% for *E. faecium* (n= 301).

- There were no confirmed reports of vancomycin-resistant *E. faecalis* or *E. faecium* for 2015.

Escherichia coli

- *E. coli* rates of resistance against the fluoroquinolones and third generation cephalosporins have been increasing for the past years with resistance rates against ciprofloxacin at 39.2% (n=5,618) and ceftriaxone at 34.6% (n=5,458) for 2015.
- Emerging resistance against the carbapenems are also reported for 2015 with rates of resistance at 4.2% for ertapenem (n=3,036); 3.5% for imipenem (n=6,132); and 3.4% for meropenem (n=5,794).
- *E. coli* extended-spectrum β –lactamase suspect rates for 2015 is at 27% (n=5,578).
- Urinary *E. coli* isolates from outpatients remain susceptible to nitrofurantoin with rate of resistance at 3.1% (n= 814). Comparatively, urinary *E. coli* isolates from hospitalized patients show variable susceptibility to parenteral agents with rates of resistance ranging from 4.2% against amikacin (n=2105); and 5.7% against ertapenem (n=1241); to as high as 40.4% against ceftriaxone (n=1973).

Klebsiella pneumoniae

- Resistance to the carbapenems are also rising with 2015 *Klebsiella* species resistance rates as high as 15.3% for ertapenem (n=4,041); 11.1% for imipenem (n=8,068) and 11.9% for meropenem (n=7,663).
- *K. pneumoniae* extended-spectrum β –lactamase suspect rates for 2015 is at 38% (n=8,407).

Pseudomonas aeruginosa

- Resistance rates of 2015 *P. aeruginosa* isolates were 13.4% for ciprofloxacin (n=4,077), 17.2% for ceftazidime (n= 4,215); 7.3% against amikacin (n= 4,137) and 17.2% for imipenem (n=4,234).

Acinetobacter baumannii

- Rate of resistance of *A. baumannii* is reported at 46.3% for ampicillin-sulbactam (n= 2,586) for 2015.
- *A. baumannii* aminoglycoside resistance rates are at 31% for amikacin (n= 2,827) and 36.4% for gentamicin (n=3,358).
- Resistance of *A. baumannii* against imipenem have been increasing in the past 10 years with rates of resistance for 2015 reported as high as 54.1% (n=3,421).

Multidrug-resistant *Pseudomonas aeruginosa* & *Acinetobacter baumannii*

- *P. aeruginosa* MDR and possible XDR rates for all isolates were at 22% and 18%, respectively.
- *A. baumannii* MDR and possible XDR rates for all isolates were at 66% and 48%, respectively.

The Isolates

Resistance data for **50,895 isolates** were reported and analyzed for the year 2015. This was a 8% increase when compared to the reported **47,280** isolates for 2014.

Sentinel Site Data Contribution

The 2015 ARSP data came from the 22 sentinel sites of the program which represents 14 regions of the Philippines **(Figure 3 and Table 7)**. Of the total number of isolates for 2015, 61% were from Luzon, 20% were from Visayas and 19% were from Mindanao. The 8 Metro Manila sentinel sites contributed 41% of the total 2015 annual data. Comparatively, the 2014 data by locality was 65% from Luzon, 18% from Visayas and 17% from Mindanao.

Specimen Types

The most common specimen types comprising the 2015 ARSP data were respiratory, blood, wound and urine specimens. Other specimen types contributing to the 2015 data were: tissues, cerebrospinal fluid, other fluids, genital specimens and stool (**Figure 4**).

Most Common Isolates

For 2015, *Klebsiella* species, followed by *Escherichia coli* and *Pseudomonas aeruginosa* were the most commonly isolated bacterial organisms from all specimen types reported. The most commonly isolated bacteria by specimen type is seen at **Table 8**.

Table 7: Total number of annual isolate contribution by sentinel site, ARSP, 2006 - 2015

SENTINEL SITES	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change %
PGH	4511	-	-	-	-	-	-	7093	12471	11710	-6
RMC	506	757	757	878	962	845	942	1207	320	1054	70
NKI	4009	2996	3112	3345	3681	2726	2403	2179	2918	1455	-101
LCP	5160	2548	2701	2694	2	1233	2083	2253	2921	2905	-1
RTM	414	361	335	280	348	328	383	303	303	336	10
SLH	881	461	662	468	615	409	318	1132	575	824	30
GMH	522	886	826	1151	936	1119	1521	1307	1351	1807	25
ZMC	550	434	440	599	1060	686	721	822	819	841	3
FEU	740	684	690	699	864	1064	931	1050	956	712	-34
STU	1124	1329	1180	1722	1470	752	1788	2050	2002	1923	-4
EVR	799	491	466	340	530	744	507	697	823	1514	46
MMH	567	380	525	562	590	855	1153	1413	2289	2940	22
DMC	2487	2161	2374	2523	2870	2439	3332	3456	4062	5109	20
VSM	991	1063	1241	1447	1931	2142	2450	3171	3951	3834	-3
BGH	1213	1041	1329	2129	2199	1916	1972	2583	2625	3214	18
CMC	796	686	541	459	600	595	639	796	833	1300	36
BRT	399	388	401	618	486	537	677	611	1047	1251	16
RTH	40	32	19	-	-	-	-	-	-	-	-
ZPH	56	67	53	38	11	-	-	-	9	8	-13
MAR				2275	1898	1851	1928	1773	1706	1849	8
BRH				1008	791	304	38	-	1022	1294	21
CVM				248	907	790	944	1100	1223	1512	19
JLM				387	1024	643	655	502	638	1266	50
NMC				814	1817	1776	1684	2131	2416	2237	-8
TOTAL	25768	16765	17652	24684	25592	23754	27069	37629	47280	50895	

Table 8: Most common isolates by specimen type, all ARSP sites, 2015			
Respiratory specimens		Blood	
1	Klebsiella pneumoniae	1	Staphylococcus, coagulase negative
2	Pseudomonas aeruginosa	2	Klebsiella pneumoniae
3	Acinetobacter baumannii	3	Staphylococcus aureus
Cutaneous or Wound		Stool	
1	Staphylococcus aureus ss. aureus	1	Escherichia coli
2	Escherichia coli	2	Enterobacter sp.
3	Klebsiella pneumoniae	3	Salmonella sp.
Cerebrospinal Fluid		Urine	
1	Staphylococcus, coagulase negative	1	Escherichia coli
2	Acinetobacter baumannii	2	Klebsiella pneumoniae
3	Staphylococcus aureus	3	Enterobacter sp.

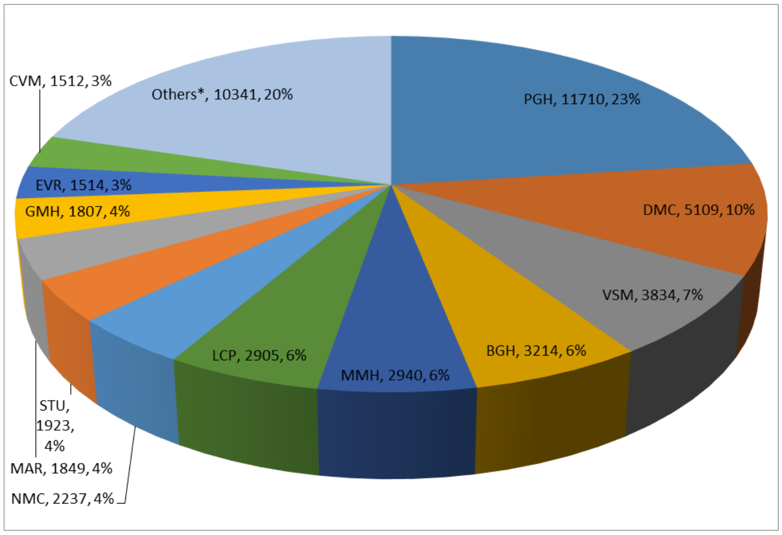

Figure 3. Percent isolate contribution by sentinel site, ARSP, 2015, (N=50,895)

*Others: NKI 3%, CMC, 2.8%, BRH 2.7%, JLM 2.7%, BRT 2.7%, RMC 2.2%, ZMC 1.8%, SLH 1.7%, FEU 1.5%, RTM 0.7%, ZPH 0.1%

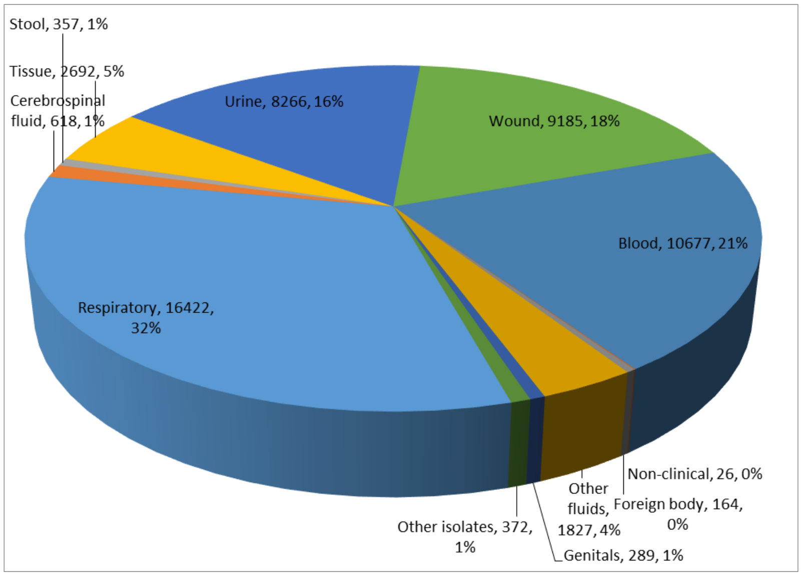

Figure 4. Percent isolate distribution by specimen type, ARSP, 2015, (N=50,895)

Streptococcus pneumoniae

Isolates

There were 436 reported *S. pneumoniae* isolates for 2015. This was 30% more than the 336 *S. pneumoniae* isolates reported for 2014. Major contributors making up 52% of the 2015 *S. pneumoniae* data were VSM (102 isolates), PGH (74 isolates) and DMC (52 isolates). Majority of the *S. pneumoniae* reported were respiratory isolates (64%) and invasive isolates (28%) from blood and cerebrospinal fluid cultures. The rest of the isolates were from wound, tissue and other body fluids (**Figure 5**).

Antimicrobial Resistance

Since 2008, the Clinical and Laboratory Standards Institute (CLSI) recommends the use of different breakpoints for meningitis and non-meningitis pneumococcal infections when testing for penicillin. The recommended meningitis breakpoints are more stringent due to the poor penetration of penicillin thru the blood brain barrier. For 2015, penicillin resistance is at 7.6% (n=369; 95% CI: 9.8-17.0) when all *S. pneumoniae* isolates were analyzed using meningitis breakpoints. When analyzed according to specimen type, penicillin resistance was higher for invasive isolates (97 blood and CSF isolates) using meningitis breakpoints at 9% while among noninvasive *S. pneumoniae* isolates, only 1% (n=246 non-invasive isolates) were reported as penicillin-resistant isolates using non-meningitis breakpoints for 2015.

Resistance rates of *S. pneumoniae* isolates for 2015 were 2.6% for chloramphenicol, 16.5% for co-trimoxazole, 5% for erythromycin and 1.2% for levofloxacin. These rates did not differ significantly from that reported for 2014 (p value > 0.5). There was no reported ceftriaxone resistant *S. pneumoniae* isolate for 2015. The 2015 resistance rates and 10 year trends of resistance are seen in **Figures 6 and 7**.

Serotyping

Serotyping of *S. pneumoniae* isolates referred to the reference laboratory was done to identify local prevailing serotype distribution. The method employed in the reference laboratory for pneumococci serotyping is the slide agglutination test (Denka Seiken). For 2015, there were 45 invasive (blood and CSF) pneumococci isolates sent to the national reference laboratory for confirmatory testing and serotyping. The commonest serotypes from the blood and CSF isolates were serogroup/serotypes 1, 4, 6 and 18 comprising 53% of the invasive isolates. In contrast, the most common invasive *S. pneumoniae* serotypes for 2014 were 6, 3 and 18.

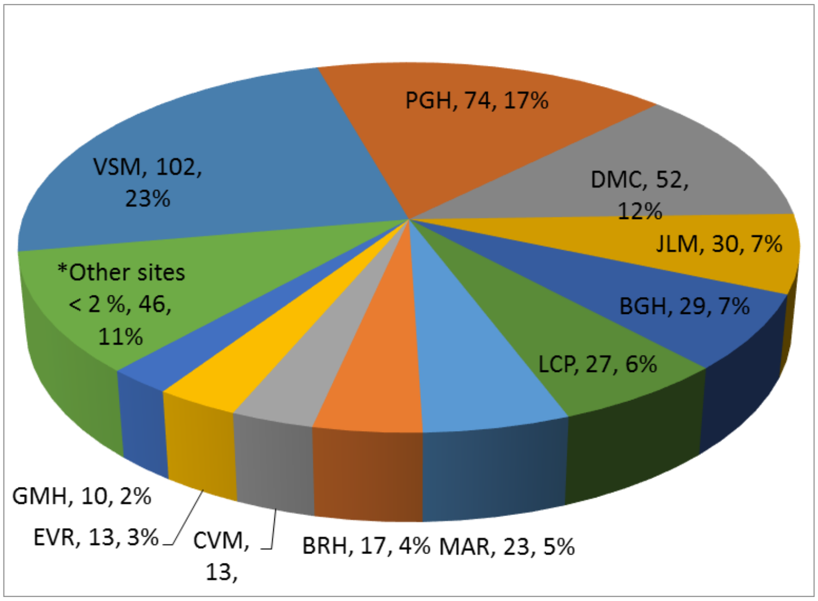

Figure 5: Percent sentinel site contribution for *Streptococcus pneumoniae*, ARSP, 2015, (N=336)

Streptococcus pneumoniae

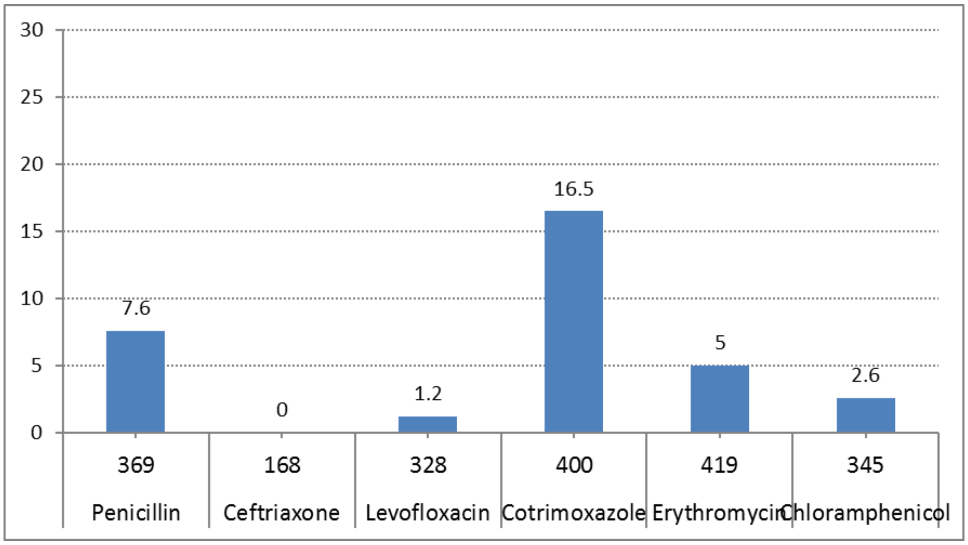

Figure 6. Percent resistance of *Streptococcus pneumoniae*, ARSP, 2015

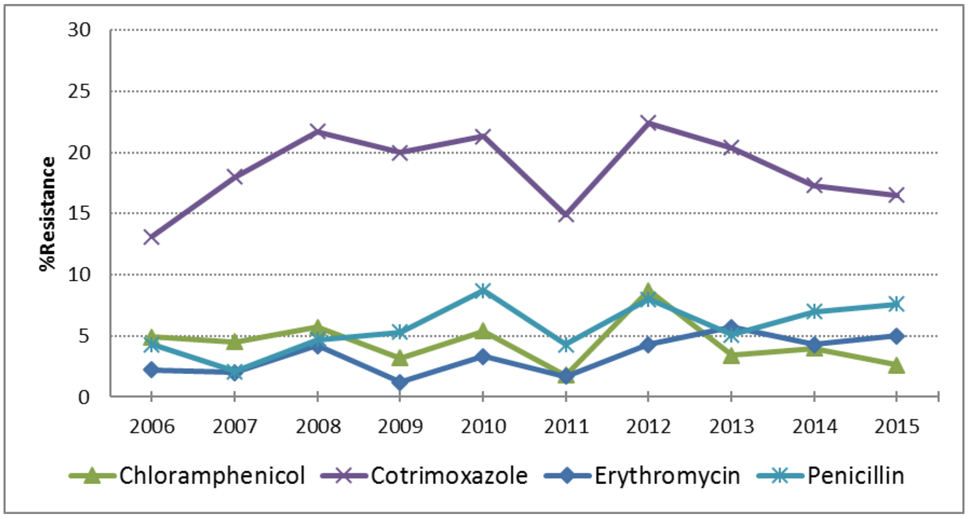

Figure 7. Yearly resistance rates of *Streptococcus pneumoniae*, ARSP, 2006-2015

Haemophilus influenzae

Isolates

There were 379 reported *H. influenzae* isolates for 2015. This was 15% more than reported for 2014. Biggest contributors for the 2014 *H. influenzae* data were VSM (168 isolates), DM (41 isolates), BGH (28 isolates) and STU (28 isolates). Percentage contribution of each sentinel site is illustrated in **Figure 8**.

Majority of the 2015 *H. influenzae* isolates were from respiratory specimens (94%) while there were 15 invasive isolates (14 blood and 1 CSF culture isolates). The 2 invasive isolates sent to ARSRL for confirmatory testing were each further identified as *H. influenzae* type a and type b, respectively.

Antimicrobial Resistance

Resistance rates among the isolates of *H. influenzae* for 2015 were: 8.9% for ampicillin (n=361; 95% CI: 6.3-12.4); 3.4% for ampicillin-sulbactam (n=314; 95% CI: 2.3-7.1); 5.7% for chloramphenicol (n=332; 95% CI: 3.6 -8.9); and 32.5% for co-trimoxazole (n=366; 95% CI: 27.8-37.6) as seen in **Figure 9**. When 2015 rates were compared to that reported for 2014, there were significant decrease in resistance rates against chloramphenicol from 13.4% in 2014 to 5.7% in 2015 (*p* value 0.0011); and co-trimoxazole from 42.9% in 2014 to 32.5% in 2015 (*p* value 0.0054). Rates of resistance for 2015 for both ampicillin and ampicillin-sulbactam did not differ significantly from that reported for 2014. Of the 16 ampicillin-resistant *H. influenzae* isolates sent for confirmatory testing in ARSRL, 100% were β-lactamase producers. There were no reported levofloxacin-resistant or azithromycin-resistant *H. influenzae* isolate for 2015 as in the past decade. Trends of resistance for H. influenzae is illustrated in **Figure 10**.

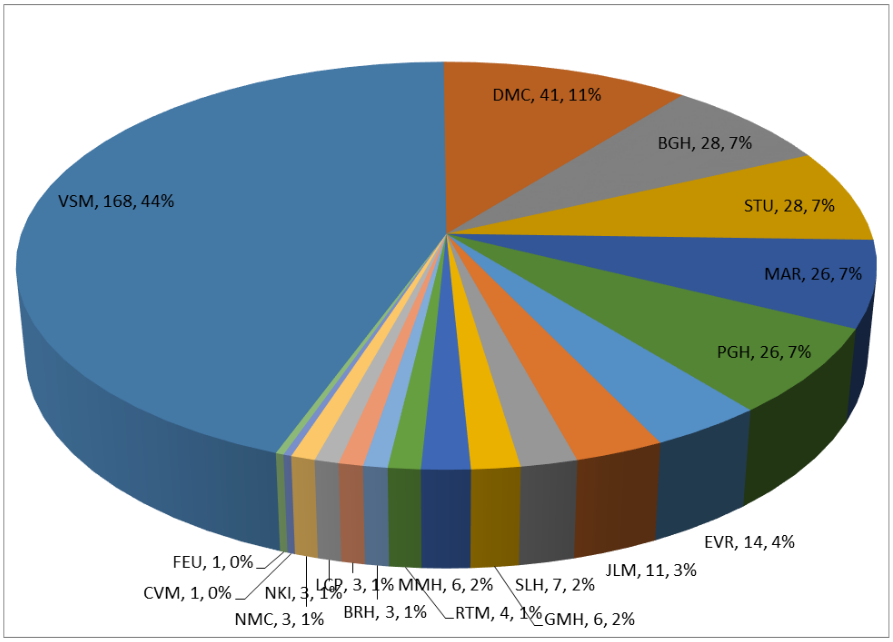

Figure 8: Percent sentinel site contribution for *Haemophilus influenza*, ARSP, 2015, (N=379)

Haemophilus influenzae

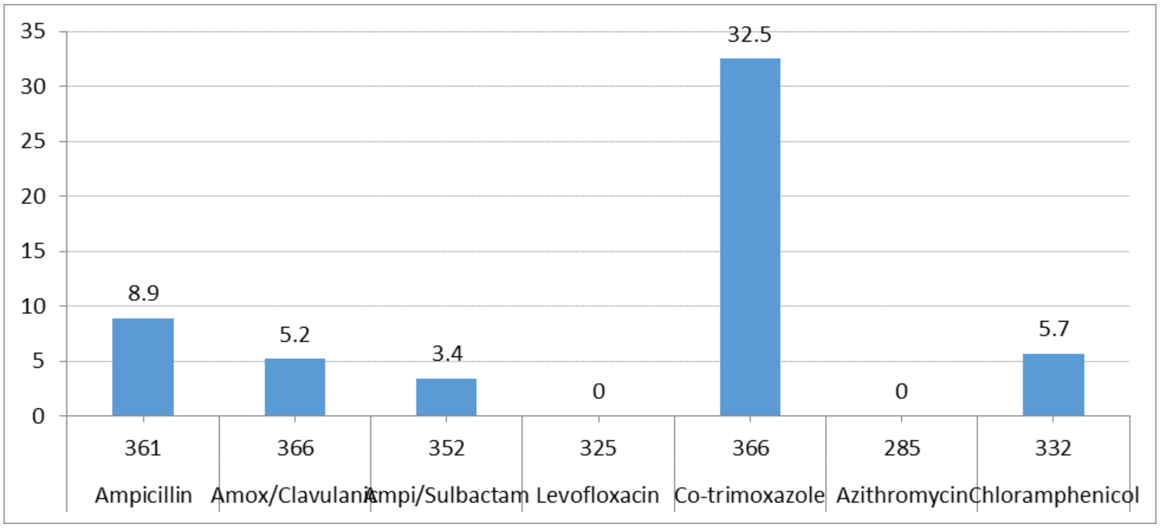

Figure 9. Percent resistance of *H. influenzae*, ARSP, 2015

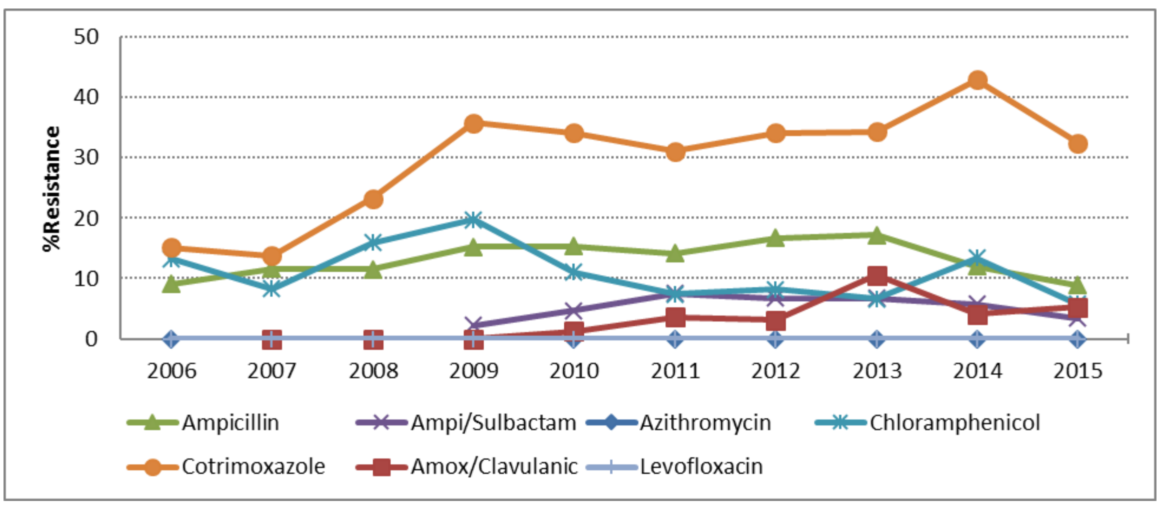

Figure 10. Yearly resistance rates of *H. influenzae* ARSP, 2006-2015

Salmonella enterica serotype *Typhi*

Isolates

There were 127 *S.* Typhi isolates reported and analyzed for 2015. This is 14% more than the total number of isolates reported for 2014. The largest sentinel site contributors making up 44% of the 2014 *S.* Typhi data were: CMC (19 isolates), BRT (17 isolates) and VSM (17 isolates) as seen in **Figure 11.** Most of the 2014 *S.* Typhi isolates were from blood specimens (94%). Others were isolated from stool, urine and other body fluids (**Figure 12**).

Antimicrobial Resistance

S. Typhi isolates have remained susceptible to first line agents with resistance rates to ampicillin at 2.6% (n=117; 95% CI: 0.7-7.9); co-trimoxazole at 2.5% (n=121; 95% CI: 0.7-7.6); and chloramphenicol at 0.9% (n=114; 95% CI: 0.1-5.5). These reported 2015 rates did not significantly differ from reported rates for 2014 (*p* value > 0.05).

Resistance rates was at 4.3% against nalidixic acid (n=117; 95% CI: 1.6-10.2) and 0.8% for ciprofloxacin (n=120; 95% CI: 0-5.2). Nalidixic acid-resistance in extra-intestinal Salmonella isolates may signify poor fluoroquinolone treatment outcomes. There were no confirmed reports of ceftriaxone-resistant *S.* Typhi for 2015.

The 2015 percentage resistance and 10 year trends of resistance for *S.* Typhi seen in **Figures 13-15**.

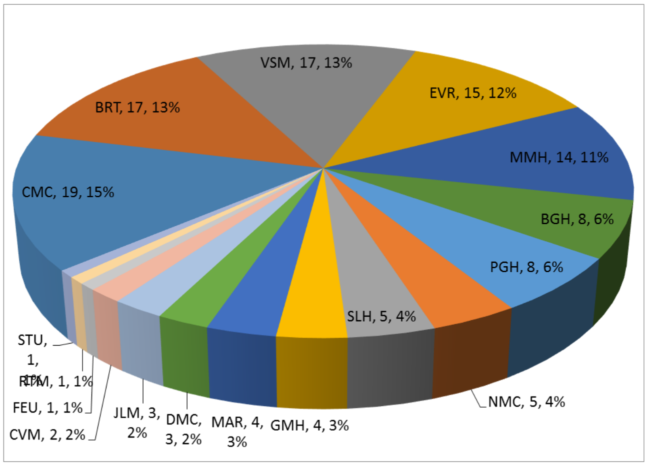

Figure 11. Percent sentinel site contribution for *Salmonella typhi,* ARSP, 2015, (N=127)

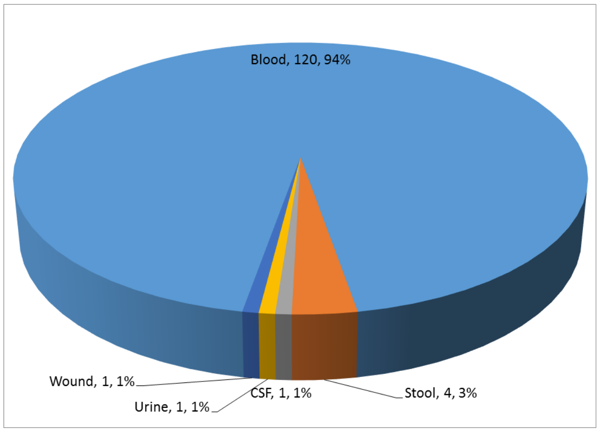

Figure 12. Percent specimen type distribution of *Salmonella typhi,* ARSP, 2015, (N=127)

Salmonella enterica serotype *Typhi*

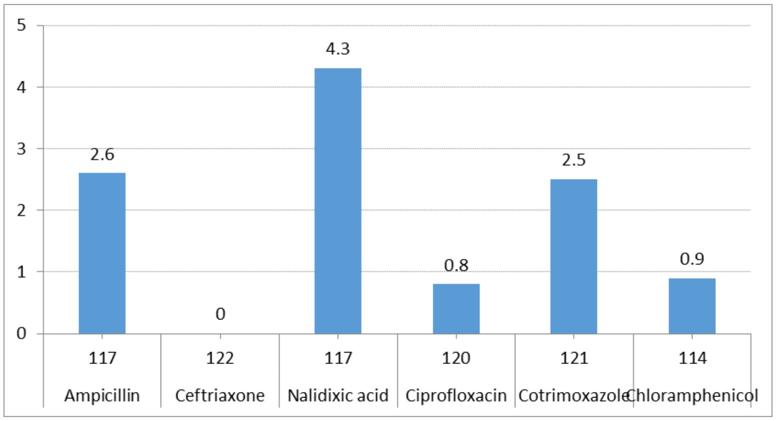

Figure 13. Percent resistance of *Salmonella typhi*, ARSP, 2015

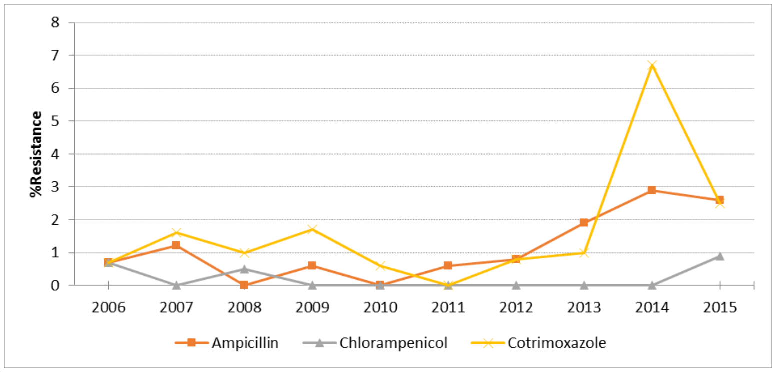

Figure 14. Yearly ampicillin, chloramphenicol and co-trimoxazole resistance rates of *Salmonella typhi,* ARSP, 2006-2015

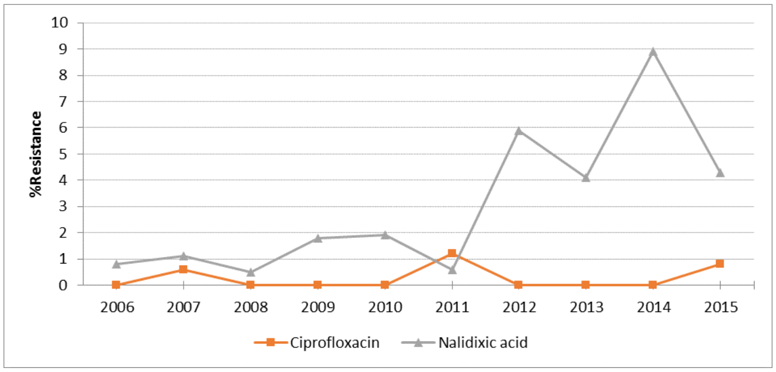

Figure 15. Yearly ciprofloxacin and nalidixic acid resistance rates of *Salmonella typhi,* ARSP, 2006-2015

Nontyphoidal *Salmonellae*

The Isolates

There were 179 reported nontyphoidal *Salmonella* for 2015. This is 24% more than the 144 reported nontyphoidal *Salmonella* isolates for 2014. The largest contributor of the 2015 isolates were PGH (35 isolates), BRT (31 isolates) and DMC (16 isolates) as seen in **Figure 16**. Most of the isolates were from blood specimens (51%). Other specimens from which nontyphoid *Salmonella* were isolated are: stool, wound, respiratory, urine, tissue and other body fluids (**Figure 17**).

Antimicrobial Resistance

For 2015, rates of resistance of nontyphoid Salmonella are reported as 28.9% for ampicillin (n=149; 95% CI: 21.9-37); 27.7% for co-trimoxazole (n=155; 95% CI:21-356); 12.9% for chloramphenicol (n=124; 95% CI: 7.8-20.4); 10.3% for ciprofloxacin (n=155; 95% CI: 6.2-16.5) and 9.8% to ceftriaxone (n=153; 95% CI: 5.8-15.9) as seen in **Figure 18**. These rates did not differ significantly from that of previous year except for the statistically significant decrease in rate of resistance against ciprofloxacin from 21.6% in 2014 to 10.3% in 2015 (**Figures 19 & 20**).

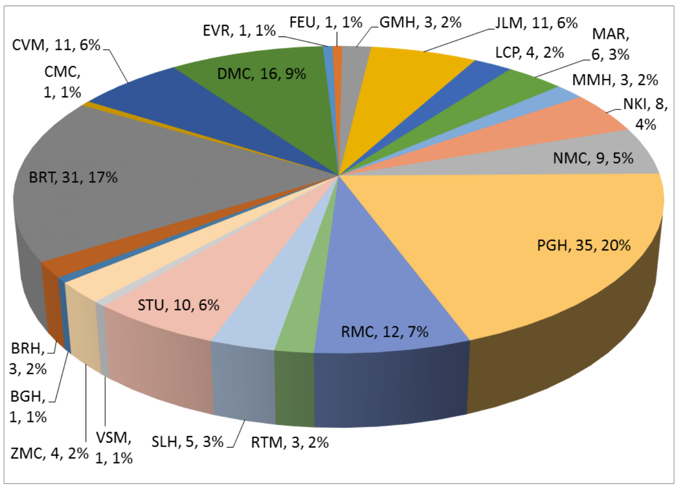

Figure 16. Percent sentinel site contribution for *nontyphoidal Salmonella,* ARSP, 2015, (N=179)

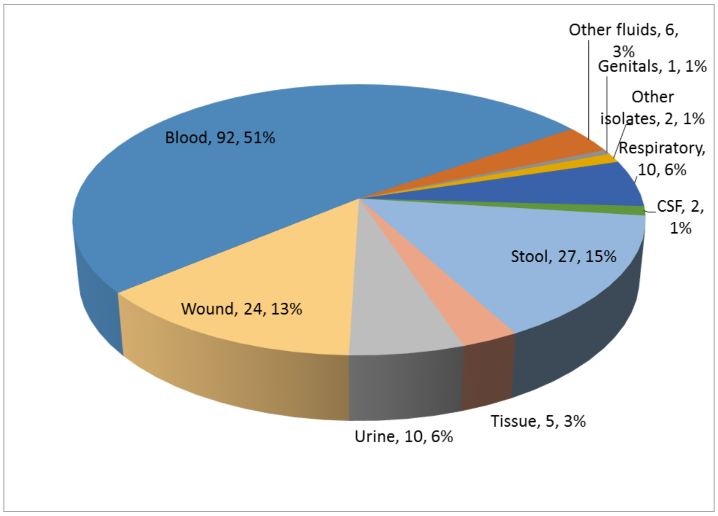

Figure 17. Percent specimen type distribution of *nontyphoidal Salmonella,* ARSP, 2015, (N=179)

Nontyphoidal *Salmonellae*

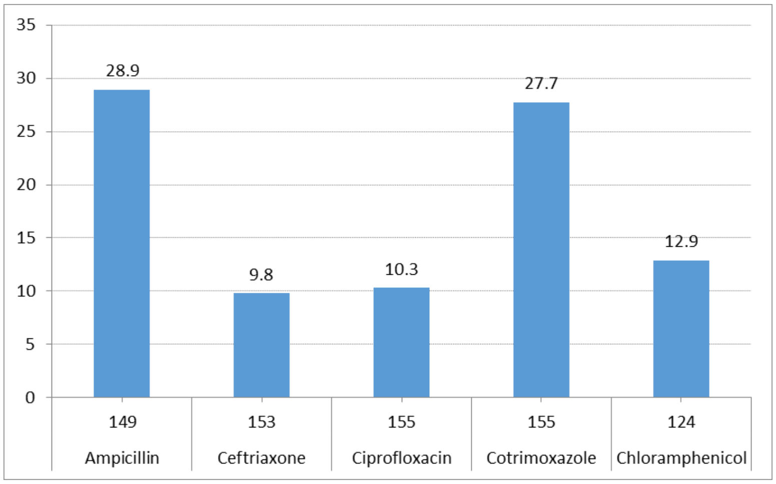

Figure 18. Percent resistance of nontyphoidal *Salmonella*, ARSP, 2015

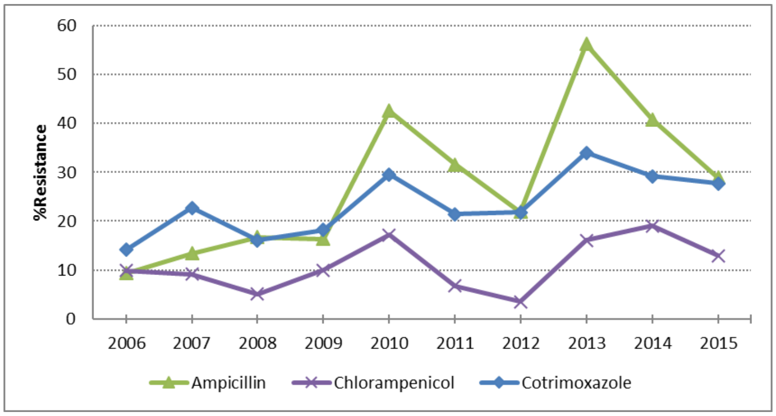

Figure 19. Yearly ampicillin, chloramphenicol and co-trimoxazole resistance rates of nontyphoidal *Salmonella,* ARSP, 2006-2015

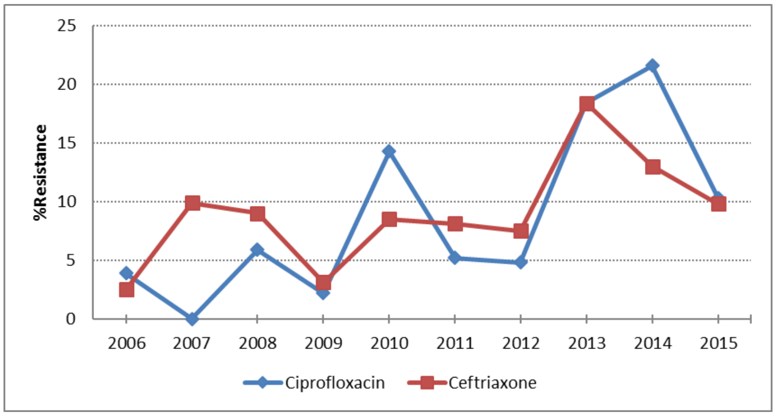

Figure 20. Yearly ciprofloxacin and ceftriaxone resistance rates of nonty-phoidal *Salmonella,* ARSP, 2006-2015

Salmonella serotypes

There were 151 *Salmonella* isolates referred for serotyping at the reference laboratory. Of these, 106 were *S. enterica* serotype Typhi while 3 were identified *S. enterica* serotype Paratyphi A. The most common non-typhoidal serotypes identified were *Salmonella enterica* serotype Enteritidis and *Salmonella enterica* serotype Typhimurium which were also the most commonly reported in the past year. **Table 9** summarizes the serotype data for *Salmonella* referred isolates for 2015.

Table 9: Confirmed Salmonellae serotype, all ARSP sites, 2015

Organism	Number of isolates
Salmonella Typhi	106
Salmonella Enteritidis	17
Salmonella Typhimurium	8
Salmonella Paratyphi A	3
Salmonella Stanley	3
Salmonella Corvallis	2
Salmonella Newport	1
Salmonella Emek	1
Salmonella Breda	1
Salmonella Agona	1
Salmonella Anatum	1
Salmonella Albany	1
Salmonella Bareilly	1
Salmonella Bonn	1
Salmonella Eastbourne	1
Salmonella Choleraesuis	1
Salmonella Abardeen	1
Salmonella Choleraesuis var. Kunzendorf	1

Shigella species

Isolates

For 2015, there were only 15 *Shigella* species isolates reported. Largest sentinel site contributors of the 2015 data were: NMC and GMH (3 isolates each) as seen in **Figure 21**. Most of the isolates were from stool specimens (**Figure 22**).

Antimicrobial Resistance

As there were very few *Shigella* isolates reported for 2015, we combined the results of isolates from 2012 to 2015 in order to obtain a reasonable statistical estimate of the cumulative percentage resistance for *Shigella* species.

High rates of resistance to the previous first line agents against Shigellosis: ampicillin, chloramphenicol and co-trimoxazole is reported with cumulative 2012-2015 rates at 56.9% (n=51; 95% CI: 42.4-70.4), 27% (n=37; 95% CI: 14.4-44.4), and 55.1% (n=49; 95% CI: 40.3-69.1), respectively (**Figures 23 and 24**). Similarly, emerging resistance to newer agents is noted at 16.3% for ciprofloxacin (n=49, 95% CI: 7.8-30.2). When these cumulative data are compared to that of the 2011 reports, rates did not differ significantly (p value >0.05).

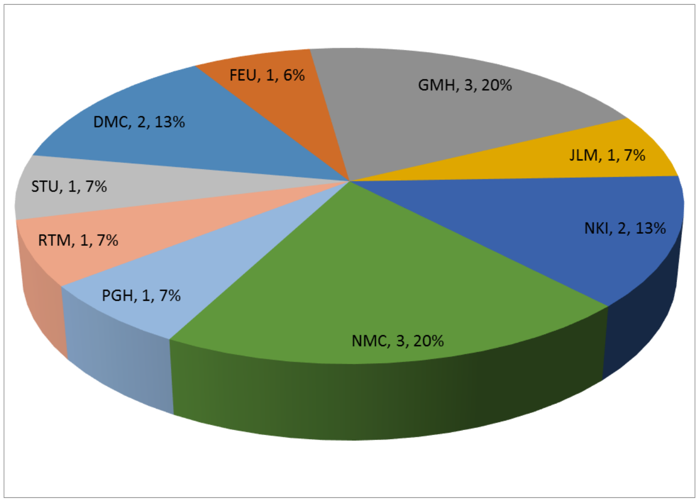

Figure 21. Percent sentinel site contribution for *Shigella sp.*, ARSP, 2015, (N=15)

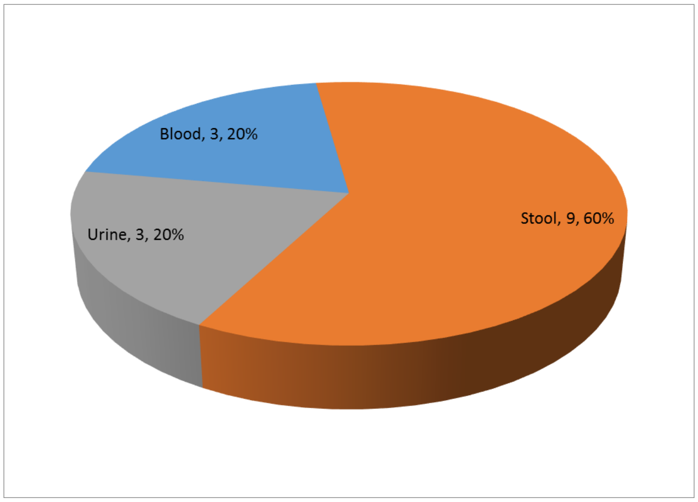

Figure 22. Percent specimen type distribution of *Shigella sp.*, ARSP, 2015, (N=15)

Shigella species

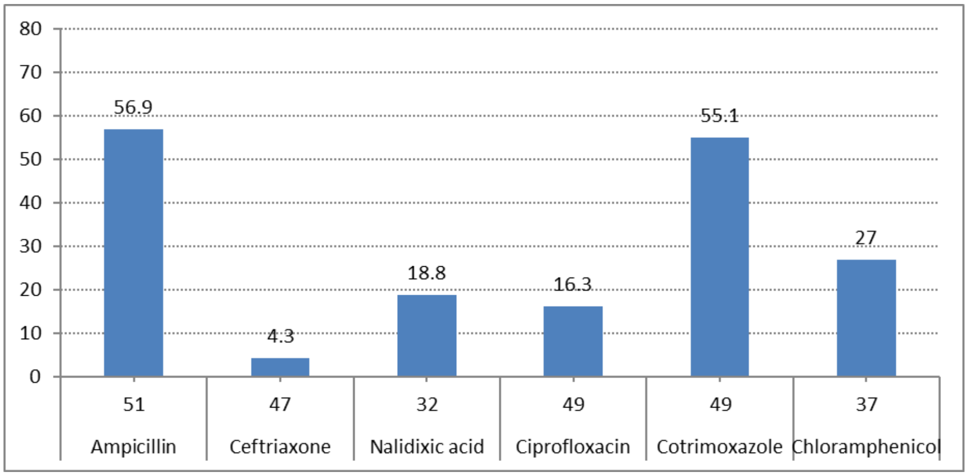

Figure 23. Percent resistance of *Shigella sp.*, ARSP, 2012-2015

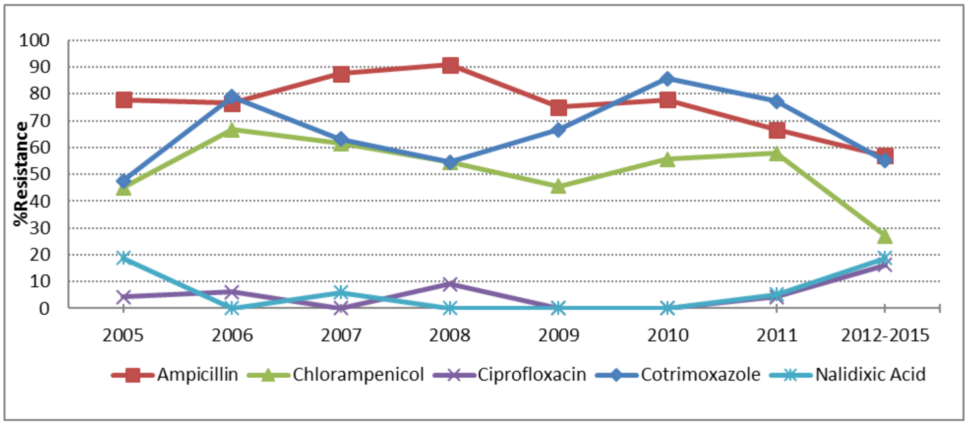

Figure 24. Yearly resistance rates of *Shigella sp.*, ARSP, 2005-2015

Vibrio cholerae

Isolates

There were only 19 isolates of *Vibrio cholerae* reported for 2015. The sentinel site RTM contributed majority (53%) of the *V. cholera* 2015 isolates (**Figure 25**). Most of the isolates were from stool specimens (**Figure 26**).

Antimicrobial Resistance

Since few isolates were reported for 2015, we combined the results of isolates from 2013 to 2015 to arrive at a reasonable statistical estimate of cumulative percentage resistance for *V. cholerae*. For this cumulative data from 2013-2015, as in the past years, *V. cholerae* isolates have remained susceptible to co-trimoxazole, chloramphenicol and tetracycline with no reported chloramphenicol and tetracycline resistant isolate and rates of resistance to co-trimoxazole at 1.7% (n=58; 95% CI: 0.1-10.4) as seen in **Figure 27**. These rates have remained stable for the past 5 years, with reported rates against each of these 3 antibiotics at 5% or less since 2006 (**Figure 28**).

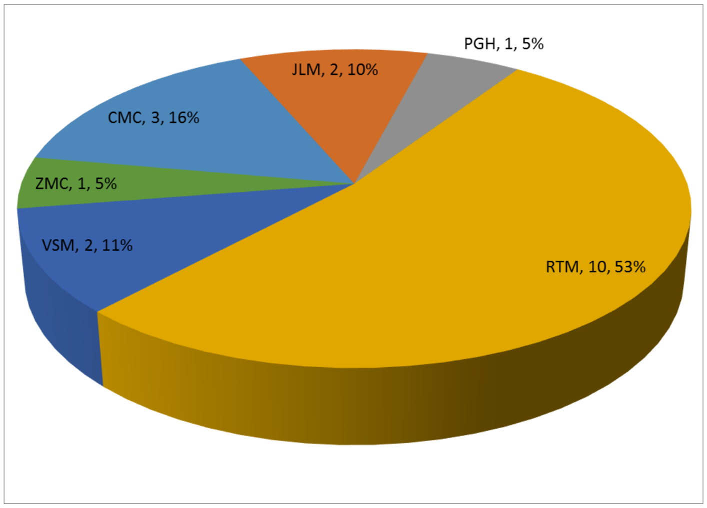

Figure 25. Percent sentinel site contribution for *Vibrio cholerae,* ARSP, 2015, (N=19)

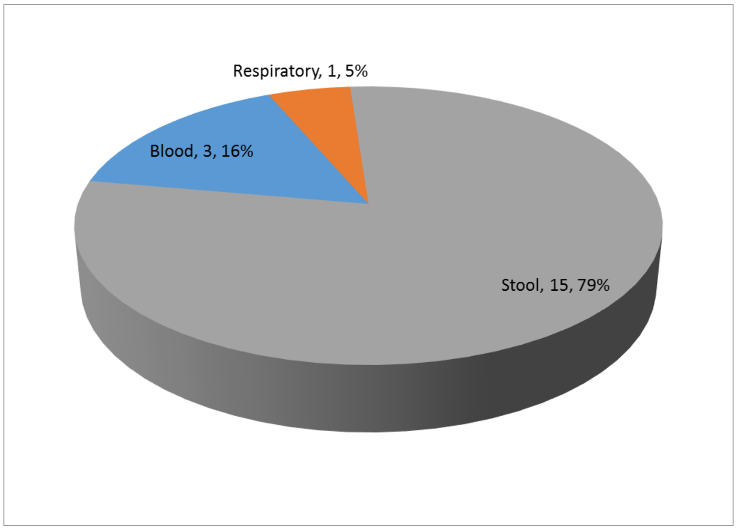

Figure 26. Percent specimen type distribution of *Vibrio cholerae,* ARSP, 2015, (N=19)

Vibrio cholerae

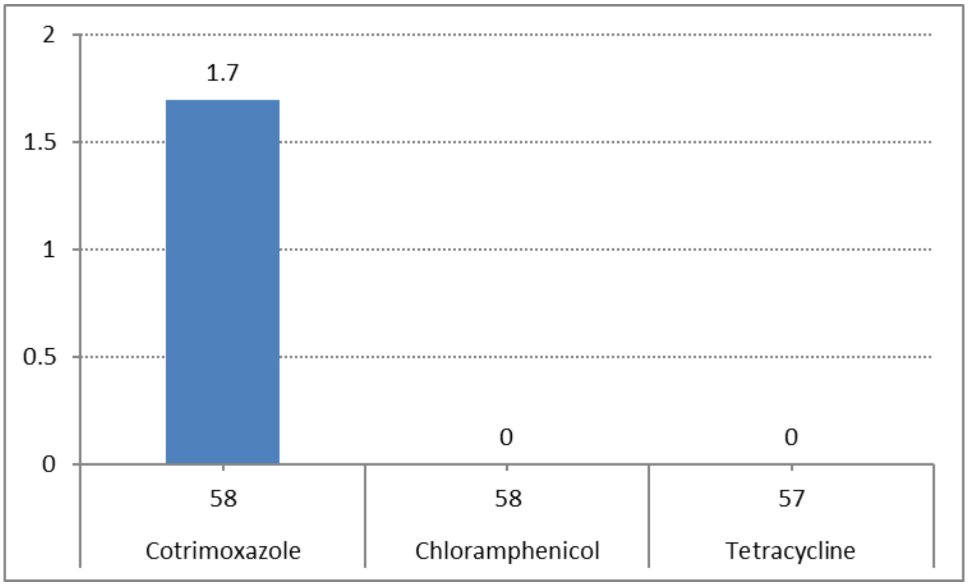

Figure 27. Percent resistance of *Vibrio cholerae*, ARSP, 2013-2015

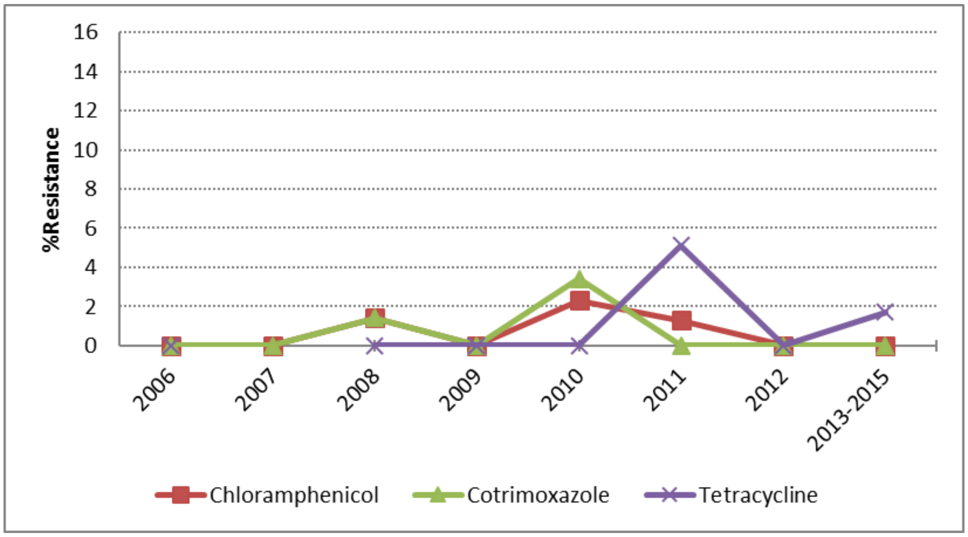

Figure 28. Yearly resistance rates of *Vibrio cholerae,* ARSP, 2006-2015

Neisseria gonorrhoeae

Isolates

There were only 84 *Neisseria gonorrhoeae* isolates reported for 2015. This more than thrice of that reported in 2014. The largest contributors of the 2015 *N. gonorrhoeae* data were BGH (26 isolates), VSM (17 isolates) and JLM (11 isolates) **Figure 29**.

Antimicrobial Resistance

Rates of resistance against penicillin have been at least 80% for the past decade with 2015 resistance rate at 93.6% (n=78; 95%CI:85=97.6). Similarly, resistance of gonococci against tetracycline and ciprofloxacin remain high at 65% (n=80; 95% CI: 53.4-75.1) and 83.1% (n=77; 95% CI: 72.5-90.3), respectively as seen in **Figure 30**. These rates do not differ significantly from the 2013-2014 combined data (**Figure 31**). There were no reported spectinomycin, ceftriaxone nor cefixime-resistant gonococcal isolate for the 2015 data, as in the past years.

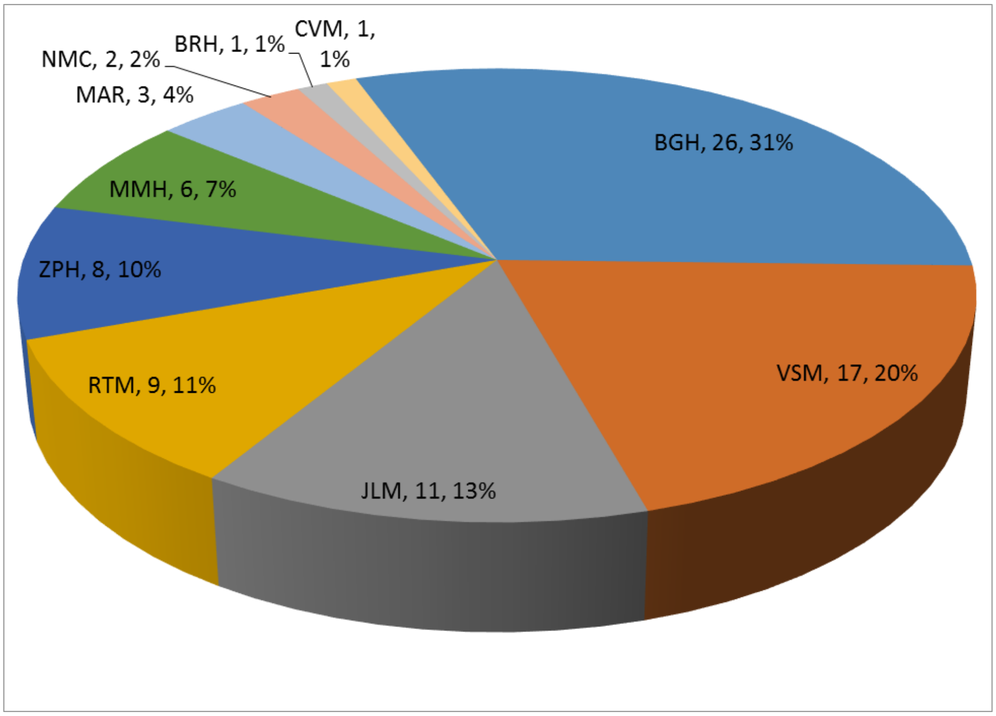

Figure 29. Percent sentinel site contribution for *Neisseria gonorrhoeae,* ARSP, 2015, (N=84)

Neisseria gonorrhoeae

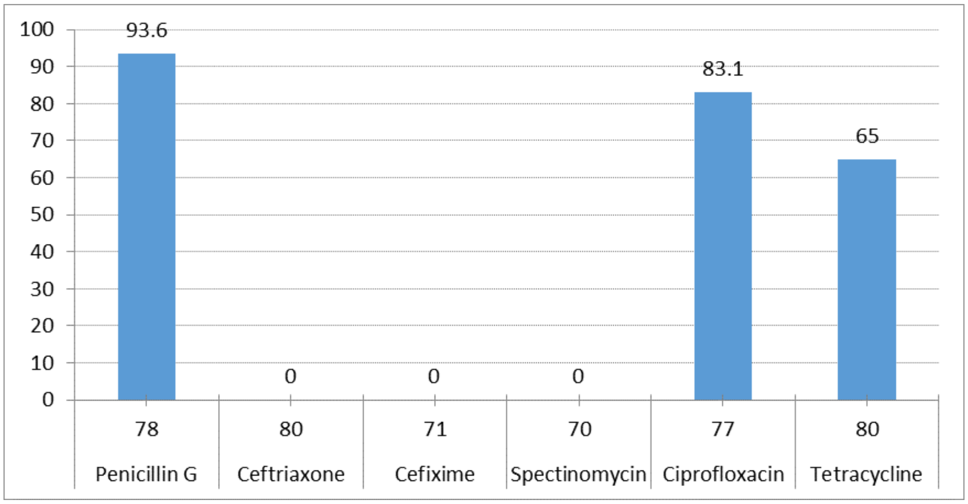

Figure 30. Percent resistance of *Neisseria gonorrhoeae*, ARSP, 2015

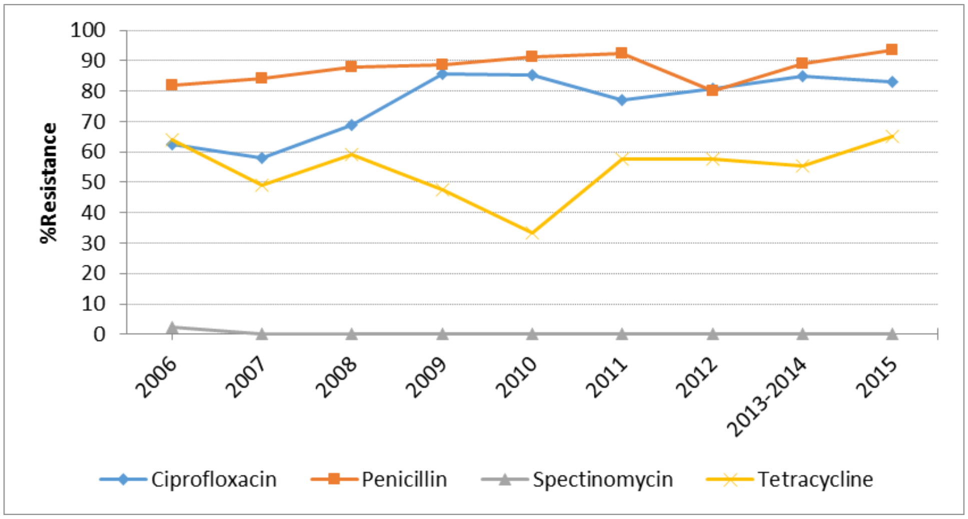

Figure 31. Yearly resistance rates of *Neisseria gonorrhoeae,* ARSP, 2006-2015

Staphylococcus aureus

The Isolates

For 2015, there were a total of 3,900 isolates of *Staphylococcus aureus* reported. These were most commonly isolated from cutaneous/wound, blood and respiratory specimens (**Figures 32**). *S. aureus* was the most common isolate from cutaneous or wound specimens for 2015.

Antimicrobial Resistance

The 2015 resistance rate of *S. aureus* against the β-lactam oxacillin is at 62.6% (n=3,555; 95% CI: 61=64.2). The 2015 methicillin-resistant *S. aureus* (MRSA) rates did not differ significantly from 60.3% reported for 2014 (*p* value > 0.05). The 2015 resistance rates to the rest of the antibiotics tested did not differ significantly from the reports from 2014 except for the significant increase in co-trimoxazole resistance from 22% for 2014 to 25.9% in 2015 (*p* value 0.0003); and significant decrease in reported resistance rate against tetracycline from 9.1% in 2014 to 7.1% in 2015 (p value 0.0032). Although there were a few isolates reported as vancomycin resistant, none of these *S. aureus* isolates were sent for confirmatory testing at the reference laboratory. Resistance rates for S. aureus isolates against commonly used antibiotics for 2015 and from the past 10 years are illustrated in **Figures 33 to 35.**

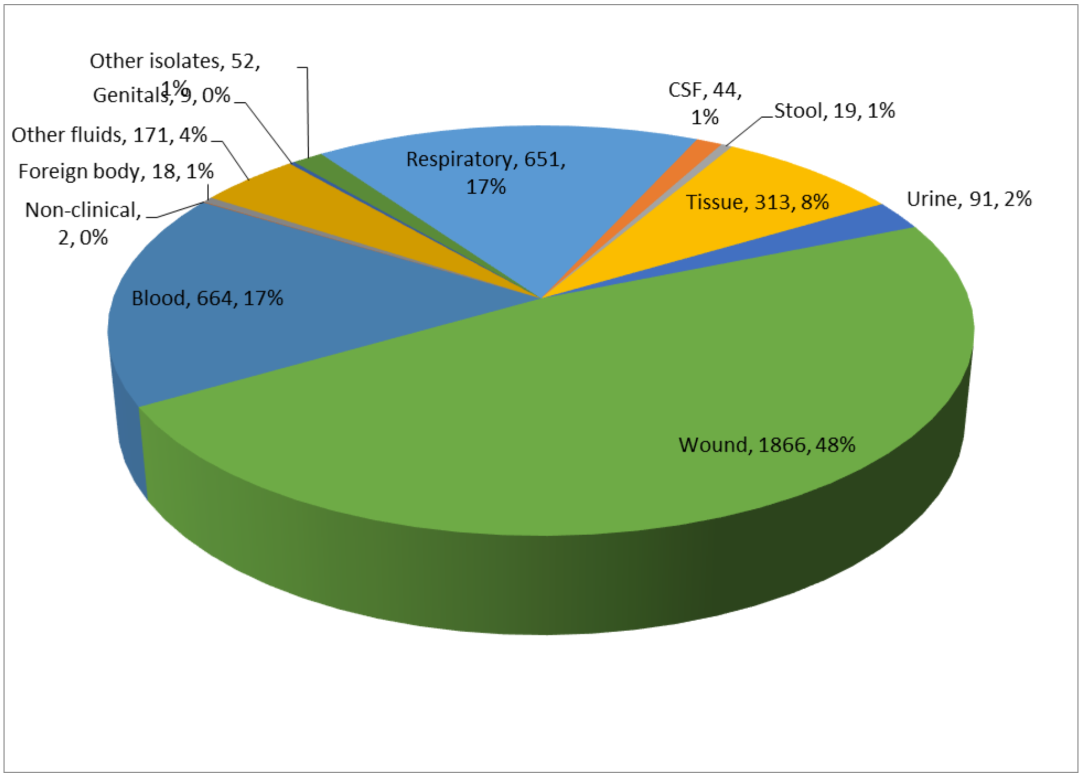

Figure 32. Percent specimen type distribution of *Staphylococcus aureus,* ARSP, 2015, (N=3,900)

Staphylococcus aureus

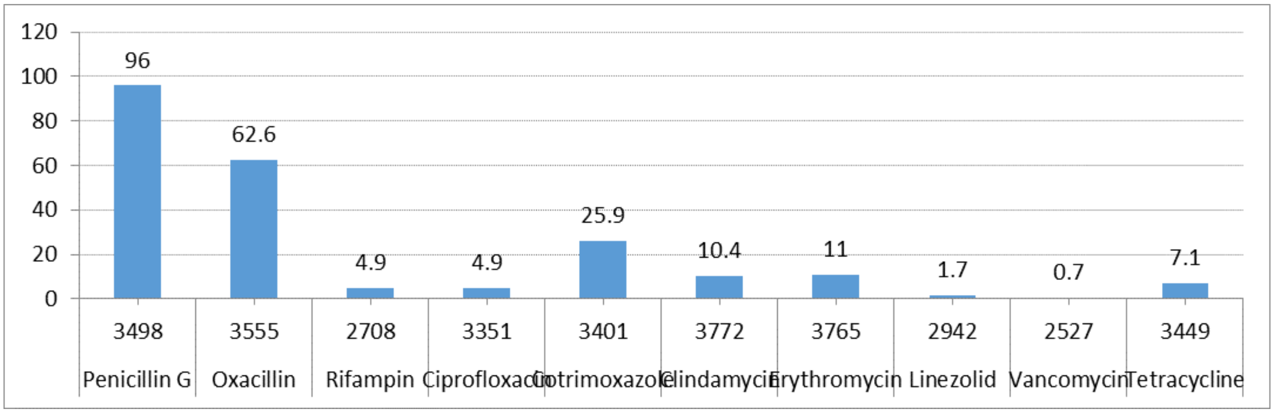

Figure 33. Percent resistance of *Staphylococcus aureus*, ARSP, 2015

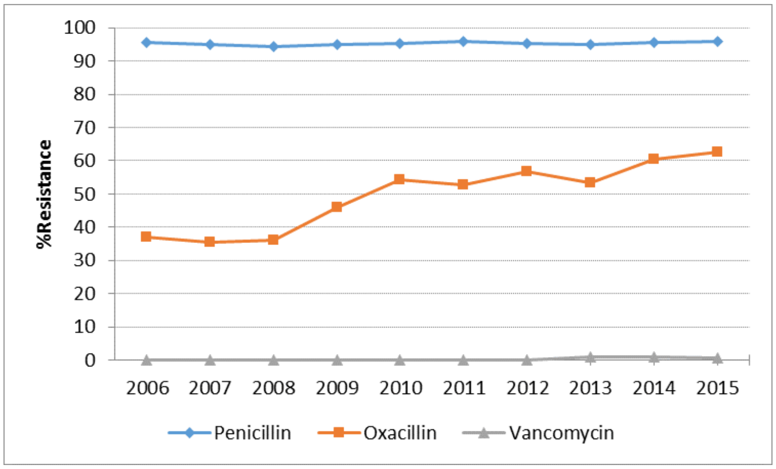

Figure 34. Yearly penicillin, oxacillin and vancomycin resistance rates of *Staphylococcus aureus,* ARSP, 2006-2015

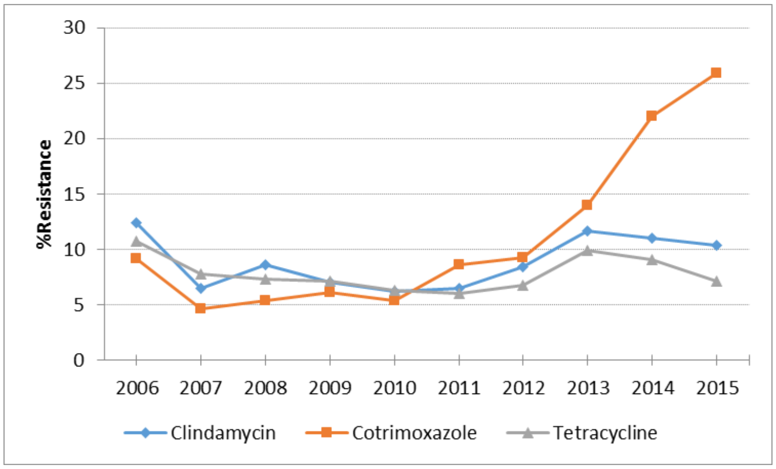

Figure 35. Yearly clindamycin, co-trimoxazole and tetracycline resistance rates of *Staphylococcus aureus,* ARSP, 2006-2015

Staphylococcus aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA)

There were 2,225 MRSA isolates reported from the ARSP sentinel sites for 2015. Most of these isolates were isolated from cutaneous and blood culture isolates. The overall cumulative MRSA rate for 2015 was at 62.6% with variations by sentinel site MRSA rates ranging from as low as 34.4% (NKI, n=61) to as high as 83.6% (LCP, n=55) as depicted in **Figure 36**. *MRSA rates for 2015 were also analyzed by specimen type with 60.2% MRSA rates in the subset of invasive (blood culture) isolates (n=570) and 64.7% MRSA rates in the subset collected from skin and wound specimens (n=1,535).*

Most of these MRSA isolates (85%) were also presumptively community-acquired or isolated from specimens taken from patients in the outpatient department, emergency room and admission within their 1st 2 hospital days.

Rates of resistance of these subset of MRSA isolates to other antibiotics tested were 6.9% to rifampicin (n=1558, 95% CI: 5.8-8.4); 29% to co-trimoxazole (n=1989; 95% CI: 27-31.1); 13% to clindamycin (n=2138; 95% CI: 11.6-14.5); 14% to erythromycin (n=2148, 95% CI: 12.6-15.6); 7.2% to tetracycline (n=2001; 95% CI: 6.1-8.4); 2.2% to linezolid (n=1777, 95% CI: 1.6-3); and 0.9% to vancomycin (n=1546; 05% CI: 0.5-1.5) as seen in **Figure 37**. None of the vancomycin and linezolid resistant isolates were sent to the reference laboratory for confirmatory testing.

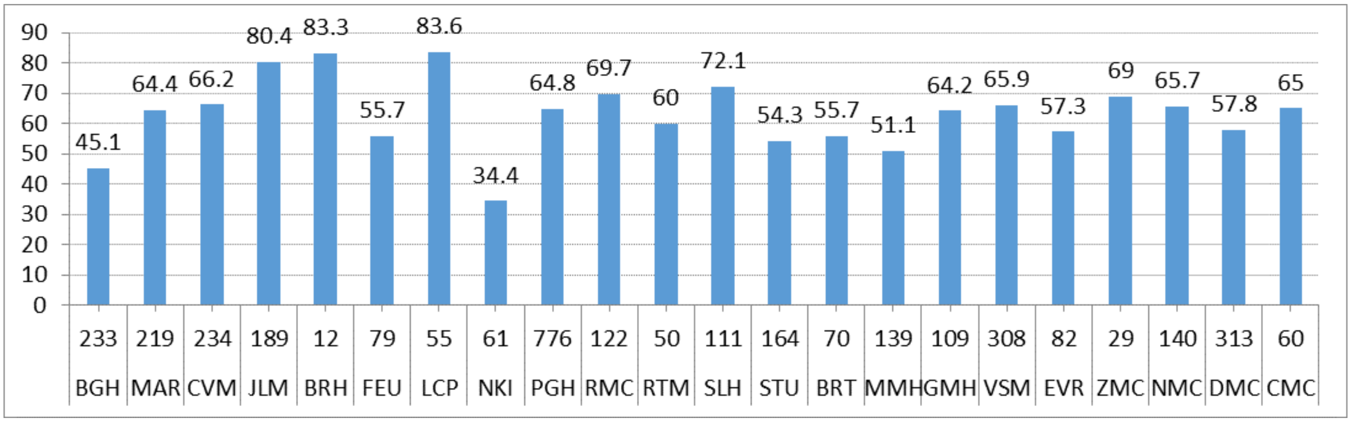

Figure 36. Percent methicillin resistance of *Staphylococcus aureus* from each sentinel sites, ARSP, 2015

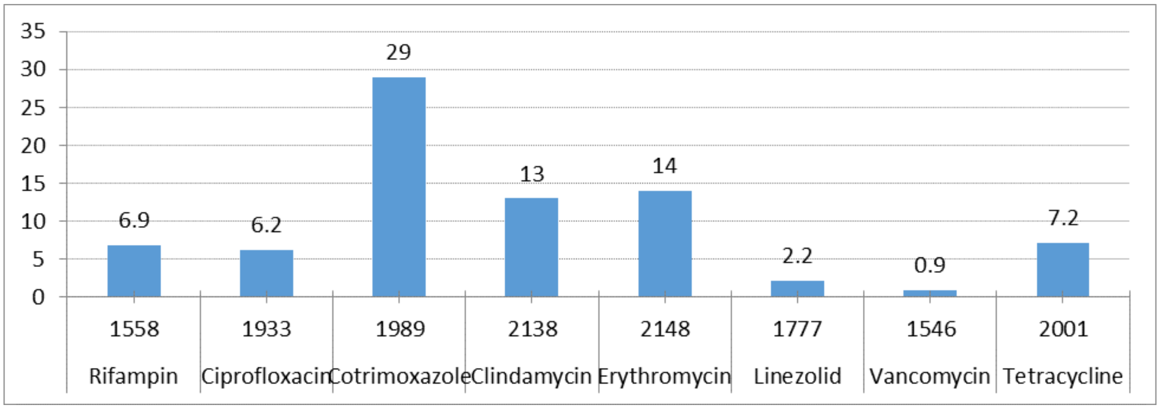

Figure 37. Percent resistance of Methicillin-resistant *Staphylococcus aureus* (MRSA), ARSP, 2015

Enterococcus species

The Isolates

For 2015, there were a total of 1,614 *Enterococcus* species reported of which the commonest were *Enterococcus faecalis* (902 isolates) and *Enterococcus faecium* (331 isolates). These were mostly isolated from urine and blood specimens (**Figure 38**).

Antimicrobial Resistance

For 2015, ampicillin resistance among *E. faecalis* was at 10.9% (n=817; 95% CI: 8.9-13.3). Comparatively, ampicillin-resistance against *E. faecium* was reported higher at 78.1% (n=301; 95% CI: 72.9-82.6). Testing for high-level aminoglycoside resistance identifies loss of the synergistic effect of aminoglycosides with β-lactams and glycopeptides when treating enterococcal infections. For 2015, high level gentamicin and streptomycin resistance for *E. faecalis* was at 17.2% (n=542; 95% CI: 14.4-20.9); and 20.3% (n=543; 95% CI: 17-24), respectively. Similarly, higher high-level gentamicin and streptomycin rates of resistance were seen with *E. faecium* with reports at 50.3% (n=161; 95% CI: 42.4-58.2) and 32.9% (n=167; 95% CI: 26.5-41.3), respectively. Resistance rates against linezolid and vancomycin were reported at 2.4% (n=763; 95% CI: 1.5-3.8) and 1.1% (=848; 95% CI: 0.5-2.1) respectively for *E. faecalis*; and 1.1% (n=269; 95% CI: 0.3-3.5) and 1.9% (n=319; 95% CI: 0.8-4.3) respectively for *E. faecium*. The 2015 rates of resistance of *E. faecalis* and *E. faecium* are seen in **Figures 39 and 40**, respectively.

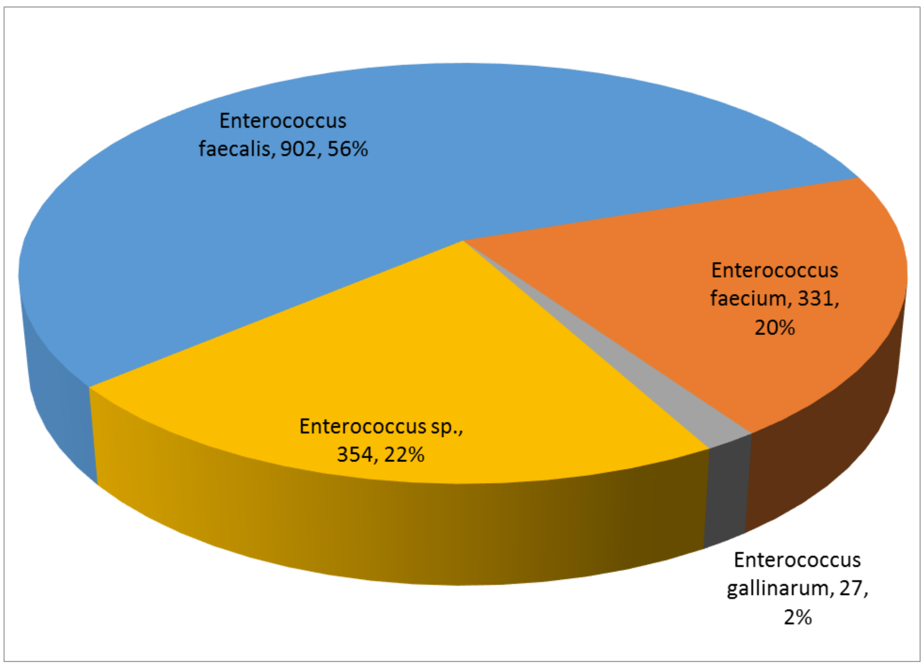

Figure 38. Percent organism distribution of *Enterococcus species,* ARSP, 2015, (N=1,614)

Enterococcus species

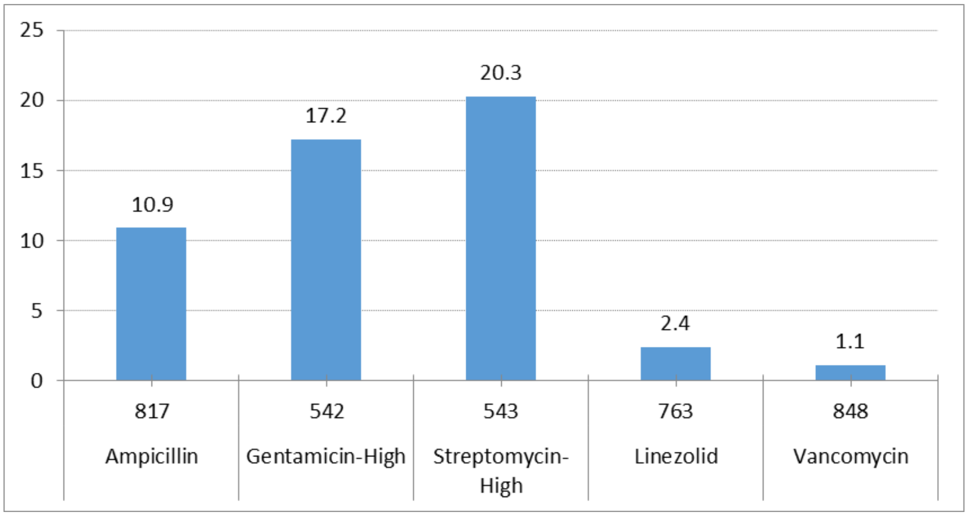

Figure 39. Percent resistance of *Enterococcus faecalis*, ARSP, 2015

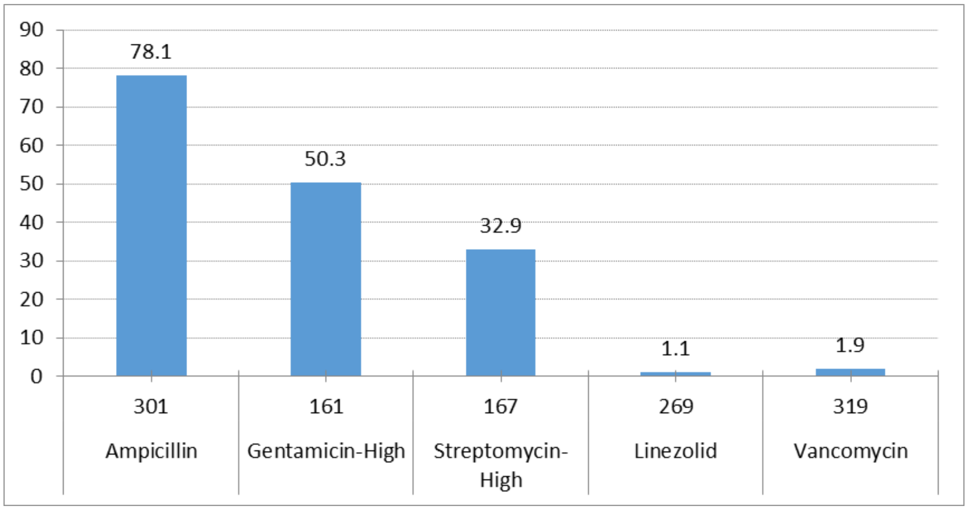

Figure 40. Percent resistance of *Enterococcus faecium*, ARSP, 2015

Escherichia coli

The Isolates

A total of 6,420 *Escherichia coli* isolates were reported for 2015. Majority of the isolates were from urine specimens (52%). Others were isolated from respiratory, blood, CSF and cutaneous specimens (**Figure 41**). *E. coli* was the most common urine specimen isolate.

Antimicrobial Resistance

E. coli rates of resistance have been increasing against commonly used and reserved drugs for the past years, with resistance rates for 2015 at 81.8% for ampicillin (n=5,488; 95% CI: 80.7-82.8); 29.1% for ampicillin-sulbactam (n=4,215; 95% CI: 27.7-30.5); 33.7% for cefuroxime (n=2,590; 95% CI: 31.9-35.6); 34.6% for ceftriaxone (n=5,458; 95% CI: 17.6-19.6); 65.8% for co-trimoxazole (n=5,490; 95% CI: 64.5-67.1); 39.2% for ciprofloxacin (n=5,618; 95% CI: 37.9-40.5); 3.7% for amikacin (n=5,605; 95% CI: 3.2-4.2); 21% for gentamicin (n=5,907; 95% CI: 20-22.1); 4.2% for ertapenem (n=3,036; 95% CI: 3.5-5); 3.5% for imipenem (n=6,132; 95% CI: 3.1-4); and 3.4 % for meropenem (n=5,794; 95% CI: 3.-3.9). These rates when compared to that of 2014 showed statistically significant increase in resistance from 24.8% in 2014 to 29.1% in 2015 for ampicillin-sulbactam (p= 0.0001); from 32.2% in 2014 to 34.6% in 2015 for ceftriaxone (p= 0.0087); and from 2.1% in 2014 to 3.5% in 2015 for imipenem (p= 0.0001). Resistance rates for 2015 and the past 10 years to the antimicrobial agents tested against *E. coli* are seen in **Figures 42-45**.

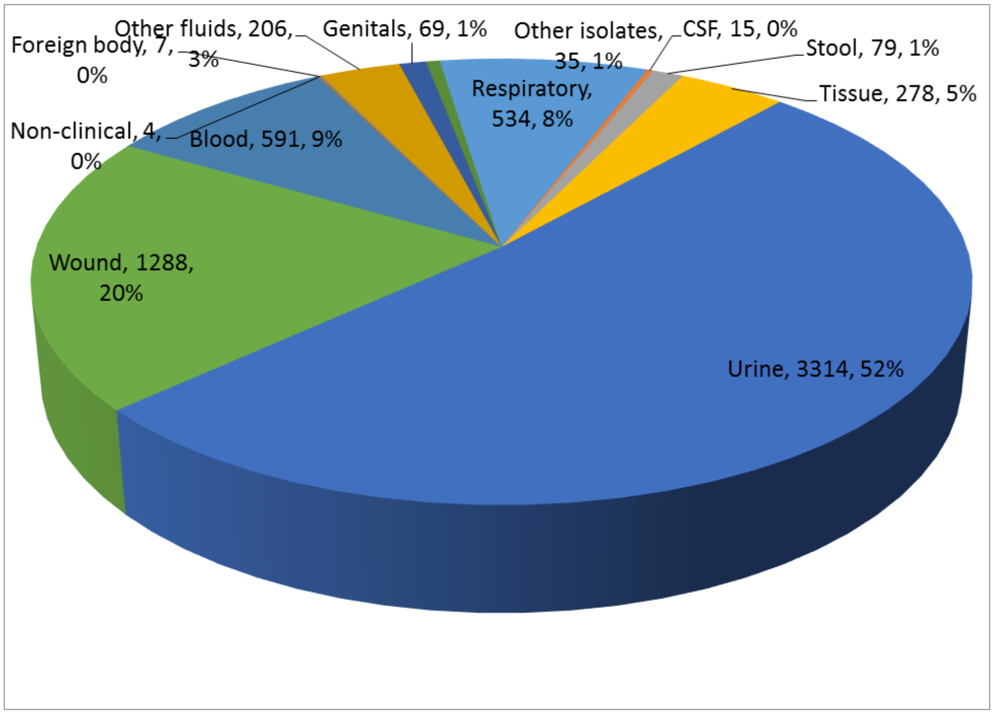

Figure 41. Percent specimen type distribution of *Escherichia coli,* ARSP, 2015, (N=6,420)

Escherichia coli

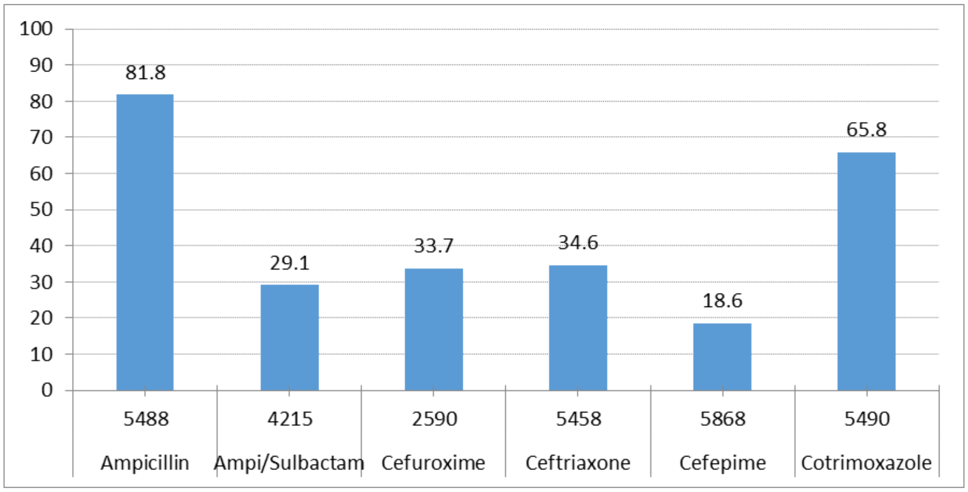

Figure 42. Percent penicillins, cephalosphorins and co-trimoxazole resistance of *Escherichia coli*, ARSP, 2015

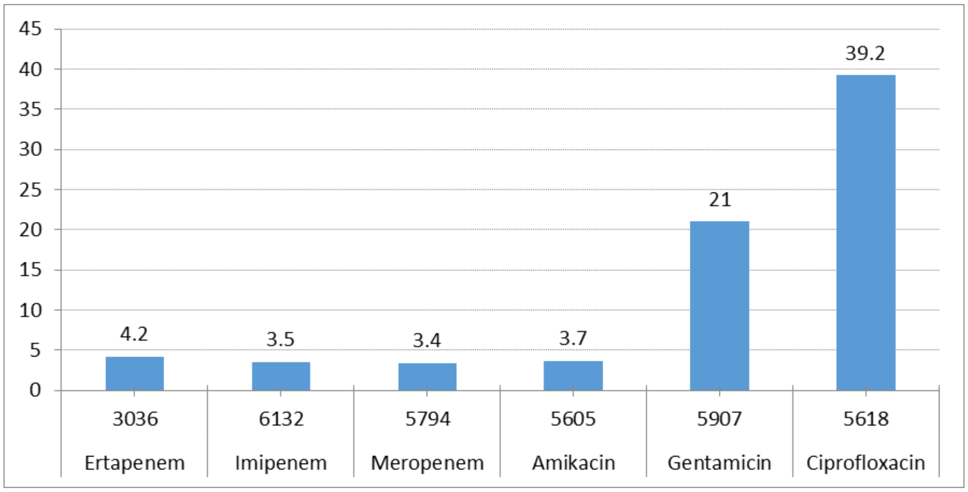

Figure 43. Percent carbapenem, aminoglycoside and fluoroquinolone resistance of *Escherichia coli*, ARSP, 2015

Escherichia coli

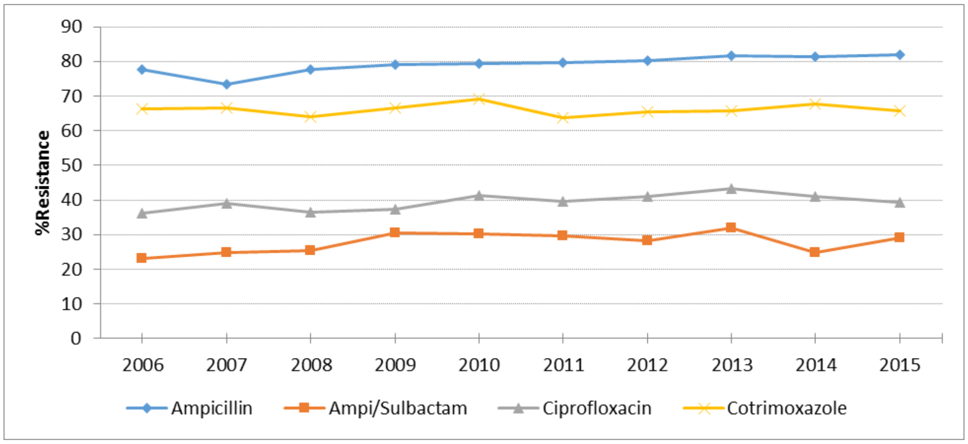

Figure 44. Yearly ampicillin, ampi-sulbactam, ciprofloxacin and co-trimoxazole resistance rates of *Escherichia coli,* ARSP, 2006-2015

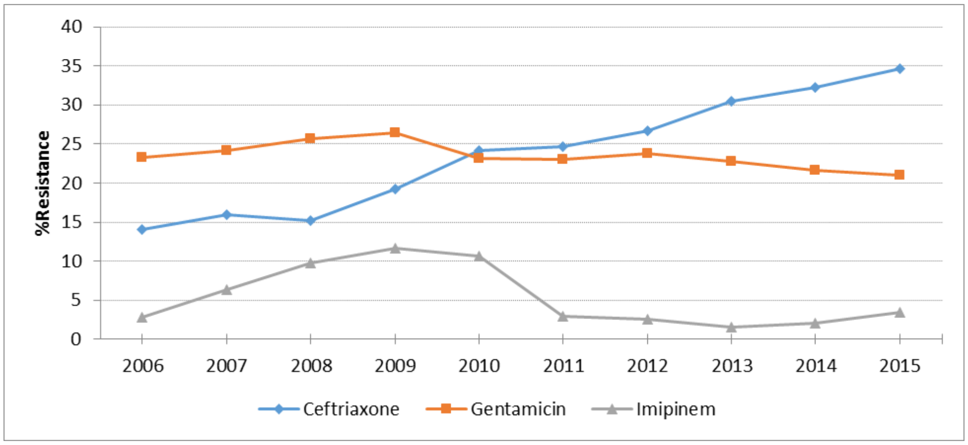

Figure 45. Yearly ceftriaxone, gentamicin and imipinem resistance rates of *Escherichia coli,* ARSP, 2006-2015

Escherichia coli

Urinary *Escherichia coli*

There were 3,314 urinary *Escherichia coli* isolates reported for 2015 making this organism the most common bacterial isolate from urine specimens. Resistance data of *outpatient urinary E. coli isolates against commonly used oral antibiotics for urinary tract infections showed lowest resistance rate against nitrofurantoin at 3.1% (n=814; 95% CI: 2.1-4.6). In the subset of urinary E. coli isolated from admitted or hospitalized patients, rates of resistance against commonly used parenteral antibiotics for urinary tract infection was lowest against amikacin at 4.2% (n=2105; 95% CI: 3.4-5.2) and ertapenem at 5.7% (n=1241; 95% CI: 4.5-7.2-).* Percentage resistance of 2015 urinary *E. coli* isolates against the panel of antimicrobials by are summarized in **Table 10**.

Table 10. Percentage of urinary Escherichia coli, all ARSP sites, Jan-Dec 2015

	Outpatient			Inpatient		
Antimicrobial	**N**	**%R**	**%R 95% C.I.**	**N**	**%R**	**%R 95% C.I.**
Ampicillin	750	77.5	74.3-80.4	2074	83.9	82.2-85.4
Co-amoxiclav	927	23.5	20.8-26.4	2209	31.6	29.7-33.6
Cefuroxime	407	21.9	18.0-26.3	990	38.1	35.1-41.2
Ciprofloxacin	798	42.7	39.2-46.2	2096	43.4	41.3-45.6
Co-trimoxazole	800	57.1	53.6-60.5	2058	67.9	65.8-69.9
Nitrofurantoin	814	3.1	2.1-4.6	1585	6.5	5.4-7.9
Intravenous Agents						
Pip/Tazobactam	864	3.9	2.8-5.5	2048	10.7	9.4-12.1
Ceftriaxone	816	29.9	26.8-33.2	1973	40.4	38.2-42.6
Ertapenem	387	0.5	0.1-2.0	1241	5.7	4.5-7.2
Amikacin	793	4.8	3.5-6.7	2105	4.2	3.4-5.2

Klebsiella pneumoniae

The Isolates

A total of 8,408 *Klebsiella pneumoniae* isolates reported for 2015. Majority of the isolates were from respiratory specimens (55%). Others were isolated from urine, wound or cutaneous and blood specimens (**Figure 46**).

Antimicrobial Resistance

Klebsiella pneumoniae rates of resistance of resistance for commonly used antimicrobials for 2015 are: 37% for amoxicillin-clavulanic acid (n=7,625; 95% CI:35.9-38.1); 21.1% for piperacillin-tazobactam (n=7,757; 95% CI: 20.3-22.1); 49.1% for cefuroxime (n=7,409; 95% CI: 47.3-50.9); 40.6% for ceftriaxone (n=7,409; 95% CI: 39.5-41.7); 26.1% for cefepime (n=26.1%; 95% CI: 25.1-27.1); 24.1% for gentamicin (n=7,833; 95% CI: 23.2-25.1); and amikacin at 6.8% (n=7,426; 95% CI: 6.2-7.4). These 2015 resistance rates did not differ significantly from reported rates from the previous year except for the statistically significant increase in resistance rates of amoxicillin-clavulanic acid from 31.1% in 2014 to 37% in 2015 (p value 0.0001).

Rapidly emerging resistance against the carbapenems has been observed for the past years with statistically significant increase in resistance rates for all 3 tested carbapenems: from 6.9% in 2014 to 11.1% in 2015 for imipenem (*p* value 0.0001); from 7.6% in 2014 to 11.9% in 2015 for meropenem (p value 0.0001); and from 10% in 2014 to 15.3% in 2015 for ertapenem (p value 0.0001). Resistance rates for the antimicrobial agents tested against *Klebsiella pneumoniae* for 2015 and the past decade are seen in **Figures 47-50**.

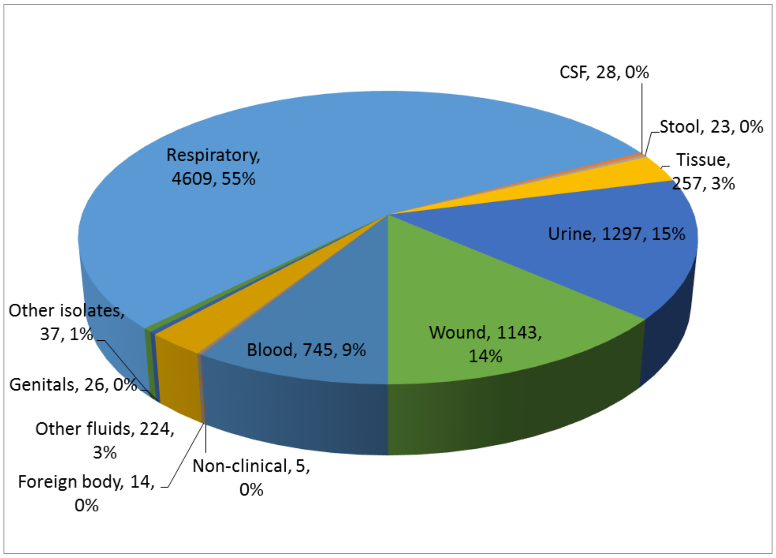

Figure 46. Percent specimen type distribution of *Klebsiella pneumoniae,* ARSP, 2015, (N=8,408)

Klebsiella pneumoniae

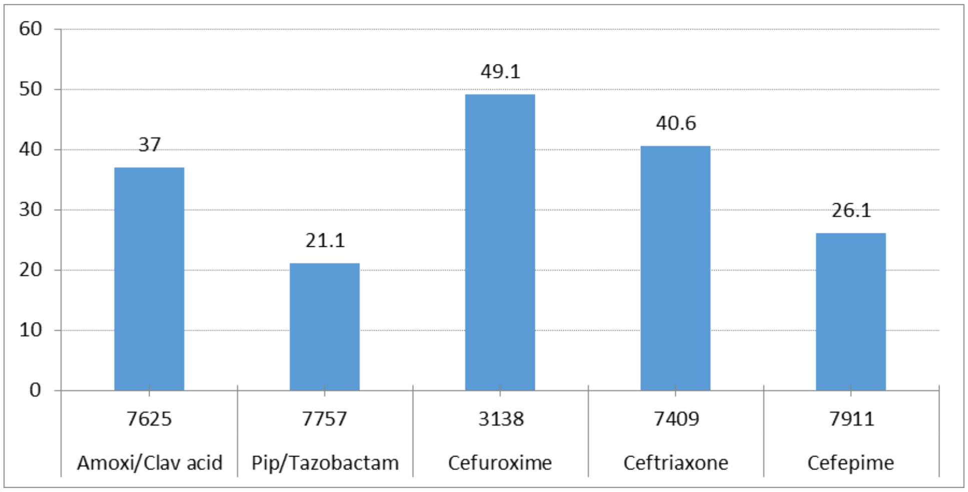

Figure 47. Percent beta-lactams resistance of *Klebsiella pneumoniae*, ARSP, 2015

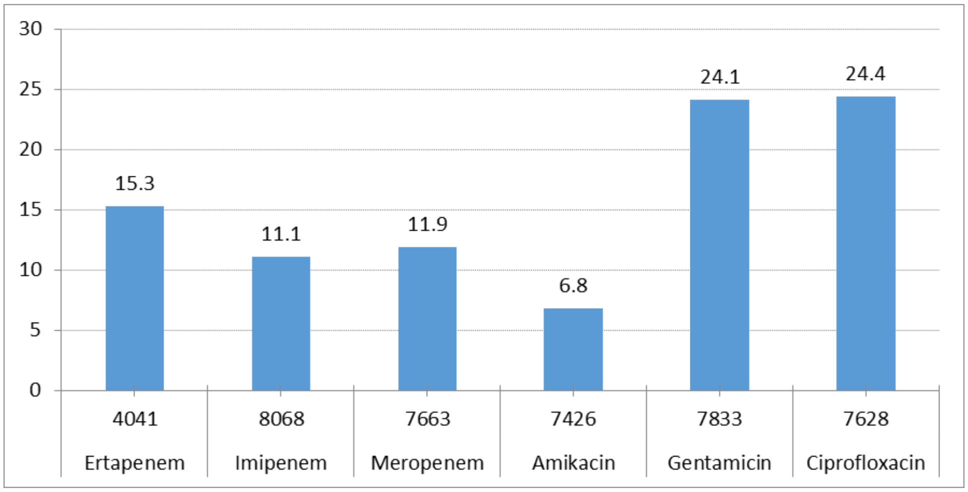

Figure 48. Percent amoxicillin-clavulanic acid, ceftriaxone and ciprofloxacin resistance of *Klebsiella pneumoniae*, ARSP, 2015

Klebsiella pneumoniae

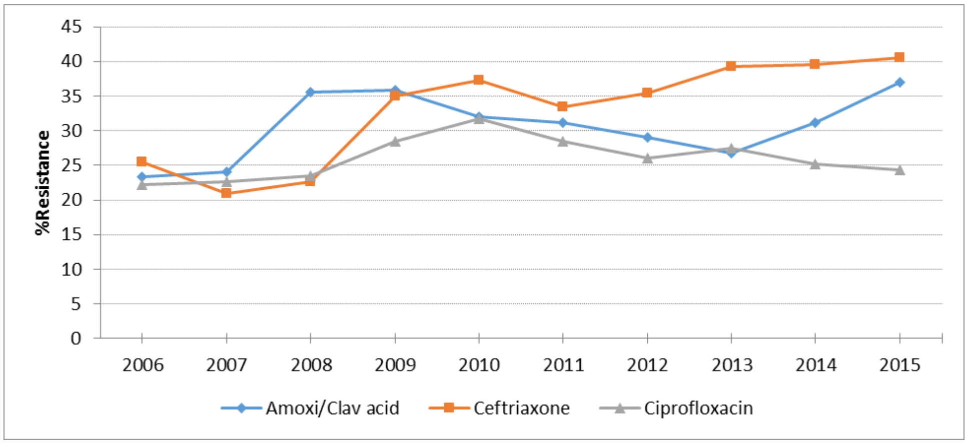

Figure 49. Yearly amoxicillin-clavulanic acid, ceftriaxone and ciprofloxacin resistance rates of *Klebsiella pneumoniae,* ARSP, 2006-2015

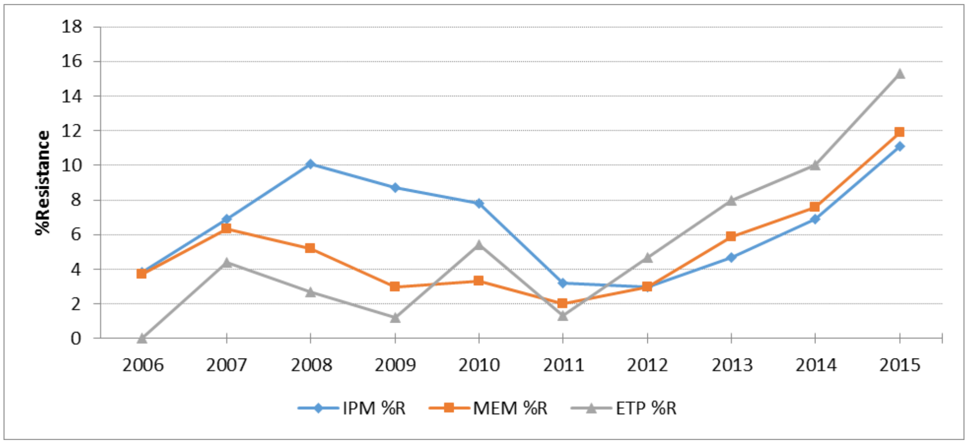

Figure 50. Yearly carbapenems resistance rates of *Klebsiella pneumoniae,* ARSP, 2006-2015

Extended-spectrum β-lactamase-producing *Enterobacteriaceae*

Extended-spectrum β-lactamases (ESBLs) are enzymes that mediate resistance to extended-spectrum cephalosporins and monobactams but do not affect cephamycins or carbapenems. (John E. Bennett, 2015)

Using ceftazidime disk diffusion as initial screening for ESBL production, *out of 5,578 E. coli isolates tested, 27% screened positive (ESBL suspect).* ESBL-suspect *E. coli* rates varied by sentinel sites from as low as 9.5% (BGH) to as high as 51.6% (STU) as seen in **Figure 51**.

Using ceftazidime disk diffusion as initial screening for ESBL production, *out of 7,620 K. pneumoniae isolates tested, 38% screened positive (ESBL suspect).* ESBL-suspect *K. pneumoniae* rates varied by sentinel sites from as low as 13.6% (BGH) to as high as 82.9% (STU) as seen in **Figure 52**.

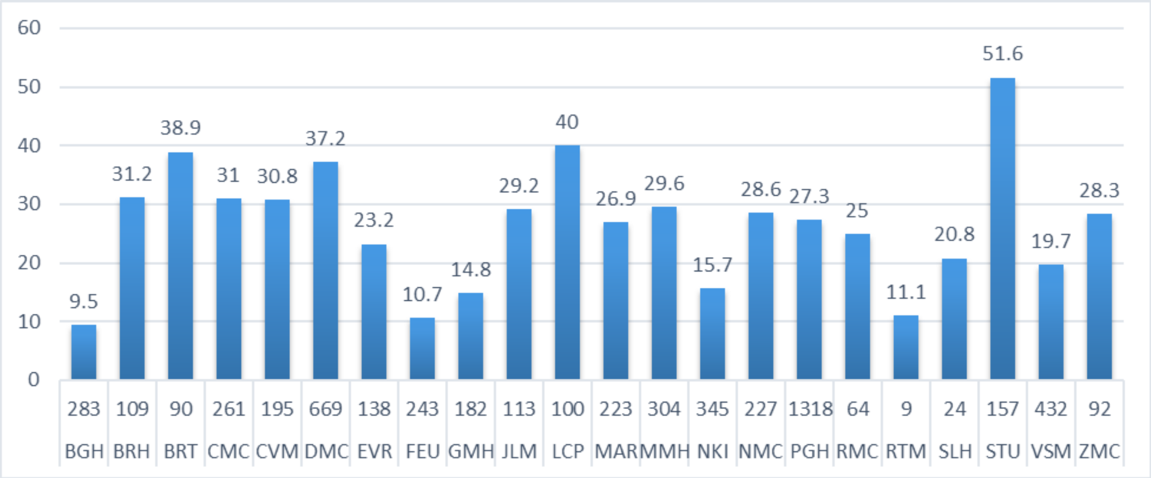

Figure 51. Percentage of ESBL-suspect (ceftazidime resistant) *Escherichia coli*, ARSP, 2015

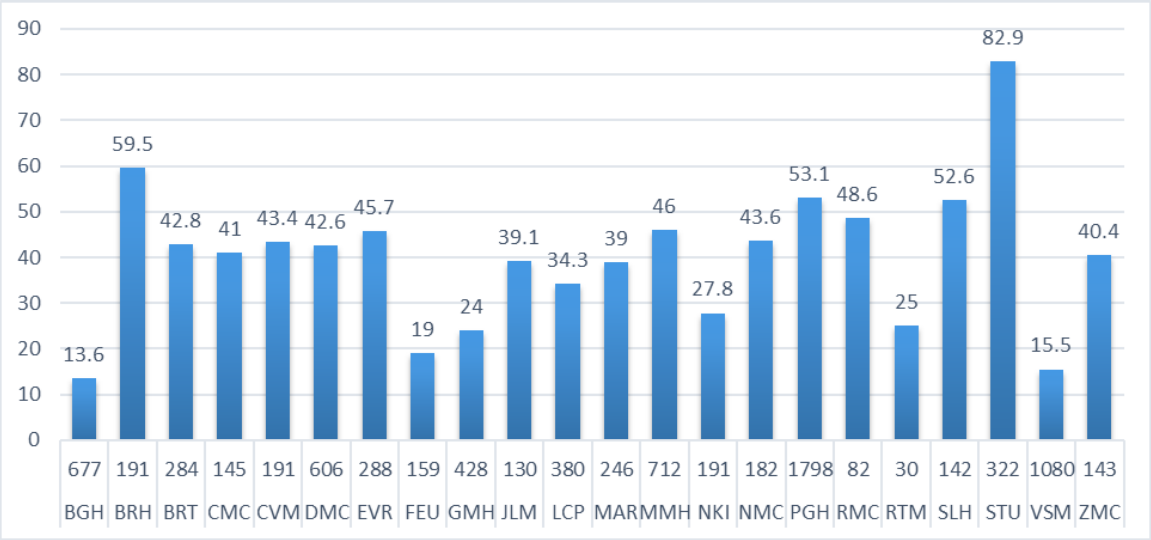

Figure 52. Percentage of ESBL-suspect (ceftazidime resistant) *Klebsiella pneumoniae*, ARSP, 2015

Pseudomonas aeruginosa

The Isolates

For 2015, there were 4,430 *P. aeruginosa* isolates which were most commonly isolated from respiratory, cutaneous, urine, tissue and blood specimens (**Figure 53)**.

Antimicrobial Resistance

The 2015 resistance rates of *P. aeruginosa* isolates to commonly used antimicrobials tested was lowest against amikacin at 7.3% (n=4,137; 95% CI: 6.5-8.1) and highest against imipenem at 17.2% (n=4,234; 95% CI: 16.1-18.4) and ceftazidime at 17.2% (n=4,215; 95% CI: 16.1-18.4). When the 2015 reported resistance data to agents used for treating *P. aeruginosa* infections are compared to those from 2014, statistically significant decrease in rates were noted for amikacin from the reported 9.5% in 2014 to the 7.3% reported for 2015 (*p* value 0.004); and ciprofloxacin from the 15.6% reported in 2014 to the 13.4% rate for 2015 (*p* value 0.0057). The rest of the antimicrobials resistance rates for 2015 did not differ statistically from those reported the year prior. Resistance rates of *P. aeruginosa* to antimicrobials for treatment for 2015 and the past 10 years are illustrated on **Figures 54-55.**

Multidrug-resistant pathogens are increasingly recognized globally. Terminologies are summarized in **Table 11**. *P. aeruginosa* MDR and possible-XDR rates are noticeably higher in the subset of invasive (blood culture) isolates as in the previous year (**Table 12**).

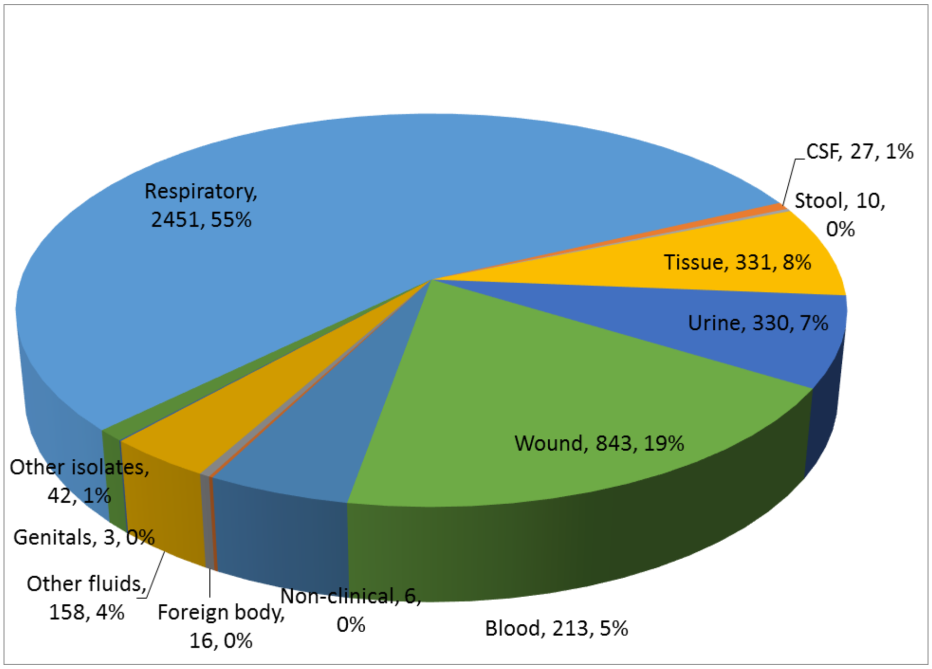

Figure 53. Percent specimen type distribution of *Pseudomonas aeruginosa,* ARSP, 2015, (N=4,430)

Pseudomonas aeruginosa

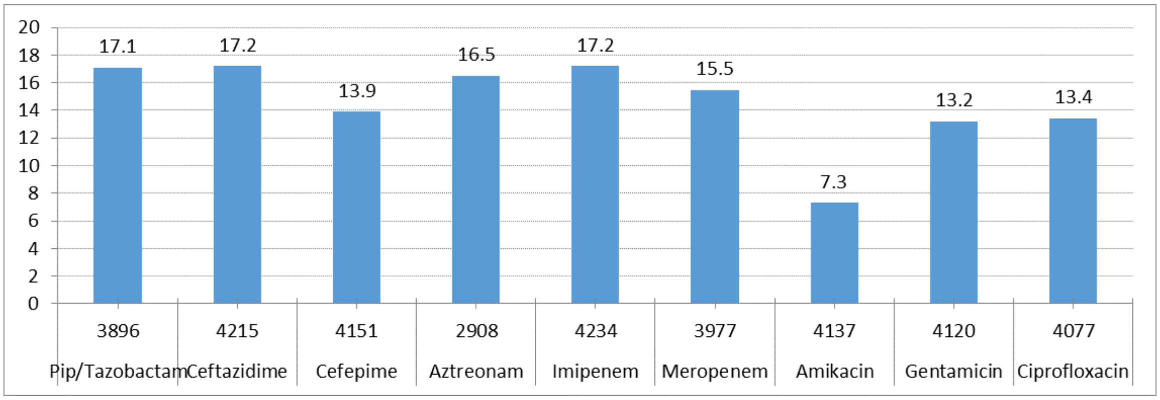

Figure 54. Percent resistance of *Pseudomonas aeruginosa*, ARSP, 2015

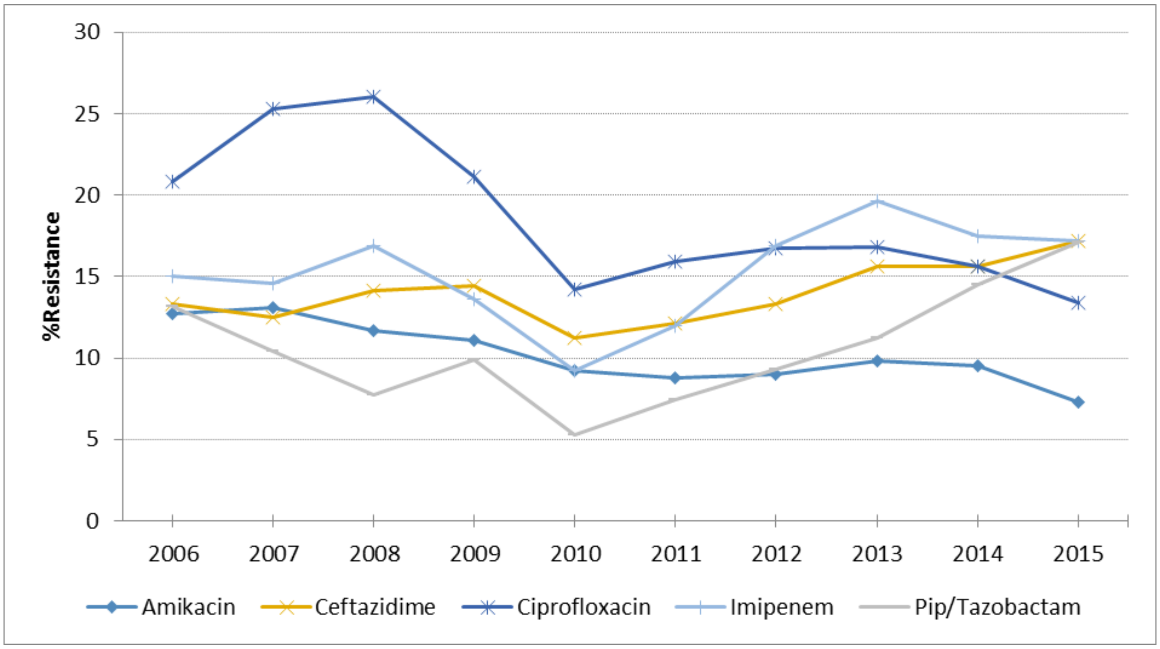

Figure 55. Yearly resistance rates of *Pseudomonas aeruginosa,* ARSP, 2006-2015

Acinetobacter baumannii

The Isolates

For 2015, there were 3,575 *A. baumannii* isolates which were most commonly isolated from respiratory, blood, urine and cutaneous wound specimens (**Figure 56**).

Antimicrobial Resistance

For the 2015 data, more than a third of the reported *A. baumannii* isolates are resistant to commonly used antimicrobials for treatment with lowest rates for the aminoglycosides amikacin at 31% (n=2,827; 95% CI: 29.3-32.7) and gentamicin at 36.4% (n=3,358; 95% CI: 34.8-38.1). Resistance rates against the other antibiotics tested remain high at 46.3% for ampicillin-sulbactam (n=2,586; 95% CI: 44.4-48.2); 55.1 for cefepime n=3,418; 95% CI: 534-56.8); 54.1% for imipenem (n=3,421; 95% CI: 52.4-55.8); 55.2% for ciprofloxacin (n=3,226; 95% CI: 53.5-56.9) and 59.3% for co-trimoxazole (n=3,129; 95% CI: 57.8-61.2).

When 2015 data were compared to reported rates for 2014, statistically significant increase in resistance rates were noted for ampicillin-sulbactam from 39.3% in 2014 to 46.3% in 2015 (p value 0.0001); ceftazidime from 39.4% in 2014 to 49.2% in 2015 (p value 00001); ciprofloxacin from 46.3% in 2014 to 55.2% in 2015 (p value 0.0001); imipenem from 45.3% in 2014 to 54.1% in 2015 (p value 0.0001); and meropenem from 46.7% in 2014 to 53.5% in 2015 (p value 0.0001). In contrast, significant decrease in *A. baumannii* resistance rates is noted for amikacin from 40% in 2014 to 31% in 2015 (p value 0.0001). Resistance rates of *A. baumannii* to antimicrobials for treatment for 2015 and the past 10 years are illustrated on **Figures 57-59**.

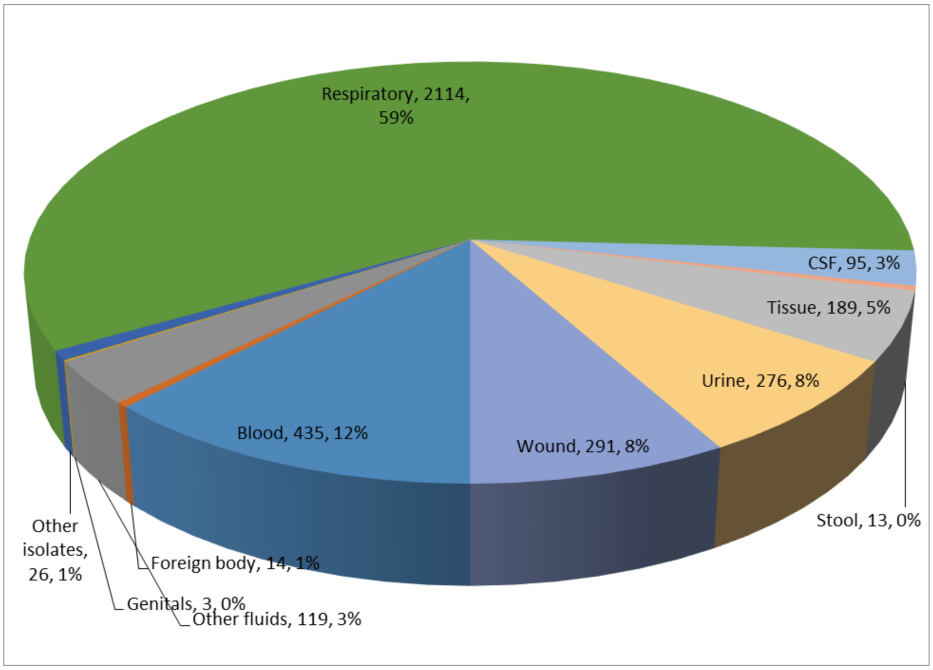

Figure 56. Percent specimen type distribution of *Acinetobacter baumannii,* ARSP, 2015, (N=3,575)

Acinetobacter baumannii

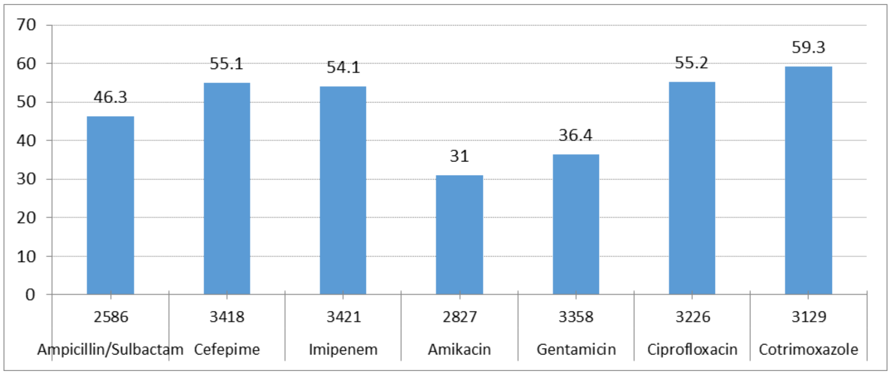

Figure 57. Percent resistance of *Acinetobacter baumannii*, ARSP, 2015

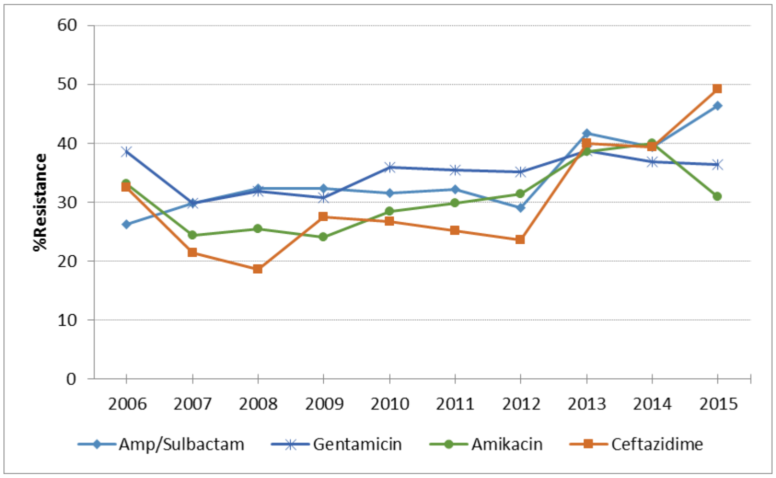

Figure 58. Yearly ampicillin-sulbactam, amikacin and gentamicin resistance rates of *Acinetobacter baumannii,* ARSP, 2006-2015

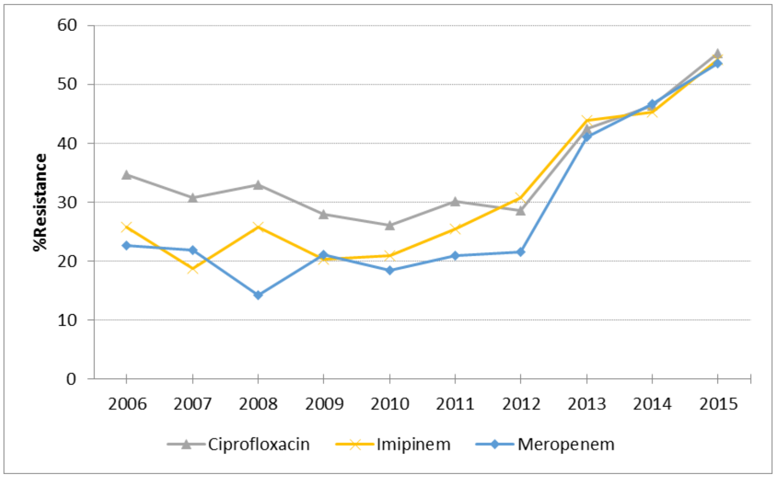

Figure 59. Yearly ciprofloxacin, imipinem and meropenem resistance rates of *Acinetobacter baumannii,* ARSP, 2006-2015

Multidrug-resistant Pathogens

Multidrug-resistant pathogens are increasingly recognized globally. Terminologies are summarized in **Table 11**. *A. baumannii and P. aeruginosa* MDR and possible-XDR rates summarized in **Table 12**.

Table 11	**Acronym**	**Definition**
Multidrug-resistant	MDR	Resistance of an organism to at least 1 or more agents in 3 or more classes of antimicrobial categories
Extensively drug-resistant	XDR	Resistance to at least 1 agent in all but 2 or fewer antimicrobial categories
Pandrug-resistant	PDR	Resistance to all available antibiotics

Table 12: MDR and Possible XDR Pseudomonas aeruginosa and Acinetobacter baumannii, all ARSP sites, Jan- Dec 2015

Organism	Number of isolates tested	Percentage MDR	Percentage Possible XDR
Pseudomonas aeruginosa			
All isolates	4430	22%	18%
Blood isolates	213	43%	20%
Acinetobacter baumannii			
All isolates	3575	66%	48%
Blood isolates	435	60%	35%

Conclusions, Recommendations and Future Directions

Antimicrobial resistance has been increasing for most of the bacterial pathogens considered of public health importance included in this surveillance.

Recommendations based on the reported the 2015 data:

- Infections secondary to *Streptococcus pneumoniae* can still be covered with penicillin or one of the anti-pneumococcal macrolides, although there is a need to closely monitor the changing trends of resistance among pneumococci. Continued surveillance on local pneumococcal serotypes distribution will allow for better evaluation of intervention and control efforts of this vaccine-preventable pathogen.
- Due to high resistance rate of *Haemophilus influenzae* to ampicillin, recommended empiric treatment for suspected *H. influenzae* infections may consist of beta-lactam-beta-lactamase inhibitor combinations and extended spectrum oral cephalosporins.
- Empiric treatment for suspected uncomplicated typhoid fever could still consist of either chloramphenicol or co-trimoxazole or amoxicillin/ampicillin. There are increasing reports of nalidixic acid resistant and ciprofloxacin non-susceptibility of *S*. Typhi which may result to clinical treatment failures. Microbiological data is recommended to aid in pathogen directed therapy.
- Increasing rates of ciprofloxacin resistance should remind clinicians to use antibiotics judiciously in *Salmonella* gastroenteritis, as this is usually a self-limited disease.
- In view of the emerging resistance of *Shigella* to the quinolones and limited data available, more vigilant surveillance of the resistance pattern of this organism should be pursued by encouraging clinicians to send specimens for culture.
- Tetracycline, chloramphenicol and co-trimoxazole remain good treatment options for cholera cases.
- Limited data is available on *Neisseria gonorrhoeae* in recent years, although based on the 2011-2014 reported isolates, ceftriaxone remains as empiric antibiotic of choice for gonococcal infections. More vigilant surveillance of the resistance patterns of this organism should be pursued by encouraging clinicians to send specimens for culture.
- In view of the continued high rates of methicillin/oxacillin resistance among staphylococci, there may be an indication to shift empiric treatment of suspected staphylococcal infections from oxacillin to alternative agents such as co-trimoxazole, doxycycline, clindamycin, linezolid or vancomycin.
- Increasing resistance among the bacterial organisms *Pseudomonas aeruginosa* and *Acinetobacter baumannii* continues to be a concern as both organisms carry intrinsic resistance to a number of antimicrobial classes and acquisition of additional resistance severely limits the available treatment options. Prudent antimicrobial use, monitoring of resistance patterns and antimicrobial use along with improved standards of infection control are essential in addressing this clinical and public health concern.
- Hospitals should base their treatment recommendations for the *Enterobacteriaceae* on their institution's prevailing resistance patterns as these have been found to be variable from hospital to hospital. High percentage of possible ESBL-producing isolates complicate treatment of serious infections caused by these organisms and may lead to increase use of carbapenems that may favor the further spread of the carbapenemase-producing *Enterobacteriaceae*. Prudent use of antimicrobials and comprehensive infection control measures serve as cornerstones of interventions aimed at preventing selection and transmission of resistant bacteria.

Future Direction

- Continued efforts to improve quality of data by sentinel site and reference laboratory capacity building thru training, efforts to improve facilities, equipment and services.
- Revive and expand the *Gonorrhoeae* surveillance network.
- Expand regional representation in the surveillance by inclusion of sentinel sites in the regions IV-B and CARAGA
- Network with DOH Epidemiology Bureau to improve clinical correlation with resistance data.
- Harmonize antibiotic use data and antimicrobial resistance surveillance data on animal specimens with ARSP data by collaborating with the Department of Agriculture and the DOH Pharmaceutical Division to enhance the relevance and significance of the surveillance information generated and present a more cohesive picture of the local state of AMR.
- Integrate a community-based antimicrobial resistance surveillance to the program.
- Enhance reference laboratory capacity by enhancing technical staff expertise and skills in molecular diagnostics.
- Improve data management, security and sharing by personnel capacity building of the reference laboratory data management unit and equipment upgrade.
- Incorporate the technology of geographic information system and mapping in the surveillance.
- Develop a protocol for notification of reportable drug-resistant pathogens
- Apply for ISO 15189 accreditation for the reference laboratory.
- Generate more relevant collaborative and investigator initiated researches.

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