

DEPARTMENT OF HEALTH
RESEARCH INSTITUTE FOR TROPICAL MEDICINE
ANTIMICROBIAL RESISTANCE SURVEILLANCE REFERENCE LABORATORY

ANTIMICROBIAL RESISTANCE SURVEILLANCE PROGRAM

2018 ANNUAL REPORT





TABLE OF CONTENTS

	Page
<u>Table of Figures</u>	4
<u>List of Tables</u>	6
<u>Acronyms and Abbreviations</u>	7
<u>Foreword</u>	9
<u>Acknowledgements</u>	10
Introduction	13
Surveillance, Testing Methods, Data Analysis and Limitations	15
<u>The Surveillance</u>	15
<u>Testing Methods</u>	15
<u>Data Analysis</u>	16
<u>Limitations</u>	16
Executive Summary	17
Highlights of the 2018 ARSP Data	19
<u>The 2018 Isolates</u>	19
<u><i>Streptococcus pneumoniae</i></u>	22
<u><i>Haemophilus influenzae</i></u>	27
<u><i>Salmonella enterica</i> serotype Typhi</u>	30
<u>Nontyphoidal <i>Salmonella</i> (NTS) species</u>	33
<u><i>Shigella</i> species</u>	37
<u><i>Vibrio cholerae</i></u>	40
<u><i>Neisseria gonorrhoeae</i></u>	42
<u><i>Staphylococcus aureus</i></u>	45
<u><i>Enterococcus</i> species</u>	51
<u><i>Enterococcus faecalis</i></u>	51
<u><i>Enterococcus faecium</i></u>	54
<u><i>Escherichia coli</i></u>	56
<u><i>Klebsiella pneumoniae</i></u>	62
<u><i>Pseudomonas aeruginosa</i></u>	67
<u><i>Acinetobacter baumannii</i></u>	70
Conclusions, Recommendations and Future Directions	74
<u>Recommendations Based on the Reported 2018 Data</u>	74
<u>Program Future Direction</u>	75
References	76

TABLE OF FIGURES

Figure No.	Title	Page
1	Regional representation in the ARSP 2018	13
2	Percent isolate distribution by sentinel site (N=89,001), DOH ARSP, 2018	20
3	Isolates distribution and patients characteristics (N=89,001) , DOH ARSP, 2018	20
4	Percent sentinel site contribution for <i>S. pneumoniae</i> (n=489), DOH ARSP, 2018	22
5	Patients characteristics for <i>Streptococcus pneumoniae</i> isolates, DOH ARSP, 2018	22
6	Yearly resistance rates of <i>Streptococcus pneumoniae</i>, DOH ARSP, 2009-2018	23
7	Percent sentinel site contribution to <i>H. influenzae</i> (n=421), DOH ARSP, 2018	27
8	Patients characteristics for <i>H. influenzae</i> isolates (n=421), DOH ARSP, 2018	27
9	Yearly resistance rates of <i>H. influenzae</i> , DOH ARSP, 2009-2018	28
10	Percent sentinel site contribution for <i>S. Typhi</i> (n=118) , DOH ARSP, 2018	30
11	Patients characteristics for <i>S. Typhi</i> isolates (n=118) , DOH ARSP, 2018	30
12	Yearly resistance rates of <i>S. Typhi</i>, DOH ARSP, 2009-2018	31
13	Percent sentinel site contribution for nontyphoidal <i>Salmonella</i> (n=231), DOH ARSP, 2018	33
14	Patients characteristics for nontyphoidal <i>Salmonella</i>, DOH ARSP, 2018	33
15	Yearly ampicillin, chloramphenicol and co-trimoxazole resistance rates of NTS, DOH ARSP, 2009-2018	34
16	Yearly ciprofloxacin and ceftriaxone resistance rates of NTS, DOH ARSP, 2009-2018	35
17	Percent sentinel site contribution for <i>Shigella sp.</i> (n=31), DOH ARSP, 2018	37
18	Patients characteristics for <i>Shigella sp.</i> isolates (n=31) , DOH ARSP, 2018	37
19	Yearly resistance rates of <i>Shigellae sp.</i>, DOH ARSP, 2009-2018	39
20	Percent sentinel site contribution of <i>V. cholerae</i> (n=14) , DOH ARSP, 2018	40
21	Patients characteristics for <i>V. cholerae</i>, DOH ARSP, 2018	40
22	Yearly resistance rates of <i>V. cholerae</i>, DOH ARSP, 2009-2018	41
23	Percent sentinel site contribution for <i>Neisseria gonorrhoeae</i>, DOH ARSP, 2018	42
24	Patients characteristics for <i>Neisseria gonorrhoeae</i>, DOH ARSP, 2018	42
25	Percent resistance to ciprofloxacin of <i>Neisseria gonorrhoeae</i> isolates by sentinel site, DOH ARSP, 2018	44
26	Yearly resistance rates of <i>Neisseria gonorrhoeae</i>, DOH ARSP, 2009-2018	44
27	Percent sentinel site contribution for <i>Staphylococcus aureus</i>, DOH ARSP, 2018	45
28	Patients characteristics for <i>Staphylococcus aureus</i>, DOH ARSP, 2018	45
29	Yearly oxacillin and vancomycin resistance rates of <i>Staphylococcus aureus</i>, DOH ARSP, 2009-2018	46
30	Percent clindamycin, co-trimoxazole and tetracycline resistance of <i>Staphylococcus aureus</i> isolates by sentinel site, DOH ARSP, 2009-2018	47
31	Map of percent resistance to oxacillin by sentinel site of <i>Staphylococcus aureus</i> isolates from blood specimens, DOH ARSP, 2018	48
32	Map of percent resistance to vancomycin by sentinel site of <i>Staphylococcus aureus</i> isolates from blood specimens, DOH ARSP, 2018	49
33	MRSA rates by sentinel site, DOH ARSP, 2018	49
34	Patients characteristics for methicillin resistant <i>Staphylococcus aureus</i> (MRSA), DOH ARSP, 2018	50
35	Percent sentinel site contribution for <i>Enterococcus faecalis</i>, DOH ARSP, 2018	51
36	Patients characteristics for <i>Enterococcus faecalis</i>, DOH ARSP, 2018	51
37	Percent sentinel site contribution for <i>Enterococcus faecium</i>, DOH ARSP, 2018	54
38	Patients characteristics for <i>Enterococcus faecium</i>, DOH ARSP, 2018	54
39	Percent sentinel site contribution for <i>Escherichia coli</i>, DOH ARSP, 2018	56
40	Patients characteristics for <i>Escherichia coli</i>, DOH ARSP, 2018	56
41	Yearly ampicillin, ampicillin/sulbactam, ciprofloxacin and co-trimoxazole resistance rates of <i>Escherichia coli</i> (all specimen), DOH ARSP, 2009-2018	58
42	Yearly ceftriaxone, gentamicin & meropenem resistance rates of <i>Escherichia coli</i> (all specimen), DOH ARSP, 2009-2018	58
43	Percentage resistance of ESBL-producing <i>E. coli</i> , DOH ARSP, 2018	61
44	Percent sentinel site contribution for <i>Klebsiella pneumoniae</i>, DOH ARSP, 2018	62

Figure No.	Title	Page
45	Patients characteristics for <i>Klebsiella pneumoniae</i>, DOH ARSP, 2018	62
46	Yearly gentamicin, amoxicillin-clavulanic acid, cefuroxime, cefepime, ceftriaxone, ciprofloxacin, and amikacin resistance rates of <i>Klebsiella pneumoniae</i>, DOH ARSP, 2009-2018	63
47	Yearly amikacin, cefepime, cefuroxime, & gentamicin resistance rates of <i>Klebsiella pneumoniae</i>, DOH ARSP, 2009-2018	64
48	Yearly carbapenem resistance rates of <i>Klebsiella pneumoniae</i>, DOH ARSP, 2009-2018	64
49	Percentage ESBL-producing <i>Klebsiella pneumoniae</i>, DOH ARSP, 2018	66
50	Percent sentinel site contribution for <i>Pseudomonas aeruginosa</i>, DOH ARSP, 2018	67
51	Patients characteristics for <i>Pseudomonas aeruginosa</i>, DOH ARSP, 2018	67
52	Yearly aztreonam, cephalosporin and piperacillin-tazobactam resistance rates of <i>P. aeruginosa</i>, DOH ARSP, 2009-2018	68
53	Yearly aminoglycosides, ciprofloxacin and carbapenem resistance rates of <i>P. aeruginosa</i>, DOH ARSP, 2009-2018	69
54	Percent sentinel site contribution for <i>Acinetobacter baumannii</i> and <i>Pseudomonas aeruginosa</i>, DOH ARSP, 2018	70
55	Patients characteristics for <i>Acinetobacter baumannii</i>, DOH ARSP, 2018	70
56	Yearly sulbactam, cefepime and aminoglycosides resistance rates of <i>A. baumannii</i>, DOH ARSP, 2009-2018	72
57	Yearly ciprofloxacin, co-trimoxazole and carbapenem resistance rates of <i>A. baumannii</i>, DOH ARSP, 2009-2018	72

LIST OF TABLES

Table No.	Title	Page
1	ARSP 2018 Sentinel sites by region	14
2	Sentinel sites isolate contribution, DOH ARSP, 2009-2018	19
3	Most common isolates by specimen type, DOH ARSP, 2018	21
4	Percent resistance for <i>Streptococcus pneumoniae</i> for all specimen, DOH ARSP, 2018	23
5	Percent resistance for <i>Streptococcus pneumoniae</i> for respiratory specimen, DOH ARSP, 2018	24
6	Percent resistance of <i>Streptococcus pneumoniae</i> for blood and CSF, DOH ARSP, 2018	25
7	Invasive <i>S. pneumoniae</i> serotypes, DOH ARSP, 2018	26
8	Percent resistance for <i>Haemophilus influenzae</i> for all specimen, DOH ARSP, 2018	28
9	Percent resistance for <i>Haemophilus influenzae</i> for respiratory specimens, DOH ARSP, 2018	29
10	Percent resistance for <i>Haemophilus influenzae</i> for blood and CSF, DOH ARSP, 2018	29
11	Percent resistance for <i>Salmonella</i> Typhi for all specimen, DOH ARSP, 2018	31
12	Percent resistance for <i>Salmonella</i> Typhi for blood specimen, DOH ARSP, 2018	32
13	Percent resistance for non typhoidal <i>Salmonella</i> for all specimens, DOH ARSP, 2018	34
14	Percent resistance for non typhoidal <i>Salmonella</i> for blood specimen, DOH ARSP, 2018	36
15	Confirmed Salmonellae serotypes, DOH ARSP, 2018	36
16	Percent resistance for <i>Shigella</i> sp. for all specimens, DOH ARSP, 2017-2018	38
17	Percent resistance for <i>Shigella</i> sp. for stool, DOH ARSP, 2017-2018	39
18	Percent resistance for <i>V. cholerae</i> for stool, DOH ARSP, 2018	41
19	Percent resistance for <i>Neisseria gonorrhoeae</i> for all specimens, DOH ARSP, 2018	43
20	Percent resistance for <i>Neisseria gonorrhoeae</i> for urethral and cervical, DOH ARSP, 2018	43
21	Percent resistance for <i>Staphylococcus aureus</i> for all specimens, DOH ARSP, 2018	46
22	Percent resistance for <i>Staphylococcus aureus</i> for skin and soft tissues, DOH ARSP, 2018	47
23	Percent resistance for <i>Staphylococcus aureus</i> for blood, DOH ARSP, 2018	48
24	Percent resistance for methicillin resistant <i>Staphylococcus aureus</i>, DOH ARSP, 2018	50
25	Percent resistance for <i>Enterococcus faecalis</i> for all specimens, DOH ARSP, 2018	52
26	Percent resistance for <i>Enterococcus faecalis</i> for blood, DOH ARSP, 2018	52
27	Percent resistance for <i>Enterococcus faecalis</i> for urine, DOH ARSP, 2018	53
28	Percent resistance for <i>Enterococcus faecium</i> for all specimens, DOH ARSP, 2018	55
29	Percent resistance for <i>Enterococcus faecium</i> for blood, DOH ARSP, 2018	55
30	Percent resistance for <i>Enterococcus faecium</i> for urine, DOH ARSP, 2018	55
31	Percent resistance for <i>Escherichia coli</i> for all specimens, DOH ARSP, 2018	57
32	Percent resistance for <i>Escherichia coli</i> for blood, DOH ARSP, 2018	59
33	Definition of multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria	59
34	Multidrug-resistant <i>E. coli</i> (blood n = 1,212), DOH ARSP, 2018	60
35	Percent resistance of urinary <i>E. coli</i>, all ARSP sites, Jan-Dec 2018	60
36	Percent resistance for <i>Klebsiella pneumoniae</i> for all specimens, DOH ARSP, 2018	63
37	Multidrug-resistant <i>Klebsiella pneumoniae</i> for blood (n = 1,316), DOH ARSP, 2018	65
38	Percent resistance for <i>Klebsiella pneumoniae</i> for blood, DOH ARSP, 2018	65
39	Percent resistance for <i>Klebsiella pneumoniae</i> for urine, DOH ARSP, 2018	66
39	Percent resistance for <i>Pseudomonas aeruginosa</i> for all specimens, DOH ARSP, 2018	68
40	Percent resistance for <i>Pseudomonas aeruginosa</i> for blood, DOH ARSP, 2018	69
41	Percent resistance for <i>Acinetobacter baumannii</i> for all specimens, DOH ARSP, 2018	71
42	Percent resistance for <i>Acinetobacter baumannii</i> for blood, DOH ARSP, 2018	73

ACRONYMS AND ABBREVIATIONS

Acronym	Description
AMR	Antimicrobial Resistance
ANSORP	Asian Network for Surveillance of Resistant Pathogens
ARSP	Antimicrobial Resistance Surveillance Program
ARSRL	Antimicrobial Resistance Surveillance Reference Laboratory
AST	Antimicrobial Susceptibility Testing
BGH	Baguio General Hospital and Medical Center
BRH	Batangas Medical Center
BRT	Bicol Regional Training and Teaching Hospital
CALABARZON	Cavite, Laguna, Batangas, Rizal and Quezon
CAR	Cordillera Administrative Region
CRH	Caraga Regional Hospital
CLSI	Clinical and Laboratory Standards Institute
CMC	Cotabato Regional Hospital and Medical Center
CVM	Cagayan Valley Medical Center
DMC	Southern Philippines Medical Center
DMU	Data Management Unit
DNA	Deoxyribonucleic acid
DOH	Department of Health
EQA	External Quality Assessment
ESBL	Extended-spectrum beta-lactamase
EVR	Eastern Visayas Regional Medical Center
FEU	Far Eastern University Hospital
GLASS	Global Antimicrobial Resistance Surveillance System
GMH	Governor Celestino Gallares Memorial Hospital
HFEP	Health Facilities Enhancement Program
JLM	Jose B. Lingad Memorial Regional Hospital
LCP	Lung Center of the Philippines
MAR	Mariano Marcos Memorial Hospital and Medical Center
MIC	Minimum Inhibitory Concentration
MIMAROPA	Mindoro, Marinduque, Romblon & Palawan
MMH	Corazon Locsin Montelibano Memorial Regional Hospital
MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>
NCR	National Capital Region
NIHR	National Institute for Health Research
NKI	National Kidney and Transplant Institute
NMC	Northern Mindanao Medical Center
ONP	Ospital ng Palawan
PCHRD	Philippine Council for Health Research and Development
PCR	Polymerase Chain Reaction
PGH	Philippine General Hospital
PhilHealth	Philippine Health Insurance Corporation
PNDF	Philippine National Drug Formulary

Acronym	Description
RMC	Rizal Medical Center
RMT	Registered Medical Technologist
RTH	Dr. Rafael S. Tumbokon Memorial Hospital
RTM	Research Institute for Tropical Medicine
SLH	San Lazaro Hospital
SOCCSKSARGEN	South Cotabato, Cotabato, Sultan Kudarat, Sarangani & General Santos City
STU	University of Sto. Tomas Hospital
VSM	Vicente Sotto Memorial Medical Center
WHO	World Health Organization
ZMC	Zamboanga City Medical Center
ZPH	Zamboanga del Norte Medical Center

FOREWORD Message from the Antimicrobial Resistance Surveillance Program Chair

The Department of Health Antimicrobial Resistance Surveillance Program (DOH-ARSP) continues to be a source of quality data on antimicrobial resistance of bacterial isolates of public importance. In its 31 years of implementation, ARSP has consistently provided relevant information in support of the Department of Health's efforts to promote rational antibiotic use. Data on the current status and developing trends of antimicrobial resistance of aerobic bacteria of public health importance contained in program's annual reports have been utilized in developing clinical practice guidelines and relevant policies towards the treatment, prevention and control of the resistant infections.

Commitment to ensure the highest quality in the implementation of the surveillance program has always underscored the efforts across all the surveillance program participants – from its leadership to the valiant medical technologists and pathologists of the program's sentinel sites in 16 regions in the country as well as the staff of the reference laboratory which serves as the program's coordinating laboratory. Such resolve is more so laudable when the surveillance program participants' efforts are viewed in the context of the challenges that have to be hurdled in the course of the program's implementation. Typically serving in various capacities and at times needing to work within limited available staff support and resources, the sentinel sites and the reference laboratory staff selflessly plod on to complete the tasks of ensuring the provision and timely submission of quality laboratory data into the program. Such dedication has always underlined the surveillance program.

The partnership of the Antimicrobial Resistance Surveillance Reference Laboratory with the Wellcome Trust Sanger Institute for the Global Health Research Unit project to provide global surveillance data through whole genome sequencing saw its second year of implementation in 2018. Aside from generating sequence data to inform public policy, the project aims to provide resourcing and local capacity development. With the developing capacity for genomic sequencing and bioinformatics in the reference laboratory, the DOH-ARSP stakeholders can look forward to provision of genomic data to better characterize high risk bacterial lineages for better management and control.

The DOH-ARSP 2018 Annual Report confirm the persistence of antimicrobial resistance as a public health threat in the country. Although methicillin resistance was observed to be decreasing among *Staphylococcus aureus* isolates, the resistance rate remains over 50% limiting the use of this previously effective antibiotic in the treatment of infections due to this bacteria. The high rates of multidrug-resistance among common pathogens such as *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* makes treatment of infections due to these bacteria challenging. Emerging penicillin resistance among *Streptococcus pneumoniae* and ciprofloxacin resistance among *Salmonella* Typhi are important trends that have to be carefully validated to inform prevention and control of this emerging resistance.

Finally, with the provision by the ARSP of AMR data to the GLASS in 2018, the country has maintained its commitment to the Global Action Plan to Combat AMR.



Celia C. Carlos, MD

Celia C. Carlos, MD
Chair
Antimicrobial Resistance Surveillance Program
Department of Health

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Celia C. Carlos, MD

Chair, Antimicrobial Resistance Surveillance Program

Antimicrobial Resistance Surveillance Reference Laboratory

Sonia B. Sia, MD

Head

Executive Assistant	Karis Lee M. Del Castillo
----------------------------	---------------------------

Laboratory Section	Data Management Unit	Secretariat
Marietta L. Lagrada, RMT	June M. Gayeta	Lea V. Platon
Agnettah M. Olorosa, RMT	Melissa Ana L. Masim, RMT	Allysa Marie S. Barnuevo
Marilyn T. Limas, RMT	Ma. Cecilia G. Alea	Danilo R. Patulot
Manuel C. Jamoralin Jr., RMT	Janine Elizabeth V. Guia, RN	
Polle Krystle V. Macaranas, RMT	Alvin C. Asuncion	
Holly Grace O. Espiritu, RMT		
Jaywardeen P. Abad, RMT		
Janziel Fiel C. Palarca, RMT		
Jeremiah M. Chilam, RMT		
Mariane A. Magbanua, RMT		
June Janice B. Borlasa, RMT		
Emmanuel Alfred S. Villamin, RMT		
Rose M. Marasigan, RMT		
Rodante H. Cerrudo		
Flordeliza C. Timajo		
Joey N. Legayada		

ARSP Sentinel Sites

Baguio General Hospital and Med. Center

Dr. Jerilyn Linggon-Dulay
Dr. Karen Tuba-ang
Mr. Rommel Verganio

Batangas Medical Center

Dr. Anacleto P. Valdez
Mr. Joseph de las Alas

Bicol Regional Training and Teaching Hospital

Dr. Karlo Emir Tayzon
Ms. Myra Olicia

Cagayan Valley Medical Center

Dr. Jane Pagaddu
Ms. Aireen Parayno
Mr. Ruel Lamorena

Caraga Regional Hospital

Dr. Raul Venerando B. Atupan Jr.
Ms. Maria Sarah Aguilar

Cotabato Regional Hosp. and Med. Center

Dr. Nena S. Salcedo
Mr. Jobert Castillon

Southern Philippines Medical Center

Dr. Marlon M. Maramion
Ms. Virginia Panal

Eastern Visayas Regional Medical Center

Dr. Cleocita Portula
Ms. Ma. Merlina A. Vistal

Far Eastern University Hospital

Dr. Mari Karr Esguerra
Ms. Ann Kristine Legaspi

Gov. Celestino Gallares Memorial Hospital

Dr. Anette L. Salillas, FPSP, FASCP, MIAC
Ms. Evelyn Andamon

Jose B. Lingad Memorial Regional Hospital

Dr. Gil Bryan Galvan
Ms. Julie Ann Cabantog

Lung Center of the Philippines

Dr. Gloria Lim-Tan
Ms. Lucrecia Bongato

Mariano Marcos Memorial Hospital and Medical Center

Dr. Modesty Leaño
Ms. Donna Marie Calaoagan

Corazon Locsin Montelibano Memorial Reg. Hospital

Dr. Hans Francis Ferraris
Ms. Mary Ann Fandida
Ms. Joselle N. Ealdama

National Kidney and Transplant Institute

Dr. Arnold Joseph Fernandez
Ms. Bernadette B. Hapitana

Northern Mindanao Medical Center

Dr. Jerry Abroguena
Ms. Grace L. Pong

Ospital ng Palawan

Dr. Frederick F. Dalingding
Ms. Floretess de Villa

Philippine General Hospital

Dr. Nelson Geraldino
Ms. Leolina Gamboa & Ms. Raquel Florece

Rizal Medical Center

Dr. Cheryl May Tan
Ms. Chanda Romero

Research Institute for Tropical Medicine

Dr. Ma. Rosario Capeding
Ms. Gloria Reclusado

San Lazaro Hospital

Dr. Elizabeth Freda O. Telan
Dr. Dorcas Umipig
Ms. Ma. Cecilia Belo & Mr. Marc Mamporte

University of Sto. Tomas Hospital

Dr. Evelina Lagamayo
Ms. Kristine Anne Vasquez

Vicente Sotto Memorial Medical Center

Dr. Reynette Christine Ligaray
Ms. Christine Ivy Paula S. Agtuca

Zamboanga City Medical Center

Dr. Myrna Angeles
Ms. Emerita Sinon

ARSP Gonorrhoeae Sentinel Sites

Dr. Rafael S. Tumbokon Memorial Hospital

Dr. Edgar Allan Sarusad

Ms. Marniel C. Reyes

Zamboanga del Norte Medical Center

Dr. Mary Ann Torregosa

Ms. Jean Tan

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INTRODUCTION

Antimicrobial resistance (AMR) is the ability of organisms that cause disease to withstand attack by antimicrobials. **AMR is a serious public health threat** because of its far reaching and serious implications in health care as well as economies. [1] Infections caused by resistant microorganisms often fail to respond to standard treatment, resulting in prolonged illness and greater risk of death. AMR hampers the control of infectious diseases because patients remain infectious for a longer time increasing the risk of spreading resistant microorganisms to others. AMR increases the cost of health care as more expensive therapies must be used when infections become resistant to first-line medicines. Infections due to resistant microorganisms increases economic burden to families and societies as it often results in longer duration of illness and treatment.

When we lose antimicrobials to resistance, the achievements of modern medicine such as organ transplant, cancer chemotherapy and major surgery would be compromised as these would not be possible without effective antimicrobials for prevention and treatment of infections. Losing antimicrobials to resistance can result in many infectious diseases becoming untreatable and uncontrollable. This can bring us back to the pre-antibiotic era.



Figure 1. Regional representation in the ARSP 2018

It is recognized that the issue of AMR must be addressed by concerted efforts of government agencies, health providers, drug industry, professional organizations, academe and civil society. **Surveillance is a fundamental part of an effective response to AMR problem.**[2] It is needed to detect resistant microorganisms, enable correct decisions to be made about treatment options and guide policy recommendations. As the country's response to the recommendation of the World Health Organization (WHO) Working Group on the Regional Information Network on Antimicrobial Resistance that a surveillance program be initiated among member states of the Western Pacific Region to contain and prevent resistance to antimicrobials, the **Philippine Committee on Antimicrobial Resistance Surveillance Program was created in 1988 by the Department of Health's Department Order 339-J**. The program aims to provide critical inputs to the Department of Health's effort to promote rational drug use by determining the status and developing trends of antimicrobial resistance of selected bacteria to specific antimicrobials.

Currently participating in the program are **24 sentinel sites and 2 gonorrhoeae surveillance sites** representing 16 regions of the country (Figure 1 & Table 1).

Table 1. ARSP 2018 Sentinel sites by region

Region	Sentinel Site
National Capital Region (NCR)	Lung Center of the Philippines
	National Kidney and Transplant Institute
	Rizal Medical Center
	San Lazaro Hospital
	Philippine General Hospital
	Research Institute for Tropical Medicine
	University of Santo Tomas Hospital
	Far Eastern University Nicanor Reyes Medical Foundation
Cordillera Administrative Region (CAR)	Baguio General Hospital and Medical Center
Region 1 – Ilocos Region	Mariano Marcos Memorial Hospital and Medical Center
Region 2 – Cagayan Valley	Cagayan Valley Medical Center
Region 3 – Central Luzon	Jose B. Lingad Memorial Regional Hospital
Region 4-A – CALABARZON	Batangas Medical Center
Region 4-B – MIMAROPA	Ospital ng Palawan
Region 5 – Bicol Region	Bicol Regional Training and Teaching Hospital
Region 6 – Western Visayas	Corazon Locsin Montelibano Memorial Regional Hospital
	Dr. Rafael S. Tumbokon Memorial Hospital
Region 7 – Central Visayas	Celestino Gallares Memorial Hospital
	Vicente Sotto Memorial Medical Center
Region 8 – Eastern Visayas	Eastern Visayas Regional Medical Center
Region 9 – Zamboanga Peninsula	Zamboanga City Medical Center
	Zamboanga del Norte Medical Center
Region 10 – Northern Mindanao	Northern Mindanao Medical Center
Region 11 – Davao Region	Southern Philippines Medical Center
Region 12 – SOCCSKSARGEN	Cotabato Regional Hospital and Medical Center
Region 13 - Caraga Region	Caraga Regional Hospital

Legend: CALABARZON: Cavite, Laguna, Batangas, Rizal, Quezon; MIMAROPA: Mindoro, Marinduque, Romblon, Palawan; SOCCSKSARGEN: South Cotabato, Cotabato, Sultan Kudarat, Sarangani, General Santos City.

SURVEILLANCE, TESTING METHODS, DATA ANALYSIS & LIMITATIONS

THE SURVEILLANCE

The DOH-ARSP is a sentinel laboratory-based antimicrobial resistance surveillance on aerobic bacteria from clinical specimens. The surveillance collects culture and antimicrobial susceptibility data from its **24 sentinel sites and 2 gonorrhoeae surveillance sites**. Case-finding is based on priority specimens sent routinely to sentinel sites laboratories for clinical purposes.

All sentinel sites implement standard methods for culture and susceptibility testing based on the WHO Manual for the Laboratory Identification and Antimicrobial Susceptibility Testing of Bacterial Pathogens of Public Health Importance in the Developing World [1] and updated Clinical Laboratory Standards Institute (CLSI) references for antibiotic susceptibility testing and quality control [2] [3] [4] [5].

The culture and antimicrobial susceptibility test results are encoded using a database software called **WHONET**. WHONET is Windows-based database software developed by the WHO Collaborating Centre for Surveillance of Antimicrobial Resistance based at the Brigham and Women's Hospital in Boston for the management and analysis of microbiology laboratory data with a special focus on the analysis of antimicrobial susceptibility test results.

Using a standard format, routine culture and antimicrobial susceptibility test results are sent monthly by the sentinel sites to the coordinating laboratory of the program – the **Antimicrobial Resistance Surveillance Reference Laboratory (ARSRL) at the Research Institute for Tropical Medicine**. Beginning January 2018, 13 sentinel sites transmit data daily to the reference laboratory. The automated data transfer facilitates prompt identification of resistant isolates of public health importance as well as the identification of potential outbreaks among sentinel sites. The ARSRL's Data Management Unit manages the cleaning, analysis, storage and security of the program's surveillance data.

Sentinel sites likewise send isolates with unusual antimicrobial susceptibility patterns to ARSRL for phenotypic and genotypic confirmatory testing.

The program sentinel sites participate in an external quality assessment scheme (EQAS) conducted by the reference laboratory to ensure quality of laboratory results. Periodic monitoring visits to sentinel sites are likewise done.

TESTING METHODS

At the reference laboratory, all referred isolates with unusual susceptibility patterns are re-identified using both automated (Vitek) and conventional methods. Both minimum inhibitory concentration (MIC) via automated method (Vitek) and gradient E-test, and disk diffusion are employed in antimicrobial susceptibility testing. Serotyping for *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Salmonellae* and *Vibrio cholerae* were done for 2018.

Panel of antibiotics for testing are based on the latest CLSI recommendations, [6] the World Health Organization Global Antimicrobial Resistance Surveillance System (GLASS) Report Early Implementation [7] and the latest Philippine National Formulary [8]. In the analysis of antimicrobial susceptibility testing, an isolate is considered resistant to an antimicrobial agent when tested and interpreted as resistant (R) in accordance with the clinical breakpoint criteria based on the most recent Clinical Laboratory Standards Institute (CLSI) references for antibiotic susceptibility testing.

DATA ANALYSIS

Analysis is restricted to the first isolate received (per genus under surveillance) per patient in the calendar year. Data are expressed as a cumulative resistance percentage, i.e. the percentage of resistant isolates out of all isolates with antimicrobial susceptibility testing (AST) information on that specific organism–antimicrobial agent combination. For selected analyses, a 95% confidence interval is determined for the resistance percentage. Cumulative percentages of resistance are compared as proportions using the either Chi-square or Fisher’s test, using a p value of <0.05 as statistically significant. Only species with testing data for 30 or more isolates are included in the analysis.

An annual report with a summary of the surveillance data focusing on aerobic bacterial pathogens of public health importance causing common infectious diseases with significant morbidity and mortality locally are disseminated to the program’s stakeholders.

LIMITATIONS

Interpretation of data in this annual report should be undertaken with caution taking into consideration that there may be several factors that could influence and introduce bias to the data resulting in over- or underestimation of resistance percentages. Potential sources of bias include population coverage, sampling, and laboratory capacity.

1. Most of the resistance data in the program come from regional hospitals which typically cater to patients from towns and cities within the vicinity of the hospital. Resistance variations in local areas not covered by regional hospitals are not represented in the program data.
2. Data for the National Capital Region come from 8 sentinel sites while data for other regions come from 1 or 2 sentinel sites.
3. Given that the program data are from routine clinical samples, differences in factors indicating need for microbiological cultures may introduce variations in the resistance data.
4. Performance of culture and susceptibility tests in the sentinel sites is dependent on the diagnostic habits of the clinicians as well as the financial capability of patients for such test. Differential sampling can occur if cultures are typically only performed after empirical treatment shows no adequate therapeutic response. Predictably, this will lead to a serious overestimation of the percentage resistance by not including susceptible isolates in the denominator.
5. Lastly, the ability of the laboratory to identify the microorganism and its associated antimicrobial susceptibility pattern may differ.

EXECUTIVE SUMMARY

Resistance data for **89,001 bacterial isolates** coming from 24 sentinel sites hospital bacteriology laboratories located in 16 regions of the Philippines and 2 gonococcal surveillance sites were analyzed for 2018. The most common isolate for 2018 was *Klebsiella pneumoniae*.

Streptococcus pneumoniae

Cumulative resistance rate of *S. pneumoniae* isolates from all specimen types reported for 2018 against penicillin, using meningitis breakpoints, was at 16% (n=374) and <1% using nonmeningitis breakpoints (n=282 isolates). When the pneumococcal isolates were analyzed by specimen type, penicillin resistance was at 12% for invasive (blood and CSF) isolates when analyzed using meningitis breakpoints but only less than 1% using non meningitis breakpoint. The most common invasive *S. pneumoniae* serogroups/serotypes identified for 2018 were 3, 1, 4 and 5.

Haemophilus influenzae

Resistance rates against panel of antibiotics for 2018 isolates of *H. influenzae* are highest for ampicillin at 11% (n=362) and chloramphenicol at 11% (n=122). There were no reports of levofloxacin-, ciprofloxacin-, meropenem- nor azithromycin-resistant *H. influenzae* for 2018.

***Salmonella enterica* serotype Typhi**

S. enterica ser. Typhi isolates have remained susceptible to first line antibiotics with reported resistant isolates at 3% or less for ampicillin, co-trimoxazole and chloramphenicol for 2018. There was a reported ciprofloxacin-resistant isolate from urine but the isolate was not confirmed as resistant at the reference laboratory. There were no ciprofloxacin-resistant *S. Typhi* isolates from blood specimens.

Nontyphoidal *Salmonella*

Resistance rate of nontyphoidal *Salmonella* from blood specimens was at 6% for ciprofloxacin (n=101) and 5% for ceftriaxone (n=103). The most common nontyphoidal *Salmonella species* serovar identified for 2018 were *S. enterica* serotype Enteritidis and *S. enterica* serotype Typhimurium.

Shigella species

Combined 2017-2018 data showed no fluoroquinolone resistance of *Shigella species* from stool specimens.

Vibrio cholerae

Vibrio cholerae isolates remain susceptible to first line agents: chloramphenicol, co-trimoxazole and tetracycline with 2% or less reported resistance rates for 2018.

Neisseria gonorrhoeae

N. gonorrhoeae isolates have high rates of resistance against ciprofloxacin at 80% (n=107); and tetracycline at 57% (n=69). There were no ceftriaxone-, cefixime-, azithromycin- nor spectinomycin-resistant isolates for 2018.

Staphylococcus aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA) rate for 2018 is at 53% (n= 6,675). This is a statistically significant decrease from the reported MRSA rate of 57% in 2017. Resistance rates for 2018 against antibiotics used for treatment of *S. aureus* infections were as follows: 31% for co-trimoxazole (n=6,271); 12% for clindamycin (n=6,387); 9% for tetracycline (n=5,571); 1% for linezolid (n=5,734); and 1% for vancomycin (n=5,589). None of the linezolid- and vancomycin-resistant isolates were confirmed as resistant at the reference laboratory.

Enterococcus species

Rates of *E. faecalis* resistance was at 2% (n=1,590) for linezolid and 2% (n=1,697) for vancomycin. Rates of *E. faecium* resistance was at 1% (n=967) for linezolid and 7% for vancomycin (n=939).

Escherichia coli

E. coli rates of resistance against the fluoroquinolones and third generation cephalosporins were at 40% for ciprofloxacin (n=9,267) and 38% for ceftriaxone (n=9,756). Resistance to carbapenems continue to rise with rates against ertapenem at 4% (n=7,030); imipenem at 5% (n=8,175) and meropenem at 5% (n=9,566). *E. coli* extended-spectrum β -lactamase suspect rates for 2018 was at 59% (n=3,948). Among *E. coli* isolates from blood, it was noted that multidrug-resistant (MDR) rate was 46%, possible extensively drug-resistant (XDR) was at 7% and possible pandrug-resistant (PDR) was at 1%.

Klebsiella pneumoniae

Resistance to the carbapenems continue to rise with 2018 *K. pneumoniae* resistance rates as high as 9% for ertapenem (n=8,591); 10% for imipenem (n=11,064) and 12% for meropenem (n=12,367). *K. pneumoniae* extended-spectrum β -lactamase suspect rates for 2018 was at 58% (n=6,168). When the subset of invasive blood culture *K. pneumoniae* isolates were analyzed, even higher carbapenem resistance rates were noted, with meropenem resistance rate as high at 19% (n=1,192). Multidrug-resistance for *K. pneumoniae* isolates from blood was at 59%, while possible extensively drug-resistant isolates was at 26% and possible pandrug-resistance was at 4%.

Pseudomonas aeruginosa

For 2018, carbapenem resistance was reported at 19% for imipenem (n=5,897) and 16% for meropenem (n=6,767).

Acinetobacter baumannii

For 2018, more than 50% resistance were observed for many antibiotics: ampicillin/sulbactam at 54% (n=2,874), ceftazidime at 53% (n= 4,741), ciprofloxacin at 55% (n=4,556), imipenem at 56% (n=3,978), meropenem at 56% (n=4,541), piperacillin/tazobactam at 58% (n=4,388), cefepime at 56% (n=4,619), cefotaxime at 63% (n=1,537), ceftriaxone at 56% (n=3,773) and cotrimoxazole at 53% (n=4,261).

HIGHLIGHTS OF THE 2018 ARSP DATA

THE 2018 ISOLATES

Resistance data for **89,001 isolates** were reported and analyzed for the year 2018. This was a 14% increase when compared to the reported 76,892 isolates for 2017.

The 2018 ARSP data came from the **24 sentinel and 2 gonorrhoeae surveillance sites** of the program (**Table 2, Figure 2**) which represents **16 out of 17 regions of the Philippines**. Of the total number of isolates for 2018, 58% were from Luzon, 21% were from Visayas and 21% were from Mindanao. The 8 Metro Manila sentinel sites contributed 32% of the total 2018 annual data (**Figure 2**).

Majority of the isolates were from male patients (53%) and from 20-64 years of age (54%). The most common specimen types were respiratory (31%), blood (22%), urine (19%), and wound (17%). Other specimen types contributing to the 2018 data were: tissues, cerebrospinal fluid, other fluids, genital specimens and stool (**Figure 3**).

Majority (55%) of the isolates were from presumptively community-acquired infections (specimen date was 2 days or less from admission date or specimens from OPD or ER patients). Many of the isolates were from patients from Medical Department (33%) (**Figure 3**).

Table 2. Sentinel sites isolate contribution, DOH ARSP, 2009-2018

SENTINEL SITES	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Change %
PGH	-	-	-	-	7093	12471	11710	12860	14572	12808	-14
RMC	878	962	845	942	1207	320	1054	3252	3160	3241	2
NKI	3345	3681	2726	2403	2179	2918	1455	5894	627	2959	79
LCP	2694	2	1233	2083	2253	2921	2905	3115	1367	3098	56
RTM	280	348	328	383	303	303	336	410	513	598	14
SLH	468	615	409	318	1132	575	824	1410	2460	2044	-20
GMH	1151	936	1119	1521	1307	1351	1807	1669	3153	3258	3
ZMC	599	1060	686	721	822	819	841	1142	1222	1346	9
FEU	699	864	1064	931	1050	956	712	810	1201	1173	-2
STU	1722	1470	752	1788	2050	2002	1923	2275	2088	2184	4
EVR	340	530	744	507	697	823	1514	1731	3303	3879	15
MMH	562	590	855	1153	1413	2289	2940	2886	3133	3026	-4
DMC	2523	2870	2439	3332	3456	4062	5109	8058	8680	10762	19
VSM	1447	1931	2142	2450	3171	3951	3834	4803	6838	8714	22
BGH	2129	2199	1916	1972	2583	2625	3214	4628	4842	5775	16
CMC	459	600	595	639	796	833	1300	1599	1704	2642	36
BRT	618	486	537	677	611	1047	1251	1584	1640	1842	11
RTH	-	-	-	-	-	-	-	25	69	159	57
ZPH	38	11	-	-	-	9	8	4	7	3	-133
MAR	2275	1898	1851	1928	1773	1706	1849	2759	3565	4293	17
BRH	1008	791	304	38	-	1022	1294	2075	2472	3133	21
CVM	248	907	790	944	1100	1223	1512	3473	4141	4276	3
JLM	387	1024	643	655	502	638	1266	2768	3261	3880	16
NMC	814	1817	1776	1684	2131	2416	2237	3105	2245	2961	24
ONP	-	-	-	-	-	-	-	2	5	68	93
CRH	-	-	-	-	-	-	-	10	624	879	29
TOTAL	24684	25592	23754	27069	37629	47280	50895	72347	76892	89001	

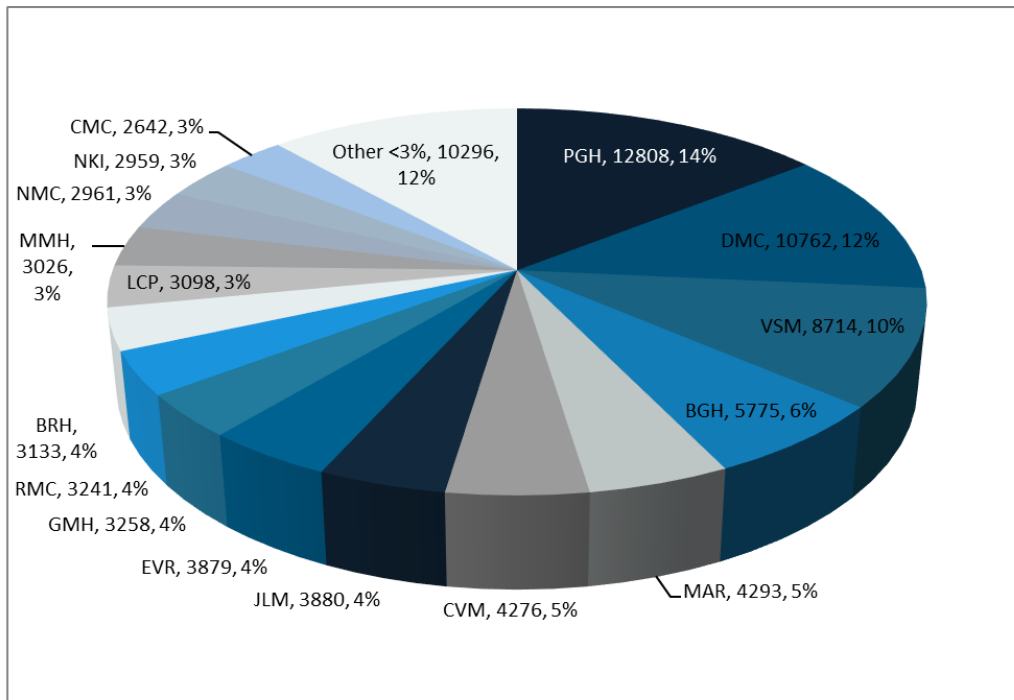


Figure 2. Percent isolate distribution by sentinel site (N=89,001), DOH ARSP, 2018

*Others — Sentinel Sites contributing less than 3% of total contribution

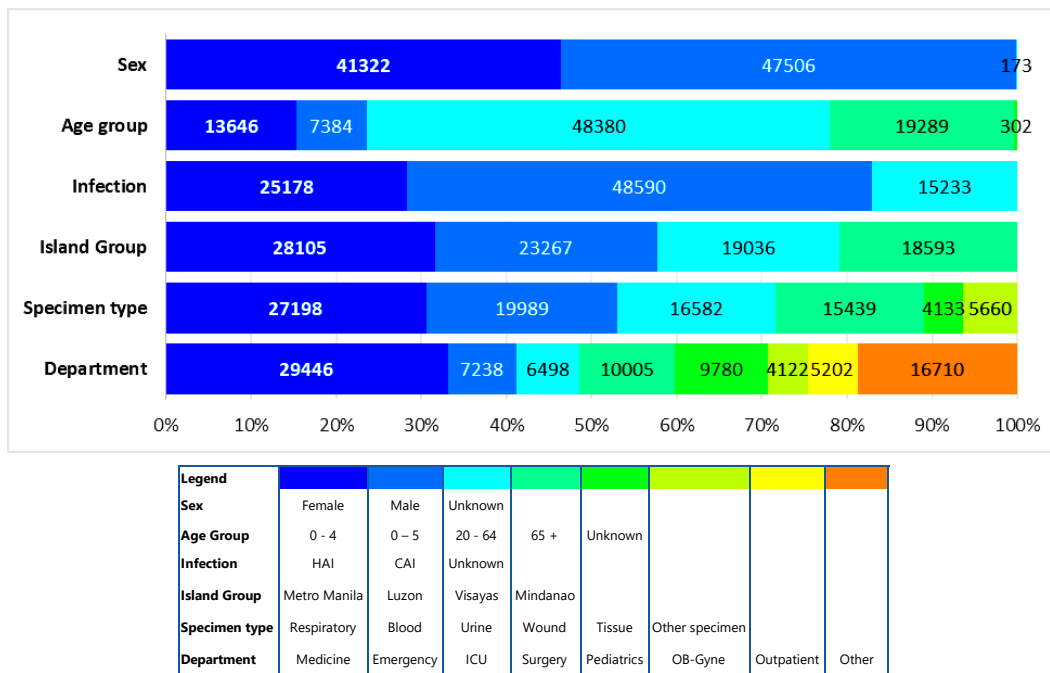


Figure 3. Isolates distribution and patients characteristics (N=89,001), DOH ARSP, 2018

Most Common Isolates

For 2018, *Klebsiella pneumoniae*, 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 3.

Table 3. Most common isolates by specimen type, DOH ARSP, 2018

Respiratory specimens		Blood	
1	<i>Klebsiella pneumoniae</i>	1	<i>Staphylococcus</i> , coagulase-negative
2	<i>Pseudomonas aeruginosa</i>	2	<i>Staphylococcus aureus</i>
3	<i>Acinetobacter baumannii</i>	3	<i>Micrococcus sp.</i>
Cutaneous or Wound		Stool	
1	<i>Staphylococcus aureus</i>	1	<i>Escherichia coli</i>
2	<i>Escherichia coli</i>	2	<i>Klebsiella pneumoniae</i>
3	<i>Klebsiella pneumoniae</i>	3	<i>Salmonella sp.</i>
Cerebrospinal Fluid		Urine	
1	<i>Staphylococcus</i> , coagulase-negative	1	<i>Escherichia coli</i>
2	<i>Acinetobacter baumannii</i>	2	<i>Klebsiella pneumoniae</i>
3	<i>Acinetobacter sp.</i>	3	<i>Enterobacter sp.</i>

Streptococcus pneumoniae

Isolates

There were 489 reported *S. pneumoniae* isolates for 2018. This was almost the same number as the *S. pneumoniae* isolates reported for 2017 which was 485.

For 2018, sentinel site isolates contributions for *S. pneumoniae* were more evenly distributed (Figure 4) compared to 2017 where 51% came from just one sentinel site (VSM). Many of the isolates came from Luzon (66%) with 31% coming from Metro Manila; 21% came from Visayas and 13% were from Mindanao (Figure 5).

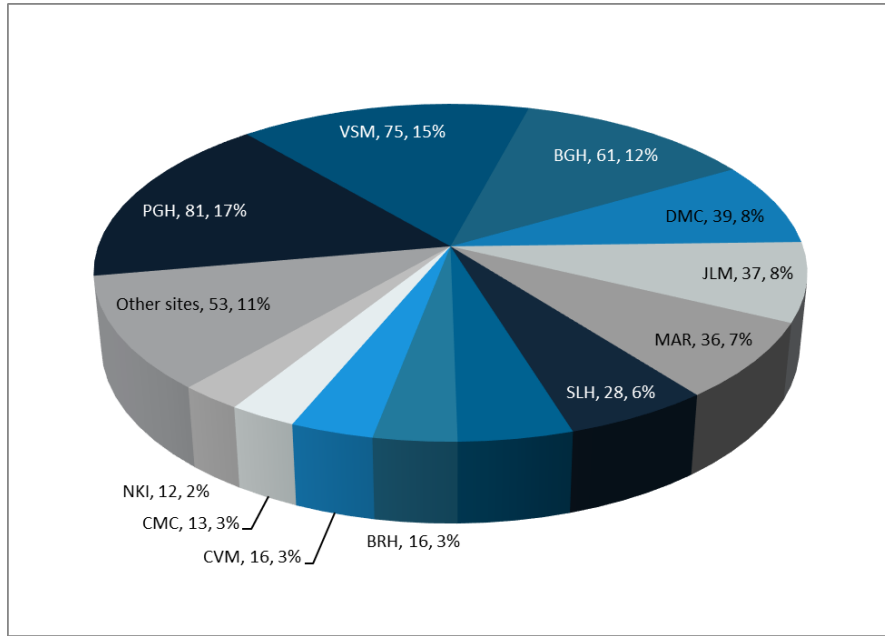


Figure 4. Percent sentinel site contribution for *S. pneumoniae* (n=489), DOH ARSP, 2018

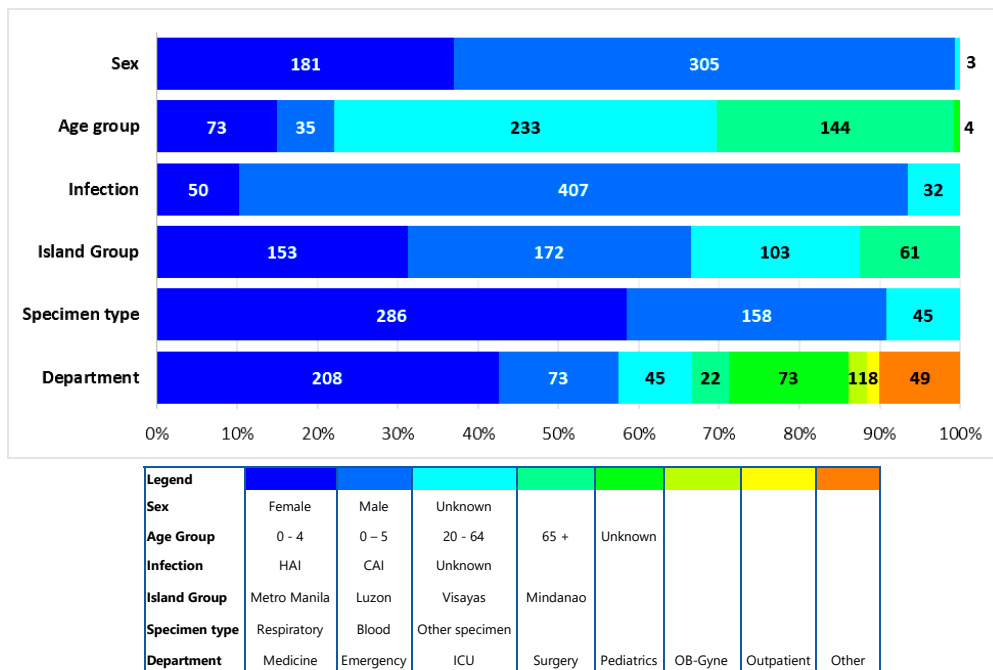


Figure 5. Patients characteristics of *Streptococcus pneumoniae* isolates, DOH ARSP, 2018

Many (48%) of the isolates came from patients 20-64 years of age, and majority (62%) were males. Most (83%) of the infections were presumptively community-acquired (isolates from specimens taken from patients who were within second hospital day or less, or from patients from OPD or ER) as shown in **Figure 5**.

Majority of the *S. pneumoniae* reported were respiratory specimens (59%), 32% were from blood and 2% were from CSF. The rest of the isolates were from wound, urine, tissue and other body fluids (**Figure 5**).

Antimicrobial Resistance

1. All specimens

Since 2008, the Clinical and Laboratory Standards Institute (CLSI) recommends the use of different breakpoints for meningitis (MIC ≥ 0.12 ug/ml) and non-meningitis (MIC ≥ 8 ug/ml) pneumococcal isolates when testing for penicillin. The recommended meningitis breakpoints are more stringent due to the poor penetration of penicillin thru the blood-brain barrier. For 2018, penicillin resistance confirmed with MIC testing was at 1% (n=282 isolates) when all *S. pneumoniae* isolates were analyzed using non-meningitis breakpoints and 16% (n=374 isolates) using meningitis breakpoints. Overall resistance rates of 2018 *S. pneumoniae* isolates against co-trimoxazole was at 17%, and erythromycin at 13%. Resistance rates were lowest for levofloxacin at 1% (**Table 4**).

Table 4. Percent resistance for *Streptococcus pneumoniae* for all specimen, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Penicillin G			
Meningitis	374	16	12.5-20.2
Non-meningitis	282	1	0.4-3.8
Erythromycin	464	13	9.9-16.2
Trimethoprim/Sulfamethoxazole	443	17	13.2-20.4
Ceftriaxone	101	3	0.8-9.1
Levofloxacin	171	1	0.2-4.7
Amoxicillin/Clavulanic acid	5*	0	0.0-53.7
Cefuroxime	1*	0	0.0-94.5
Ertapenem	6*	0	0.0-48.3

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

Yearly resistance rates for select antibiotics are shown in **Figure 6**. Erythromycin resistance increased from 10% in 2017 to 13% in 2018. The increase in rate was not statistically significant. For 2018, there was no linezolid nor vancomycin non-susceptible isolate reported.

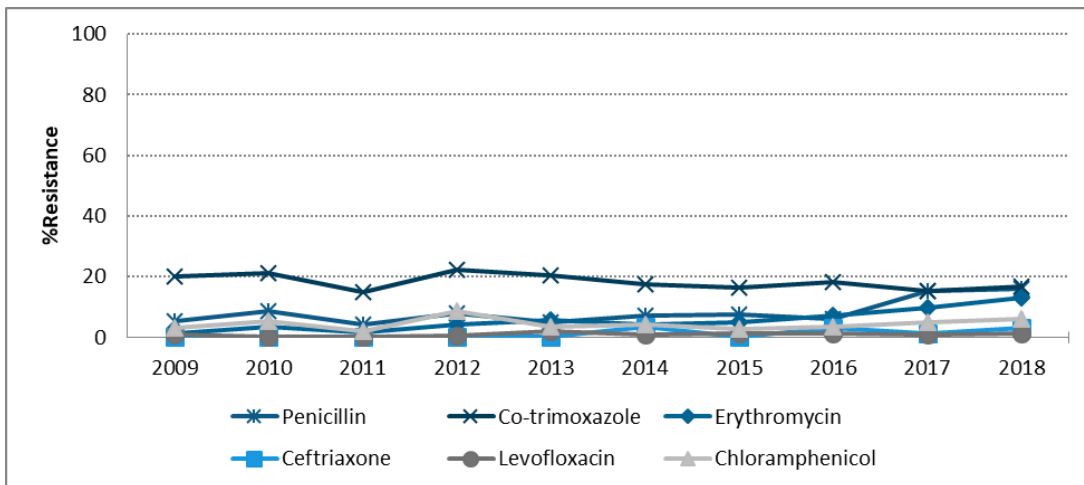


Figure 6. Yearly resistance rates of *Streptococcus pneumoniae*, DOH ARSP, 2009-2018

2. Respiratory Isolates

The percent resistance of *S. pneumoniae* from 286 respiratory isolates are shown in **Table 5**. Percent resistance ranged from 2% for levofloxacin to 18% for trimethoprim/sulfamethoxazole. Resistance to penicillin based on non-meningitis breakpoints among respiratory isolates was at 1% while penicillin resistance based on meningitis breakpoints was at 17%.

The reported levofloxacin-resistant isolates were both from presumptive community-acquired infections, one from a 20 year old male from a Metro Manila site and one from a 66 year old male from a sentinel site from Mindanao. Both isolates were not sent to ARSRL for confirmation.

The reported 3 ceftriaxone-resistant *S. pneumoniae* isolates were multidrug-resistant, were all presumptively community-acquired and all were from male patients. One isolate each were from two sentinel sites in Metro Manila with one coming from a 27 year old and another from a 50 year old patient. The third isolate was from an 18 year old from a sentinel site in Mindanao. All 3 isolates were not sent to ARSRL for confirmation.

Table 5. Percent resistance for *Streptococcus pneumoniae* for respiratory specimen, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Penicillin G			
Meningitis	214	17	12.6-23.2
Non-meningitis	214	1	0.1-3.6
Amoxicillin/Clavulanic acid	4*	0	0.0-60.4
Cefuroxime	1*	0	0.0-94.5
Ceftriaxone	58	3	0.6-12.9
Ertapenem	6*	0	0.0-48.3
Levofloxacin	97	2	0.4-8.0
Trimethoprim/Sulfamethoxazole	258	18	13.8-23.6
Erythromycin	274	15	11.1-19.9

*Very few isolates were tested ($N < 30$); percentage of resistance should be interpreted with caution

3. Blood and Cerebrospinal Fluids Isolates

Table 6 shows the percent resistance for *S. pneumoniae* isolates from combined 158 blood and 8 cerebrospinal fluid (CSF). Among antibiotics for which susceptibility data for more than 30 isolates were available, resistance ranged from 0% for ceftriaxone to 14% for trimethoprim/sulfamethoxazole.

Among *S. pneumoniae* isolates from blood, 1% were resistant to penicillin using non-meningitis breakpoints while 12% were resistant using meningitis breakpoints. Of the 11 isolates confirmed at the reference laboratory to be penicillin-resistant, 7 were from Luzon with only 2 from Metro Manila, 3 were from the Visayas and 1 isolate was from Mindanao. Six were from pediatric patients less than 1 year of age, 4 were adults and 1 was an elderly. All isolates were presumptively community-acquired and none was MDR.

Among the CSF isolates tested ($n=8$), only one was resistant to penicillin using meningitis breakpoints. This isolate was from a one year old male from a sentinel site from Mindanao. The isolate was susceptible to erythromycin, co-trimoxazole, ceftriaxone, and clindamycin. This penicillin-resistant isolate was not sent to ARSRL for confirmation.

One isolate, from a one year old male from a Metro Manila site was multidrug-resistant (resistant to erythromycin, clindamycin, and chloramphenicol) but was susceptible to penicillin. This isolate was not sent to the reference laboratory for confirmation.

Table 6. Percent resistance of *Streptococcus pneumoniae* for blood and CSF, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Penicillin G			
Meningitis	134	12	7.2-18.9
Non-meningitis	134	1	0-4.6
Ceftriaxone	33	0	0.0-13.0
Cefotaxime	15*	0	0.0-25.3
Meropenem	4*	0	0.0-60.4
Levofloxacin	59	0	0.0-7.6
Trimethoprim/Sulfamethoxazole	156	14	9.2-20.8
Erythromycin	160	8	4.1-13.0
Chloramphenicol	45	7	1.8-19.4

**Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution*

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 was the slide agglutination test (Denka Seiken). For 2018, there were 79 invasive (blood and CSF) pneumococci isolates that were sent to the national reference laboratory for confirmatory testing and serotyping. There were 24 different serotypes/groups identified, with most common being 3, 1, 4 and 5. **Table 7** summarizes identified serotypes/groups for the 2018 invasive *S. pneumoniae* isolates by age group.

Table 7. Invasive *S. pneumoniae* serotypes, DOH ARSP, 2018

Serotype	Number of patients	0-4 years old	5-19 years old	20-64 years old	65+ years old
Non-serotypable	5	3	1	1	
Serotype 1	6		1	3	2
Serotype 2	1			1	
Serotype 3	8			3	5
Serotype 4	6	1	1	2	2
Serotype 5	5	1		1	3
Serotype 6	3	2			1
Serotype 7	1			1	
Serotype 9	3	2		1	
Serotype 10	3	1		2	
Serotype 12	1				1
Serotype 14	3	2	1		
Serotype 15	2		1		1
Serotype 16	5	1	1	3	
Serotype 17	1			1	
Serotype 18	4	2	1		1
Serotype 19	4	3			1
Serotype 20	3	1		2	
Serotype 22	1		1		
Serotype 23	4	1		2	1
Serotype 24	2			2	
Serotype 25	1		1		
Serotype 29	2	1		1	
Serotype 34	3		1	2	
Serotype 35	2			1	1
TOTAL	79	21	10	29	19

Haemophilus influenzae

Isolates

There were 421 reported *H. influenzae* isolates for 2018. This was 18% less than the 498 isolates reported for 2017. Biggest contributors for the 2018 *H. influenzae* data were VSM (72 isolates), BGH (72 isolates), and DMC (58 isolates) (Figure 7). Based on island group, 65% came from Luzon with 33% coming from the NCR, 21% from Visayas and 14% from Mindanao (Figure 8).

Majority (53%) of the isolates came from patients 20-64 years of age, and majority (59%) were males. Most (81%) of the infections were presumptively community-acquired (isolates from specimens taken from patients who were within second hospital day or less, or from OPD and ER patients) (Figure 8).

Majority of the *H. influenzae* reported were from respiratory specimens (91%), and 5% were from blood. The rest of the isolates were from tissue, genitals, wound, other body fluids.

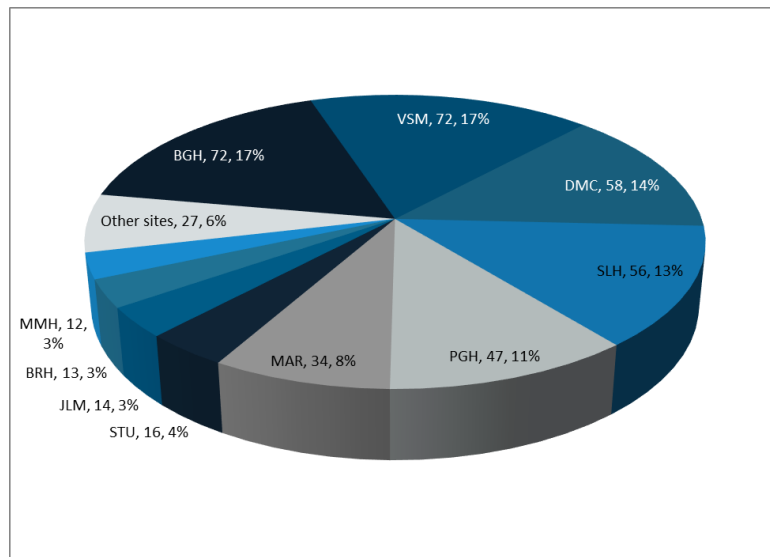


Figure 7. Percent sentinel site contribution to *H. influenzae* (n=421), DOH ARSP, 2018

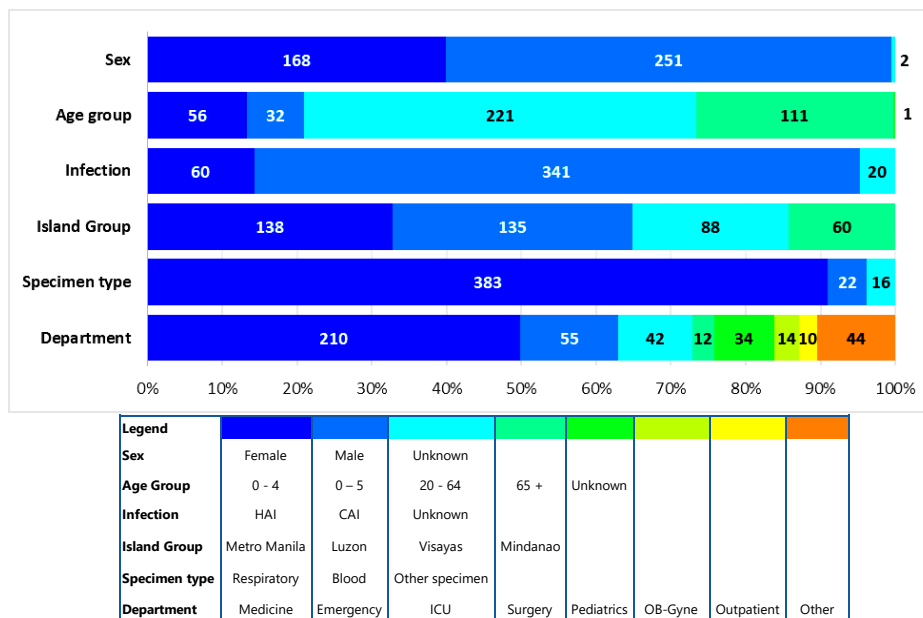


Figure 8. Patients characteristics for *H. influenzae* isolates (n=421), DOH ARSP, 2018

Antimicrobial Resistance

1. All specimens

Resistance rates of *H. influenzae* for 2018 ranged from zero resistance for ciprofloxacin, levofloxacin, meropenem and azithromycin to 11% for ampicillin (Table 8). There was no ampicillin-resistant beta-lactamase-negative *H. influenzae* reported for 2018. It is worthy to note that for beta-lactamase-negative ampicillin-resistant (BLNAR) *H. influenzae* isolates, resistance to penicillin and ampicillin may be due to mechanism other than beta-lactamase such as alterations in penicillin-binding proteins, particularly PBP3. Such phenotypes are associated with increasing resistance to ampicillin, amoxicillin, amoxicillin-clavulanate, and many cephalosporins, limiting the efficacy of expanded-spectrum cephalosporins against meningitis and of many oral cephalosporins against other diseases.

Table 8. Percent resistance for *Haemophilus influenzae* (all specimen), DOH ARSP 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	362	11	8.1-14.8
Ampicillin/Sulbactam	324	4	2.2-6.9
Ceftriaxone	374	1	1.4-5.1
Ciprofloxacin	354	0	0.2-2.6
Levofloxacin	121	0	0.0-3.8
Cefuroxime	74	8	3.3-17.4
Meropenem	364	0	1.0-4.5
Amoxicillin/Clavulanic acid	349	6	3.6-8.8
Azithromycin	250	0	0-2.6
Chloramphenicol	122	11	6.1-17.9

Trends of resistance for *H. influenzae* is illustrated in Figure 9. Compared to 2017 rates, resistance to ampicillin decreased by 3% while resistance to chloramphenicol increased by 2%. These changes were not statistically significant.

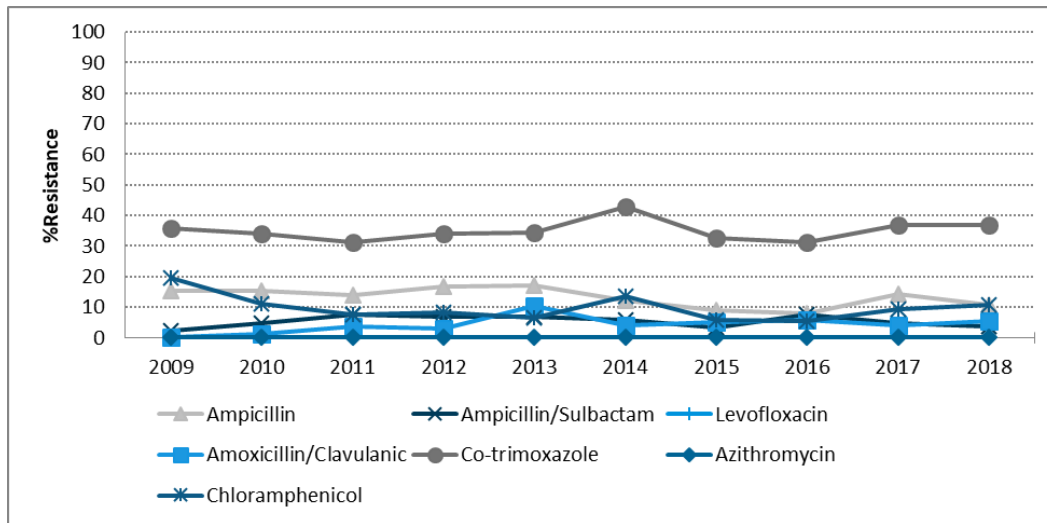


Figure 9. Yearly resistance rates of *H. influenzae*, DOH ARSP, 2009-2018

2. Respiratory Isolates

Resistance rates among the 383 respiratory isolates of *Haemophilus influenzae* are shown in **Table 9**.

Table 9. Percent resistance for *Haemophilus influenzae* for respiratory specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	328	10	7.2-14.0
Ampicillin/Sulbactam	293	3	1.7-6.4
Ceftriaxone	342	1	0.9-4.4
Ciprofloxacin	322	0	0.2-2.9
Levofloxacin	106	0	0.0-4.4
Cefuroxime	68	7	2.8-17.1
Meropenem	331	0	0.7-4.1
Azithromycin	230	0	0-2.7
Amoxicillin/Clavulanic acid	319	5	3.0-8.2

There were 10 *H. influenzae* respiratory isolates reported to be ampicillin/sulbactam-resistant. Of the 10 ampicillin/sulbactam-resistant respiratory isolates, 4 were from two sentinel sites in Metro Manila, 4 were from two sentinel sites in the Visayas and 2 isolates were from a sentinel site in Mindanao. Six out of the 10 isolates were from males, 9 were from age group 20-64 years, and 8 were presumptively community-acquired. Only 1 isolate from Mindanao was referred to ARSRL and was confirmed to be ampicillin/sulbactam-resistant.

There were 2 ceftriaxone-resistant *H. influenzae* respiratory isolates reported for 2018 – one from sentinel site in Metro Manila and one from Mindanao. One from a male and one from a female and both were from age group 20-64 years. One was presumptively nosocomial while the other was presumptively community-acquired. Neither isolates were sent to ARSRL for confirmation.

Of the 18 amoxicillin/clavulanic-resistant isolates reported for 2018, 2 were reported by a sentinel site from Luzon, 1 and 2 isolates were reported by two sentinel sites, respectively, from Mindanao and 13 were from three sentinel sites from Metro Manila. Fourteen of the 18 isolates were from respiratory specimens where 3 were from blood and 1 from tissue. Most (13 out of 18) were males. Though many (8 out of 18) were from age group 20-64 years, there were 7 isolates from 0-4 years age group. Only one respiratory isolate from Mindanao was confirmed to be amoxicillin/clavulanic-resistant in ARSRL.

3. Blood and Cerebrospinal Fluid isolates

There were fewer than 30 isolates of *H. influenzae* from blood and CSF reported for 2018. Thus the percent resistance shown in **Table 10** should be interpreted with caution.

Table 10. Percent resistance for *Haemophilus influenzae* for blood and CSF, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	21	38	19.0-61.3
Cefotaxime	9	0	0.0-37.1
Ceftazidime	13	0	6.2-54.0
Ceftriaxone	18	0	1.9-36.1
Meropenem	22	0	1.6-30.6

Salmonella enterica serotype Typhi

Isolates

There were 118 *S. Typhi* isolates reported and analyzed for 2018. This is 38% less than the 163 isolates reported for 2017 (Figure 10). The sentinel site contributors ranged from 4% (DMC) to 16% (VSM) as seen in Figure 10. Based on island group, 61% came from Luzon with 32% coming from the NCR, 32% from Visayas and 25% from Mindanao (Figure 11).

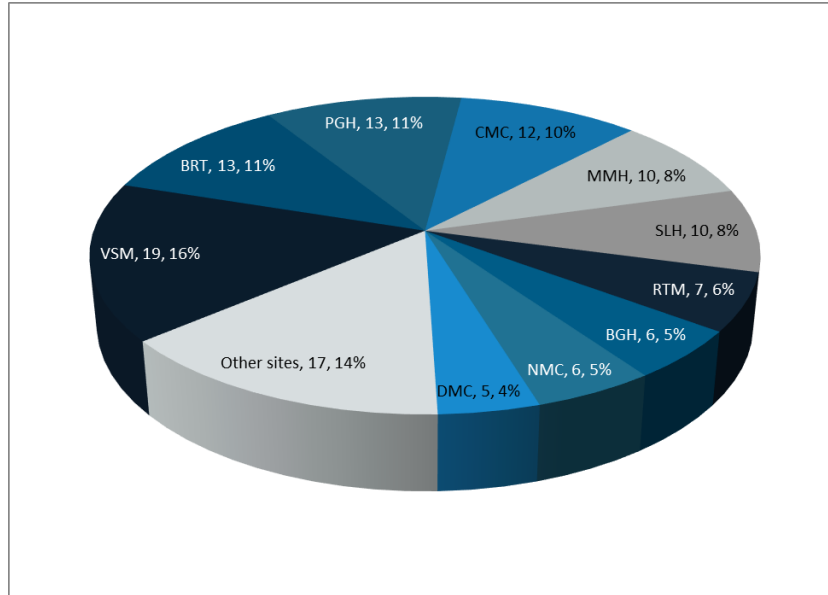


Figure 10. Percent sentinel site contribution for *S. Typhi* (n=118), DOH ARSP, 2018

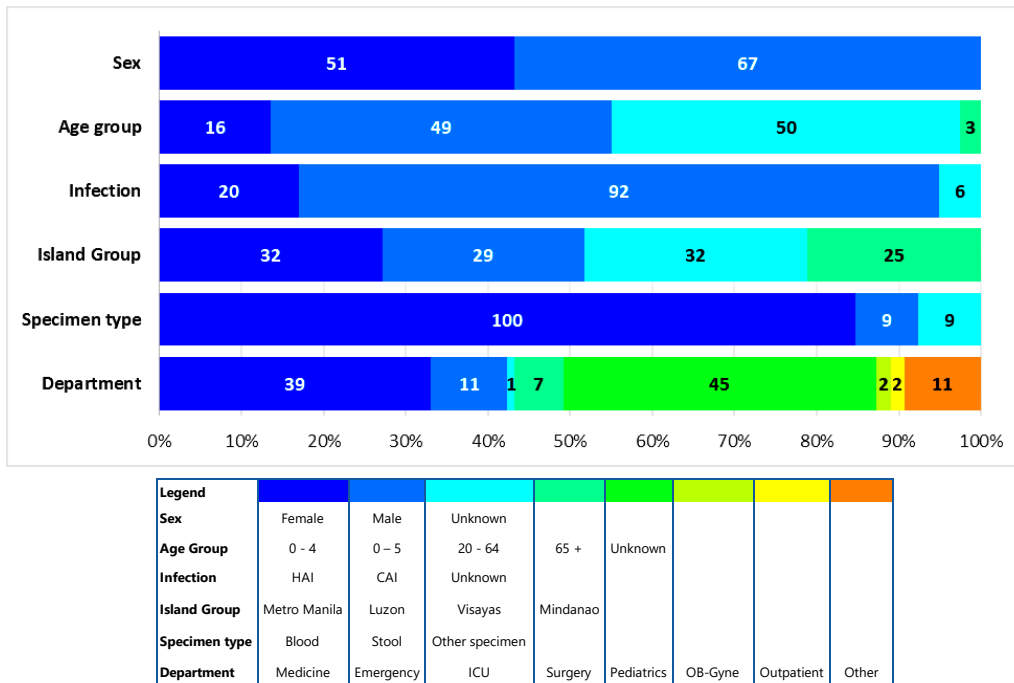


Figure 11. Patients characteristics for *S. Typhi* isolates (n=118), DOH ARSP, 2018

Many of the isolates came from patients 20-64 years of age (42%), and majority were males (57%). Most (78%) of the infections were presumptively community-acquired (isolates from specimens taken from patients who were within second hospital day, or less or from OPD or ER patients) (Figure 11).

Majority of the *S. Typhi* reported were from blood (85%), and 8% were from stool. The rest of the isolates were from wound, urine, tissue and other body fluids (Figure 11).

Antimicrobial Resistance

1. All specimens

Overall resistance rates of *Salmonella Typhi* to antibiotics for which more than 30 isolates were tested remained at less than 5% (Table 11). There was a reported ciprofloxacin resistant *S. Typhi* isolate from the urine of a 37 year old male from Mindanao. The isolate was presumptively hospital-acquired and was susceptible to the other antibiotics tested. This isolate was not sent for confirmation to the reference laboratory.

Table 11. Percent resistance for *Salmonella Typhi* (all specimen), DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95% C.I.
Ampicillin	115	3	0.7-8.0
Ceftriaxone	109	1	0-5.7
Cefotaxime	84	2	0.4-9.2
Ciprofloxacin	112	2	0.3-7.0
Levofloxacin	5*	0	0.0-53.7
Trimethoprim/Sulfamethoxazole	114	2	0.3-6.9
Chloramphenicol	82	2	0.4-9.3

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

The 10-year trends of resistance for *S. Typhi* is shown in Figure 12. Ciprofloxacin resistance increased from zero in 2017 to 2% in 2018, and chloramphenicol resistance decreased from 4% in 2017 to 2% in 2018. Both changes in resistance rates were not statistically significant.

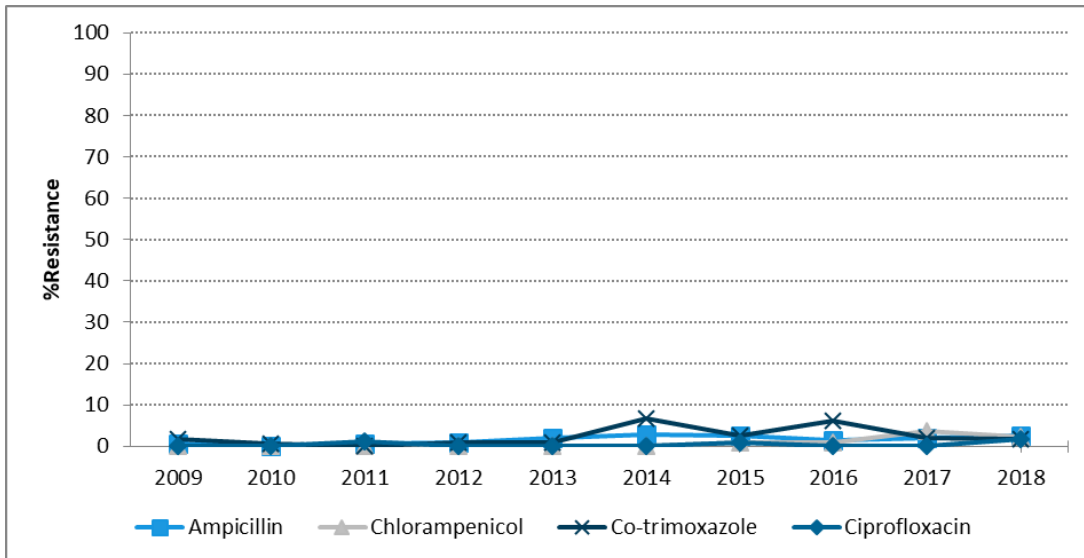


Figure 12. Yearly resistance rates of *S. Typhi*, DOH ARSP, 2009-2018

2. Blood isolates

For the 100 isolates of *Salmonella* Typhi from blood specimens, resistance was observed only for cefotaxime, azithromycin and chloramphenicol, and azithromycin (**Table 12**). There were no ciprofloxacin-resistant *S. Typhi* among blood isolates.

Table 12. Percent resistance for *Salmonella* Typhi for blood specimen, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	98	0	0.0-4.7
Ceftriaxone	97	0	0.0-4.7
Cefotaxime	77	3	0.5-9.9
Ciprofloxacin	95	0	0.0-4.8
Levofloxacin	4*	0	0.0-60.4
Trimethoprim/Sulfamethoxazole	97	0	0.0-4.7
Azithromycin	25*	4	0.2-22.3
Chloramphenicol	73	1	0.1-8.5

*Very few isolates were tested ($N < 30$); percentage of resistance should be interpreted with caution

Nontyphoidal *Salmonella* species

The Isolates

There were 231 reported nontyphoidal *Salmonella* (NTS) for 2018. This is 9% more than the 211 reported nontyphoidal *Salmonella* isolates for 2017. The contributions of NTS isolates of sentinel sites ranged from 16% (PGH) to 3% (SLH) (Figure 13). Based on island group, 71% came from Luzon with 38% coming from the NCR, 13% from Visayas and 16% from Mindanao (Figure 14).

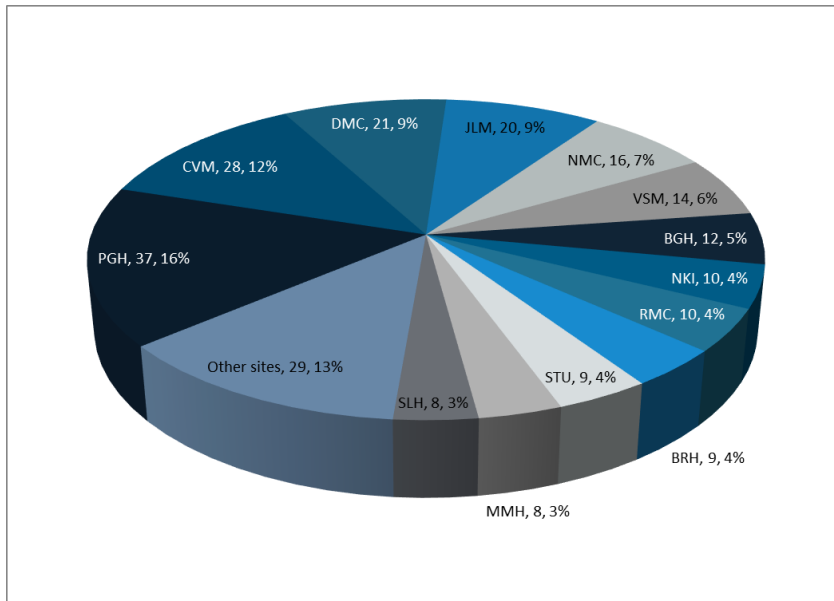


Figure 13. Percent sentinel site contribution for nontyphoidal *Salmonella* (n=231), DOH ARSP, 2018

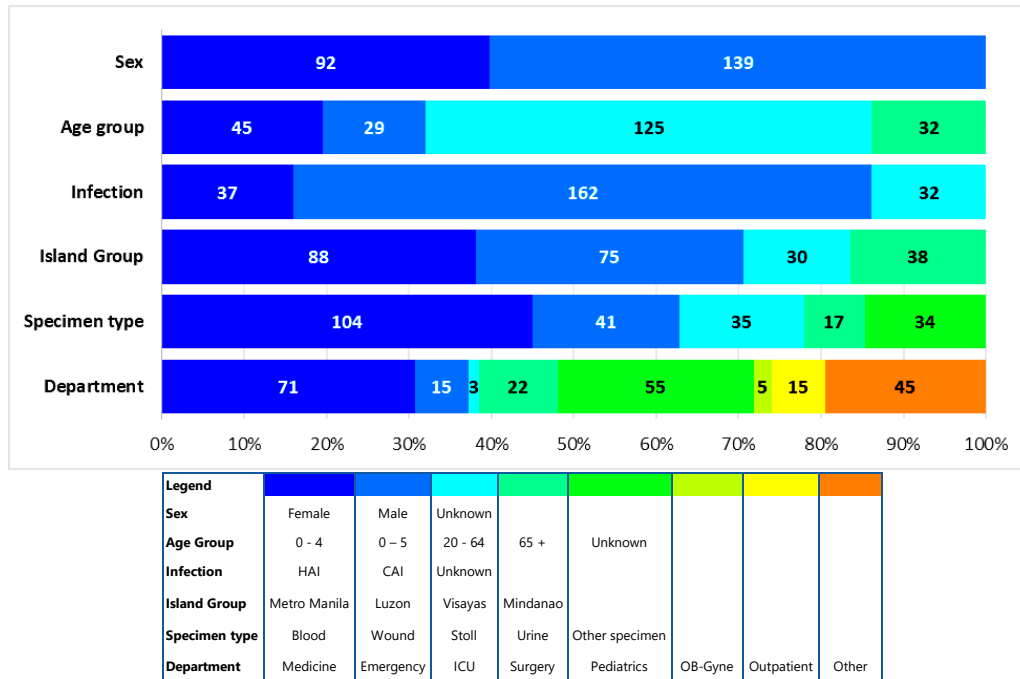


Figure 14. Patients characteristics for nontyphoidal *Salmonella* isolates (n=231), DOH ARSP, 2018

Majority (54%) of the isolates came from patients 20-64 years of age, and majority (60%) were males. Most (70%) of the infections were presumptively community-acquired (isolates from specimens taken from patients who were within second hospital day or less, or from OPD or ER patients). (Figure 14).

Many of the NTS reported were from blood (45%), 18% were from wound, 15% were from stool and 7% from urine. The rest of the isolates were from respiratory specimens and other body fluids (Figure 14).

Antimicrobial Resistance

1. All specimens

Table 13 shows overall resistance for 231 nontyphoidal *Salmonella*. For antibiotics for which more than 30 isolates were tested, resistance ranged from 11% for cefotaxime to 40% for ampicillin.

Table 13. Percent resistance for nontyphoidal *Salmonella* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	200	40	32.7-46.7
Chloramphenicol	124	12	7.2-19.5
Trimethoprim/Sulfamethoxazole	202	18	12.9-23.9
Ciprofloxacin	195	11	7.4-16.8
Levofloxacin	39	5	0.9-18.6
Cefotaxime	148	11	6.5-17.2
Ceftriaxone	212	12	7.9-17.1
Azithromycin	16*	19	5.0-46.4

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

Yearly resistance for NTS are shown in Figures 15 and 16. There was an observed increase in percent resistance for ampicillin, chloramphenicol and ciprofloxacin for 2018 compared to the respective rates for 2017. These changes were not statistically significant.

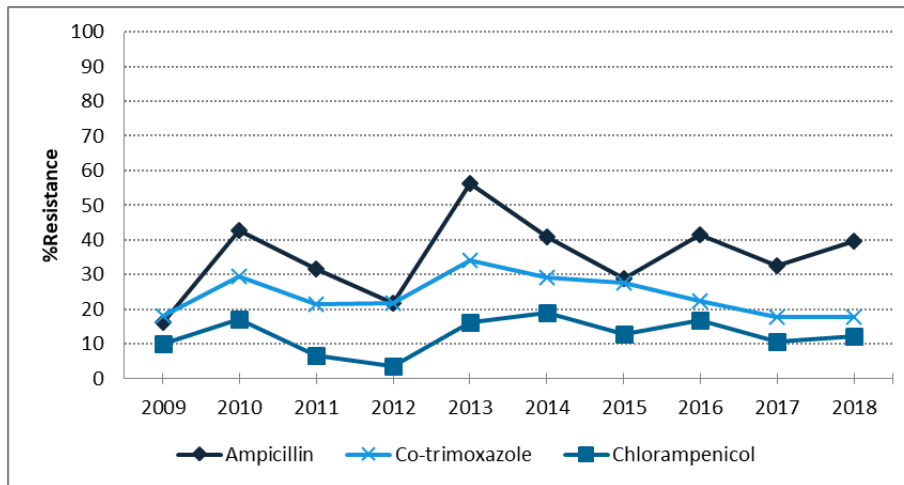


Figure 15. Yearly ampicillin, chloramphenicol and co-trimoxazole resistance rates of NTS, DOH ARSP, 2009-2018

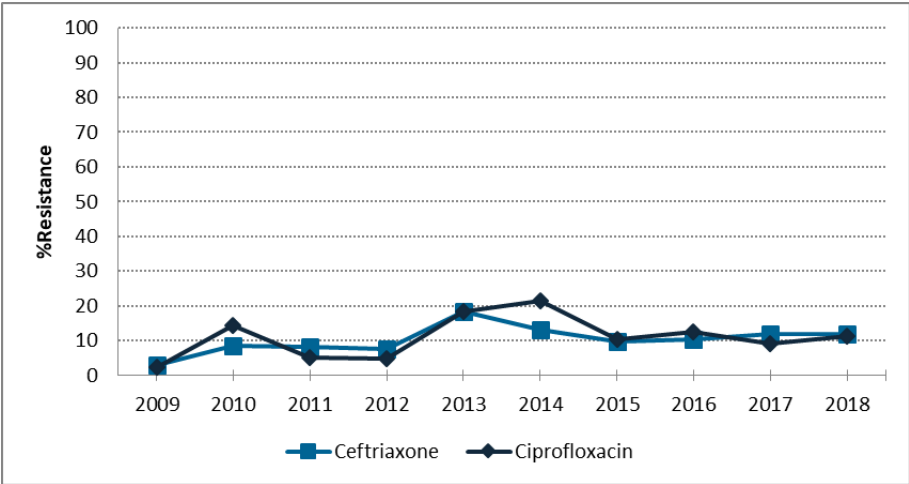


Figure 16. Yearly ciprofloxacin and ceftriaxone resistance rates of NTS, DOH ARSP, 2009-2018

2. Blood specimen

Percent resistance rates of 104 NTS isolates from blood are shown in **Table 14**. For antibiotics for which more than 30 isolates were tested, resistance ranged from 0% for levofloxacin to 28% for ampicillin.

Table 14. Percent resistance for nontyphoidal *Salmonella* for blood specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	102	28	20.1-38.3
Chloramphenicol	62	7	2.1-16.6
Trimethoprim/Sulfamethoxazole	96	6	2.5-13.6
Ciprofloxacin	101	6	2.4-12.9
Levofloxacin	7*	0	0.0-43.9
Cefotaxime	71	4	1.1-12.6
Ceftriaxone	103	5	1.8-11.6
Azithromycin	9*	0	0.0-37.1

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

Salmonella Serotyping

There were 139 *Salmonella* referred for serotyping at the reference laboratory. Many (47%) of the referred *Salmonellae* isolates were confirmed to be *Salmonella* Typhi.

Among the 73 nontyphoidal *Salmonella*, the most common serotypes identified were *Salmonella enterica* serotype Enteritidis (37 isolates) and *Salmonella enterica* serotype Typhimurium (7 isolates) which were also the most commonly reported for the past 4 years. **Table 15** summarizes the serotype data for *Salmonella* sp. referred isolates for 2018. Antimicrobial resistance for NTS varies by serotype. Overall changes in resistance among NTS may reflect changes in resistance within serotypes, changes in serotype distribution, or both.

Table 15. Confirmed *Salmonellae* serotypes, DOH ARSP, 2018

Serotype	Number of isolates
<i>Salmonella</i> Typhi	66
<i>Salmonella</i> Enteritidis	37
<i>Salmonella</i> Typhimurium	7
<i>Salmonella</i> Paratyphi A	3
<i>Salmonella</i> Group C	2
<i>Salmonella</i> Kentucky	2
<i>Salmonella</i> Paratyphi B	2
<i>Salmonella</i> Stanley	2
<i>Salmonella</i> Weltevreden	2
<i>Salmonella</i> Ajiobo	1
<i>Salmonella</i> Anatum	1
<i>Salmonella</i> Chailey	1
<i>Salmonella</i> Derby	1
<i>Salmonella</i> Group E1	1
<i>Salmonella</i> Group K	1
<i>Salmonella</i> Itami	1
<i>Salmonella</i> Agona	1
<i>Salmonella</i> Nessziona	1
<i>Salmonella</i> Rissen	1
<i>Salmonella</i> Saintpaul	1
<i>Salmonella</i> Seftenberg	1
<i>Salmonella</i> sp.	1
<i>Salmonella</i> Tumodi	1
<i>Salmonella</i> Virchow	1
<i>Salmonella</i> Lome	1
Total	139

Shigella species

Isolates

For 2018 there were 31 *Shigella species* isolates reported which is just 3 isolates more than those reported in 2017 (28 isolates). Largest sentinel site contributors for *Shigella sp.* in 2018 data were: VSM and PGH (10 and 5 isolates, respectively) as seen in **Figure 17**. Based on island group, 42% came from Luzon with 10% coming from the NCR, 39% from Visayas and 19% from Mindanao (**Figure 18**).

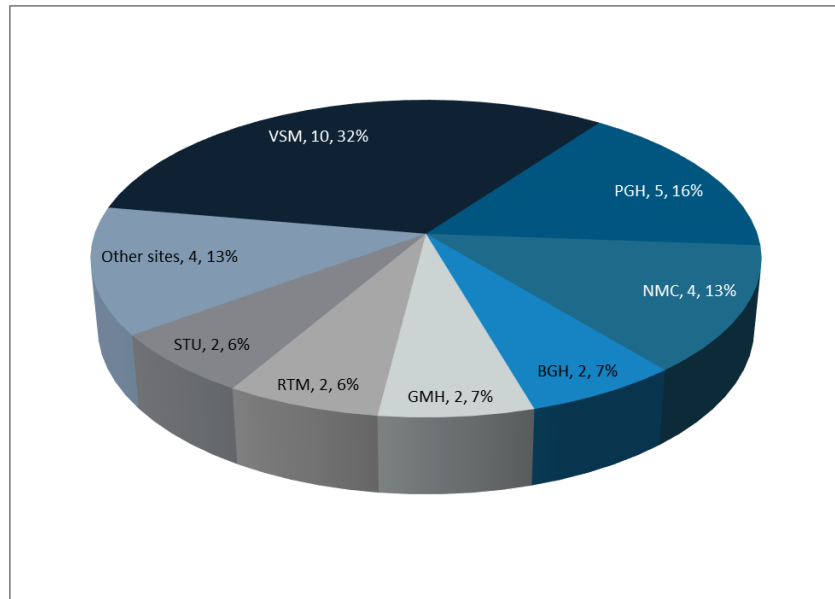


Figure 17. Percent sentinel site contribution for *Shigella sp.* (n=31), DOH ARSP, 2018

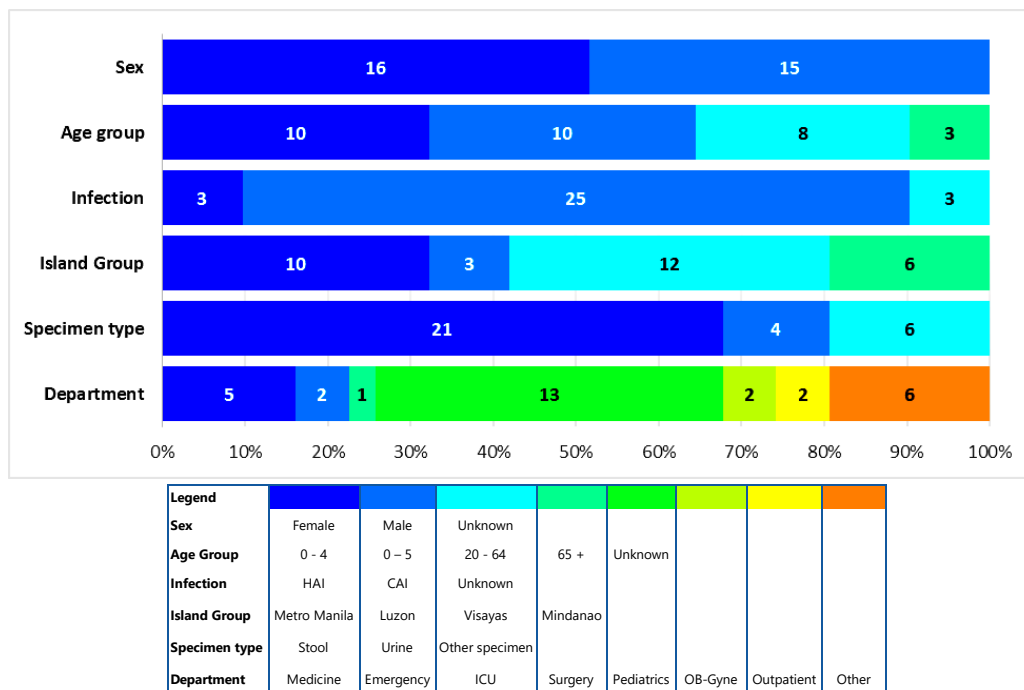


Figure 18. Patients characteristics for *Shigella sp.* isolates (n=31), DOH ARSP, 2018

Many of the isolates came from patients 0-4 years of age (32%) and 5-19 years of age (32%). Majority (52%) were females. Most (81%) of the infections were presumptively community-acquired (isolates from specimens taken from patients who were within second hospital day, or less or from OPD or ER patients) (Figure 18).

Most of the reported *Shigella sp.* 2018 isolates were from stool (68%), 13% from urine and 7% from blood. The rest of the isolates were from genitals, wound and other body fluids.

Antimicrobial Resistance

1. All specimens

As there were very few *Shigella sp.* isolates reported for 2018, we combined the data of isolates from 2017 and 2018 to obtain a reasonable statistical estimate of the cumulative percentage resistance for *Shigella sp.* Resistance rates for the combined 2017 & 2018 *Shigella spp.* isolates (all specimens) are shown in Table 16. Very high resistance was seen for co-trimoxazole while resistance for ciprofloxacin was at 2% and to ceftriaxone at 14%.

Table 16. Percent resistance for *Shigella sp.* for all specimens, DOH ARSP, 2017-2018

Antibiotic name	Number	%R	%R 95%C.I.
Ceftazidime	1*	0	0.0-94.5
Ceftriaxone	44	13.6	5.6-28.0
Ciprofloxacin	48	2.1	0.1-12.5
Levofloxacin	7*	0	0.0-43.9
Co-trimoxazole	51	60.8	46.1-73.8
Azithromycin	9*	11.1	0.6-49.3

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

Yearly resistance of *Shigella sp.* is shown in Figure 19. The increase in resistance rates of antibiotics for *Shigella sp.* from 2017 to rates in 2018 have to be interpreted with caution as these data were based on very few isolates.

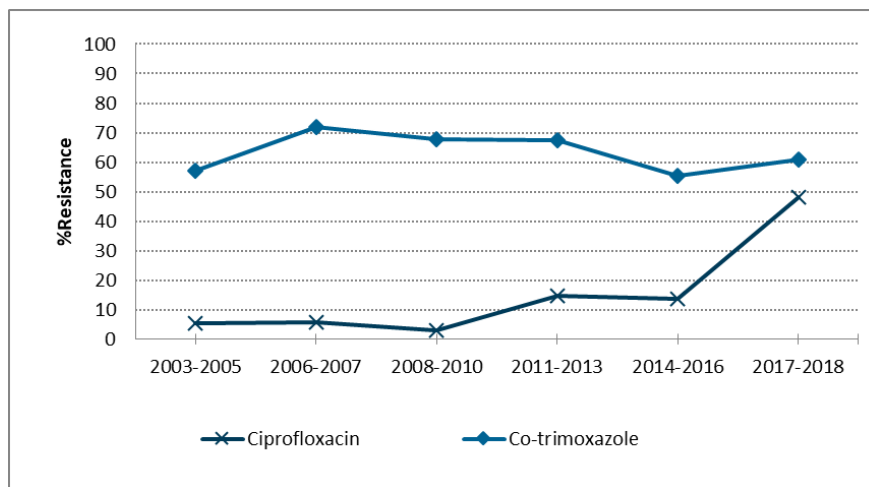


Figure 19. Yearly resistance rates of *Shigella sp.*, DOH ARSP, 2009-2018

2. Stool specimens

Among *Shigella sp.* isolates from stool, resistance to co-trimoxazole was very high at 64% and resistance to ceftriaxone was at 6%. There was no ciprofloxacin resistance among *Shigella sp.* isolates from stool (**Table 17**).

Table 17. Percent resistance for *Shigella sp.* for stool, DOH ARSP, 2017-2018

Antibiotic name	Number	%R	%R 95%C.I.
Ceftriaxone	31	6.5	1.1-22.9
Ciprofloxacin	37	0	0.0-11.7
Levofloxacin	6*	0	0.0-48.3
Co-trimoxazole	39	64.1	47.2-78.3
Azithromycin	8*	0	0.0-40.2

*Very few isolates were tested ($N < 30$); percentage of resistance should be interpreted with caution

Vibrio cholerae

Isolates

There were only 14 isolates of *Vibrio cholerae* reported for 2018 compared to 103 isolates reported for 2017. The sentinel site VSM contributed most (43%) of the *V. cholerae* 2018 isolates (Figure 20). Based on island group, 64% came from Visayas, 22% from Mindanao and 14% from Luzon with 17% coming from the NCR (Figure 21).

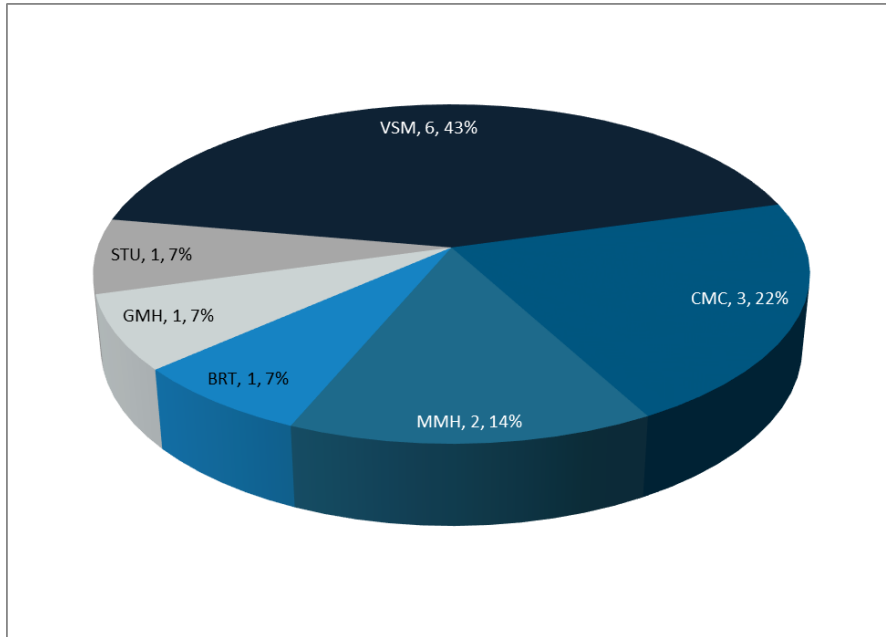


Figure 20. Percent sentinel site contribution of *Vibrio cholerae* (n=14), DOH ARSP, 2018

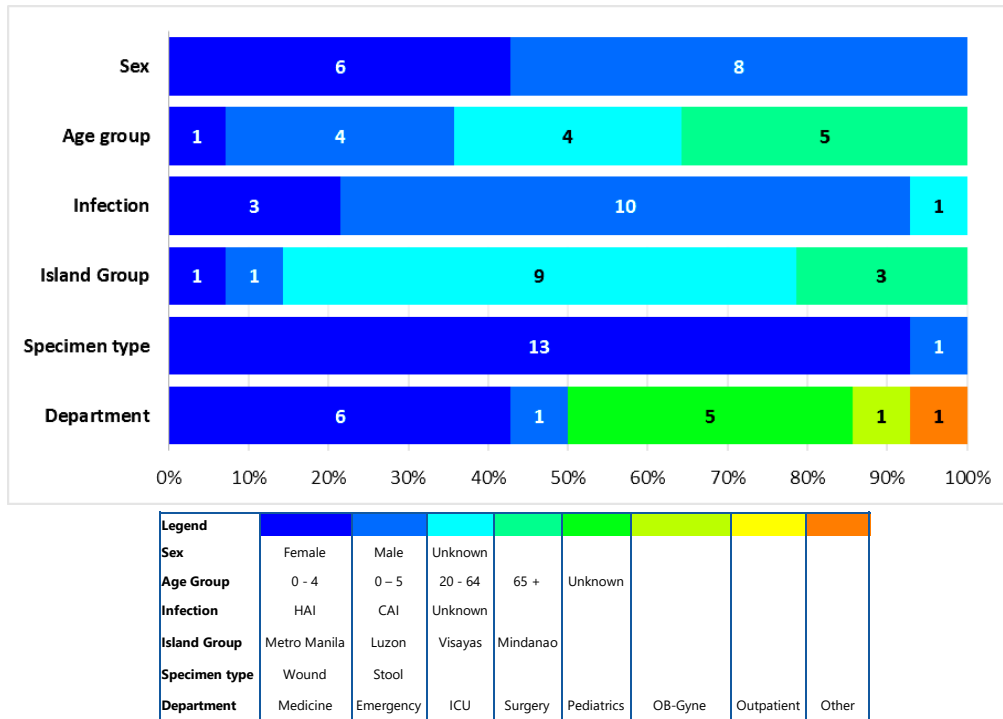


Figure 21. Patients characteristics for *Vibrio cholerae*, DOH ARSP, 2018

Most of the 2018 isolates came from patients 65+ years of age (36%). Majority (52%) were males. Most (71%) of the infections were presumptively community-acquired (isolates from specimens taken from patients who were within second hospital day or less, or from OPD or ER patients) (Figure 20). Most of the isolates were from stool (13 out of 14 isolates) with 1 isolate from wound.

Antimicrobial Resistance

As there were very few *V. cholerae* isolates reported for 2018, we combined the results of isolates from 2017 with 2018 to obtain a reasonable statistical estimate of the cumulative percentage resistance for *V. cholerae*.

As in the past several years, *V. cholerae* isolates have remained susceptible with resistance rates of 3% for co-trimoxazole and zero for chloramphenicol and tetracycline resistant for the combined 2017 and 2018 isolates (Table 18). These rates have remained stable for the past 10 years, with reported rates against each of these 3 antibiotics at 5% or less since 2008 (Figure 22).

Table 18. Percent resistance for *V. cholerae* (stool), DOH ARSP, 2018

Antibiotic name	Number	%Resistance	%R 95%C.I.
Co-trimoxazole	102	2.9	0.7-8.9
Chloramphenicol	97	0	0.0-4.7
Tetracycline	88	0	0.0-5.2

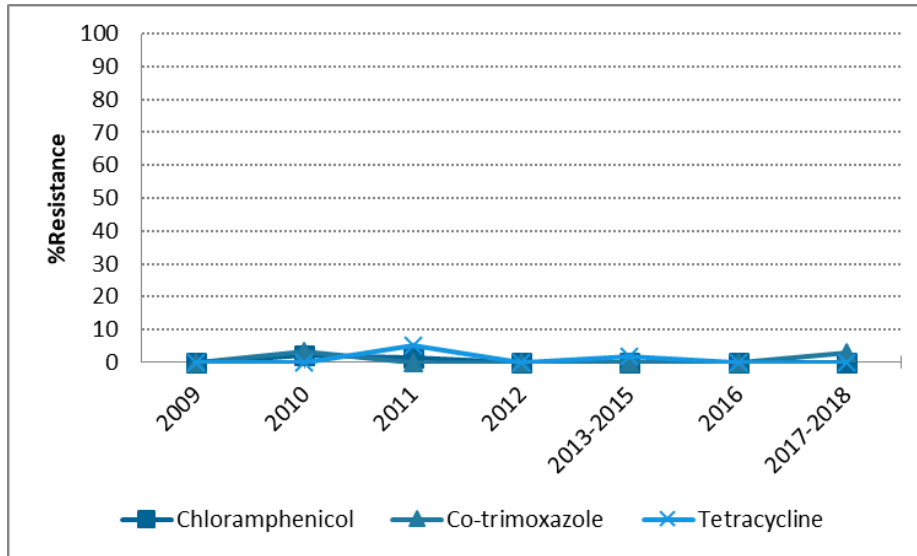


Figure 22. Yearly resistance rates of *Vibrio cholerae*, DOH ARSP, 2009-2018

Neisseria gonorrhoeae

Isolates

There were only 112 *Neisseria gonorrhoeae* isolates reported for 2018. This is 43% less than those reported for 2017 (n=160). The largest contributors of the 2018 *N. gonorrhoeae* data were RTM (44 isolates), VSM (26 isolates) and RTH (10 isolates) (Figure 23). Based on island group, 62% of *N. gonorrhoeae* isolates reported for 2018 were from Luzon with 40% coming from Metro Manila, 35% from the Visayas and 27% from Mindanao (Figure 24).

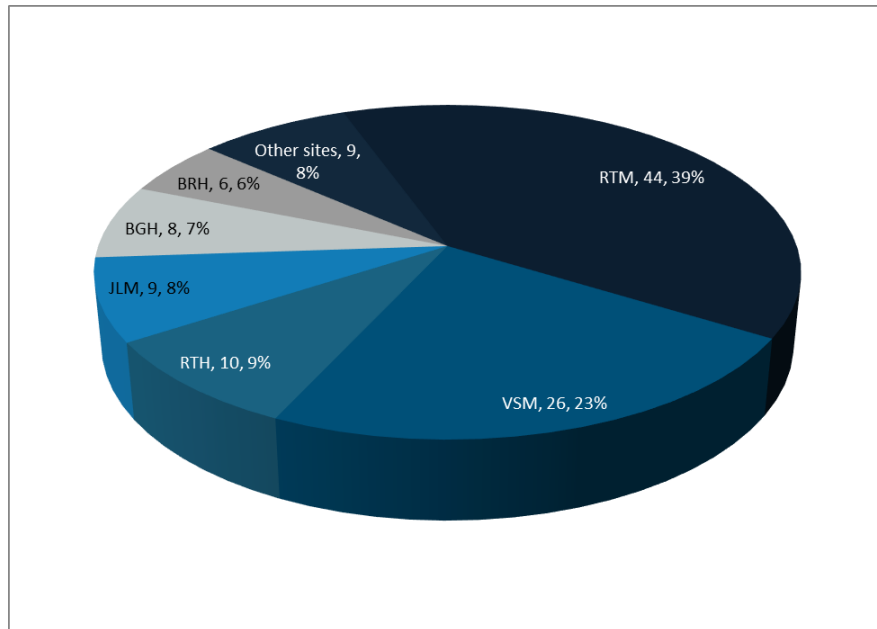


Figure 23. Percent sentinel site contribution for *Neisseria gonorrhoeae*, DOH ARSP, 2018

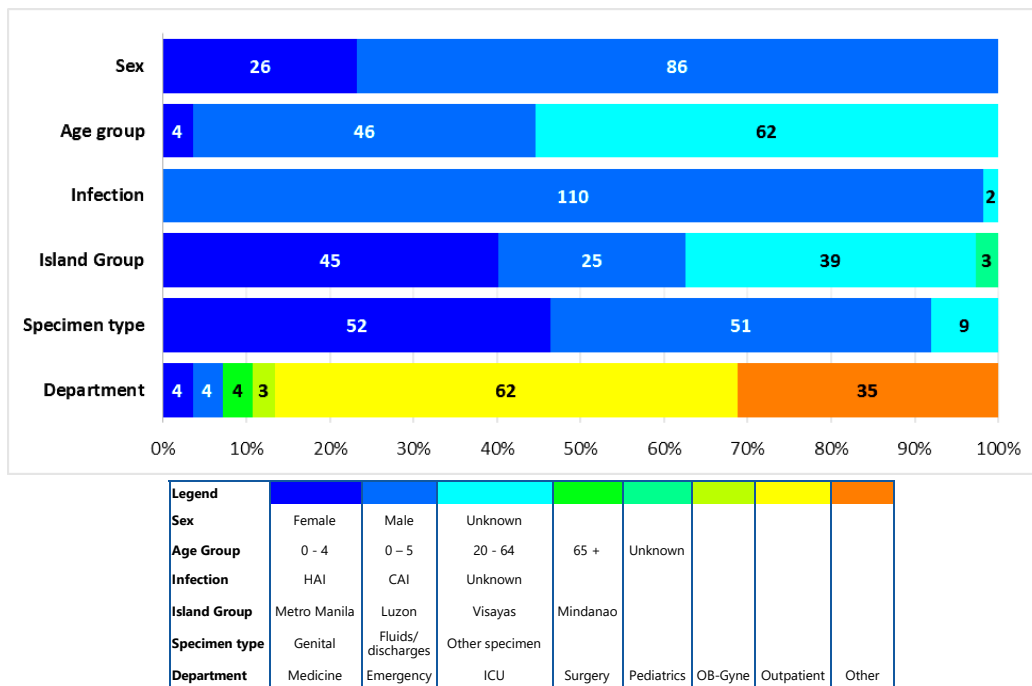


Figure 24. Patients characteristics for *Neisseria gonorrhoeae*, DOH ARSP, 2018

Most of the 2018 isolates came from patients 20-64 years of age (55%). Majority (77%) were males. As expected, except for few isolates for which no information were available, almost all (98%) of the infections were presumptively community acquired (isolates from specimens taken from patients who were within second hospital day or less, or from OPD or ER patients) and most (92%) are from genitals and discharge (Figure 24).

Antimicrobial Resistance

1. All specimens

Cumulative resistance rates of *Neisseria gonorrhoeae* isolates reported for 2018 are shown in Table 19. While resistance to ciprofloxacin and tetracycline were both above 50%, no resistance was reported for ceftriaxone, cefixime, azithromycin and spectinomycin. Resistance to ciprofloxacin of *N. gonorrhoeae* isolates by sentinel sites is shown in a map in Figure 25.

Table 19. Percent resistance for *Neisseria gonorrhoeae* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ceftriaxone	108	0	1.2-9.8
Cefixime	103	0	1.3-10.2
Ciprofloxacin	107	80	71.4-87.2
Tetracycline	69	57	44.1-68.2
Azithromycin	51	0	0.0-8.7
Spectinomycin	49	0	0.0-9.1

2. Urethral and Cervical discharge

Ciprofloxacin and tetracycline resistance rates of *N. gonorrhoeae* isolates from urethral and cervical discharge were above 50% (Table 20). No resistance was reported for ceftriaxone, cefixime, azithromycin and spectinomycin.

Figure 26 shows the yearly resistance rates for *N. gonorrhoeae* for the past decade. Ciprofloxacin resistance increased from 67% in 2017 to 82% in 2018. This increase was statistically significant. Tetracycline resistance likewise increased from 45% in 2017 to 57% in 2018 but this increase was not statistically significant.

Table 20. Percent resistance for *Neisseria gonorrhoeae* for urethral and cervical, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ceftriaxone	49	0	1.6-17.8
Cefixime	50	0	0.7-14.9
Ciprofloxacin	51	82	68.7-91.2
Tetracycline	28	57	37.4-74.9
Azithromycin	18	0	0.0-21.9
Spectinomycin	18	0	0.0-21.9

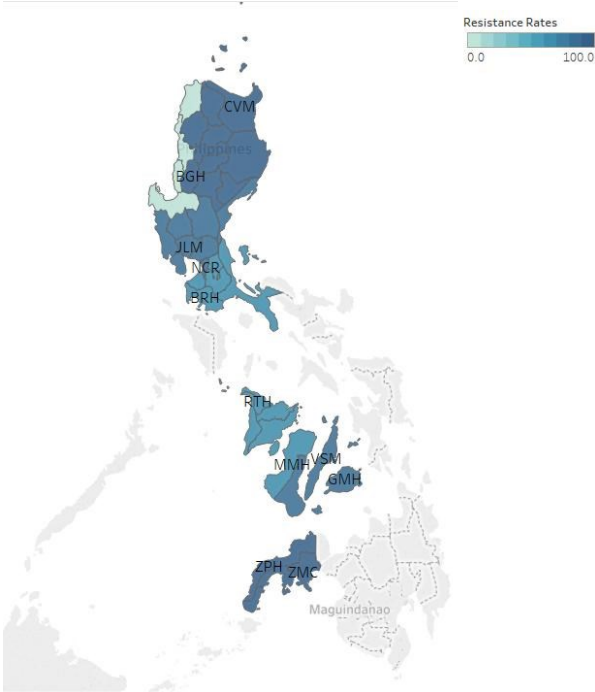


Figure 25. Percent resistance to ciprofloxacin of *Neisseria gonorrhoeae* isolates by sentinel site, DOH ARSP, 2018

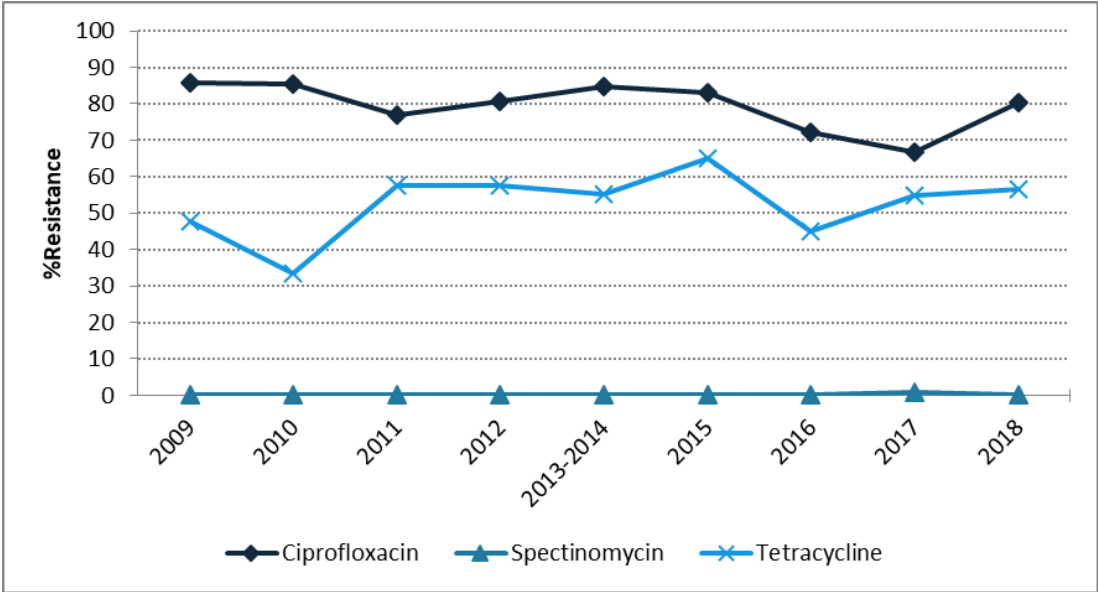


Figure 26. Yearly resistance rates of *Neisseria gonorrhoeae*, DOH ARSP, 2009-2018

Staphylococcus aureus

The Isolates

For 2018, there were a total of 7,026 isolates of *Staphylococcus aureus* reported compared to 5,882 isolates in 2017 showing a 16% increase. Percent contribution per site is shown in **Figure 27**. Most (63%) of the isolates were from Luzon with 29% coming from Metro Manila sites, 19% from the Visayas and 18% from Mindanao (**Figure 28**).

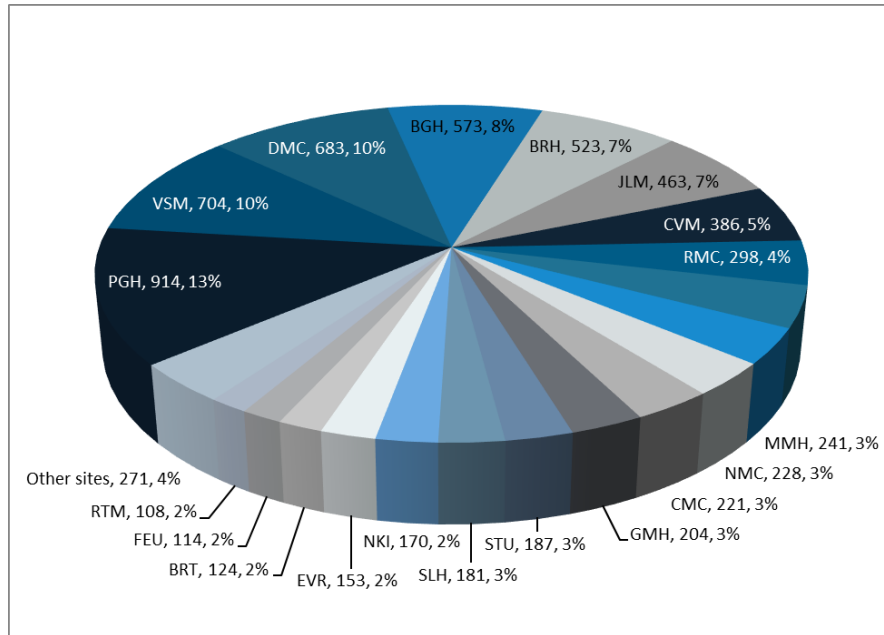


Figure 27. Percent sentinel site contribution for *Staphylococcus aureus*, DOH ARSP, 2018

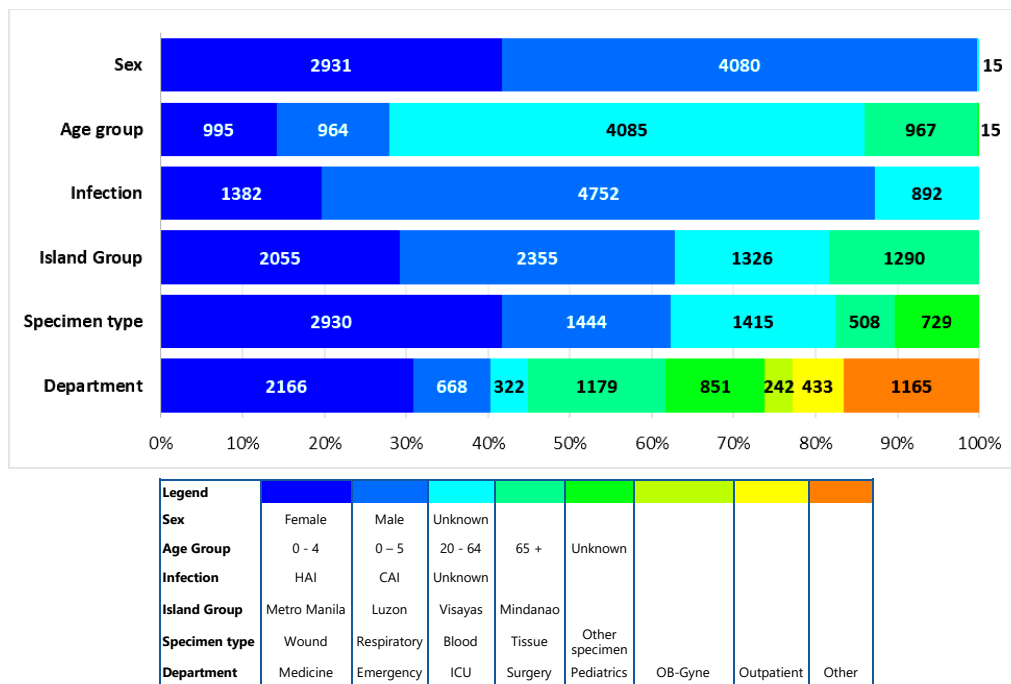


Figure 28. Patients characteristics for *Staphylococcus aureus*, DOH ARSP, 2018

Most of the isolates were from males (58%) and from age group 20-64 years old (58%). Many (42%) were from wound and most were presumptively community-acquired (68%).

Antimicrobial Resistance

1. All specimens

Overall cumulative resistance of *S. aureus* isolates reported for 2018 are shown in **Table 21**. Percent resistance ranged from 1% for linezolid and vancomycin to 53% for oxacillin.

Table 21. Percent resistance for *Staphylococcus aureus* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Clindamycin	6387	12	10.8-12.4
Trimethoprim/Sulfamethoxazole	6271	31	29.5-31.8
Linezolid	5734	1	0.4-0.8
Vancomycin	5589	1	0.3-0.7
Tetracycline	5571	9	7.9-9.4
Oxacillin	6675	53	51.8-54.2

Resistance rates for *S. aureus* isolates against commonly used antibiotics for the past 10 years are illustrated in **Figures 29** and **30**. Oxacillin resistance continued to decrease to 54% in 2018 from 57% in 2017 and 62% in 2016. This decrease is statistically significant. On the other hand, resistance to co-trimoxazole increased from 26% in 2017 to 30% in 2018.

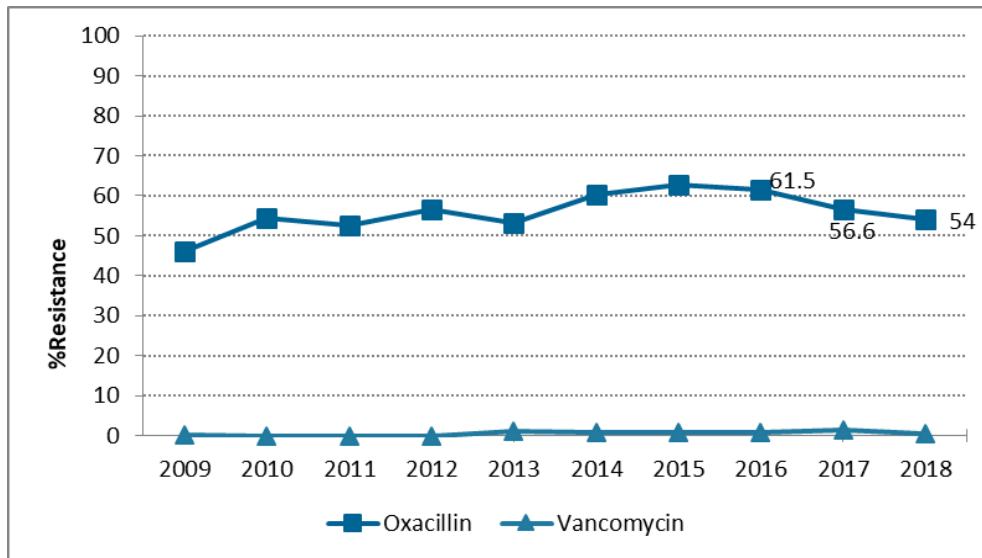


Figure 29. Yearly oxacillin and vancomycin resistance rates of *Staphylococcus aureus*, DOH ARSP, 2009-2018

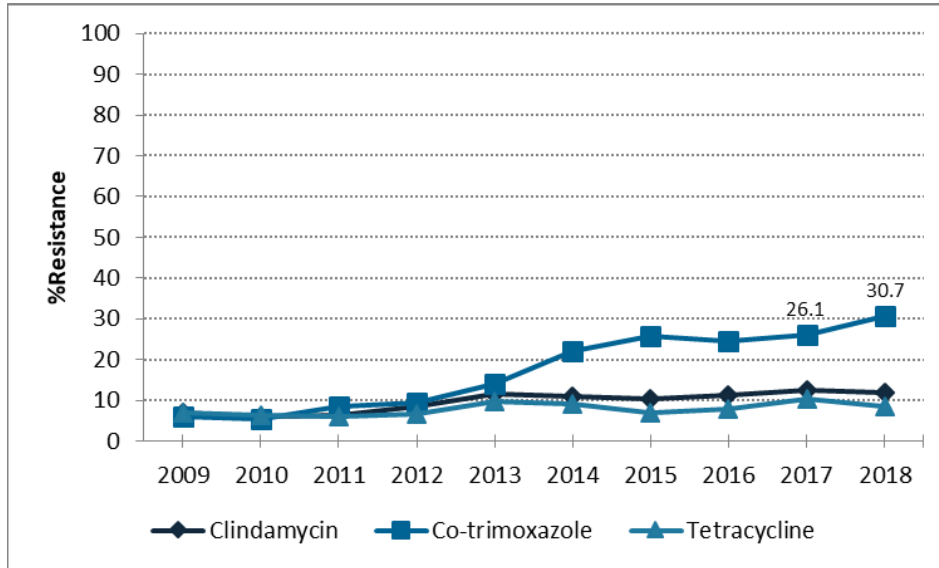


Figure 30. Percent clindamycin, co-trimoxazole and tetracycline resistance of *Staphylococcus aureus* isolates by sentinel site, DOH ARSP, 2009-2018

2. Skin and Soft Tissue specimens

Among *S. aureus* isolates from skin and soft tissues, percent resistance ranged from 1% for linezolid and vancomycin to 55% for oxacillin (Table 22).

Table 22. Percent resistance for *Staphylococcus aureus* for skin and soft tissues, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Oxacillin	3413	55	53.3-56.7
Trimethoprim/Sulfamethoxazole	3273	33	31.4-34.6
Clindamycin	3327	9	8.2-10.1
Linezolid	2894	1	0.3-0.9
Vancomycin	2808	1	0.4-1.0
Tetracycline	2843	7	6.2-8.1

3. Blood

Among *S. aureus* from blood, no linezolid-resistant isolates was seen (Table 23). Oxacillin resistance was at 55% and vancomycin resistance was at 1%. Vancomycin-resistant isolates were reported by two sentinel sites – one from Metro Manila and one from Mindanao. Of the 6 isolates from Mindanao, 4 were from 0-4 years age group. The isolates were multidrug-resistant with one isolate being possible pandrug-resistant. None of the isolates were confirmed at the reference laboratory. Resistance of *Staphylococcus aureus* isolates from blood specimens to oxacillin and vancomycin by sentinel sites is shown in Figures 31 and 32.

Table 23. Percent resistance for *Staphylococcus aureus* for blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Oxacillin	1419	55	52.2-57.4
Trimethoprim/Sulfamethoxazole	1315	29	26.9-31.9
Clindamycin	1351	12	10.1-13.6
Linezolid	1199	0	0.1-1.0
Vancomycin	1189	1	0.2-1.1
Tetracycline	1132	9	7.0-10.3

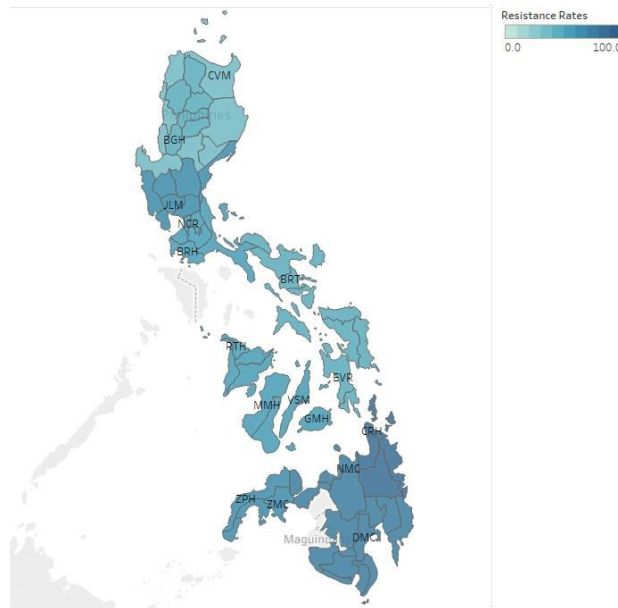


Figure 31. Map of percent resistance to oxacillin by sentinel site of *Staphylococcus aureus* isolates from blood specimens, DOH ARSP, 2018

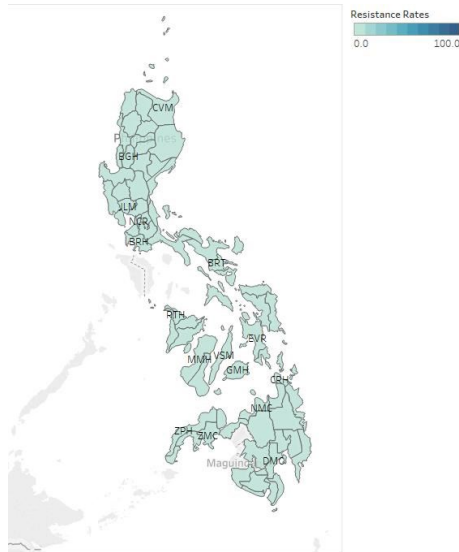


Figure 32. Map of percent resistance to vancomycin by sentinel site of *Staphylococcus aureus* isolates from blood specimens, DOH ARSP, 2018

4. Methicillin-resistant *Staphylococcus aureus* (MRSA)

There were 3,794 MRSA isolates reported from the ARSP sentinel sites for 2018. As mentioned above, the overall cumulative MRSA rate for 2018 was at 53% with variations by sentinel site MRSA rates ranging from as low as 32% (CVM) to as high as 77% (NMC) as depicted in **Figure 33**.

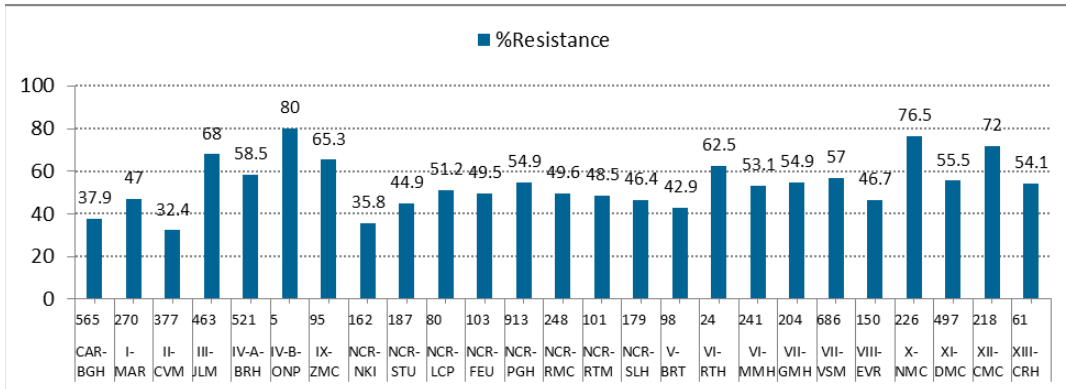


Figure 33. MRSA rates by sentinel site, DOH ARSP, 2018

Many of these isolates were from cutaneous (43%) and blood (21%) culture isolates (Figure 34). Most were from males (58%) and from age group 20-64 years old (57%). Majority (63%) were presumptively community-acquired.

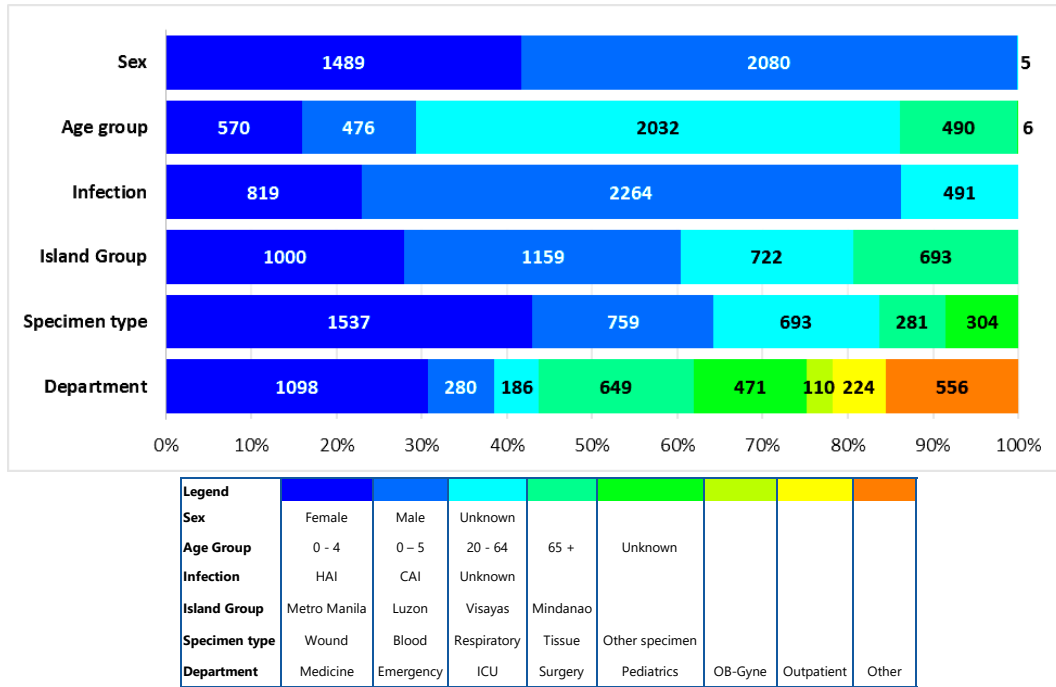


Figure 34. Patients characteristics for methicillin resistant *Staphylococcus aureus* (MRSA), DOH ARSP, 2018

Table 24 shows the resistance rates of methicillin resistant *S. aureus*. Resistance ranged from less than 1% for vancomycin and linezolid to 31% for co-trimoxazole.

Table 24. Percent resistance for methicillin resistant *Staphylococcus aureus*, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Rifampin	5324	5.3	4.7-5.9
Ciprofloxacin	6266	5.1	4.6-5.7
Co-trimoxazole	6269	30.5	29.4-31.7
Clindamycin	6386	11.6	10.8-12.4
Erythromycin	6795	12.3	11.5-13.1
Linezolid	5734	0.6	0.4-0.8
Vancomycin	5587	0.5	0.3-0.7
Tetracycline	5570	8.6	7.9-9.4

Enterococcus species

The Isolates

For 2018, there were a total of 3,618 *Enterococcus species* reported of which the most common were *Enterococcus faecalis* (52%) and *Enterococcus faecium* (30%).

1. *Enterococcus faecalis*

Sentinel site contribution for *Enterococcus faecalis* is shown in **Figure 35**. Sentinel sites contribution ranged from 3% for NKI to 23% from DMC.

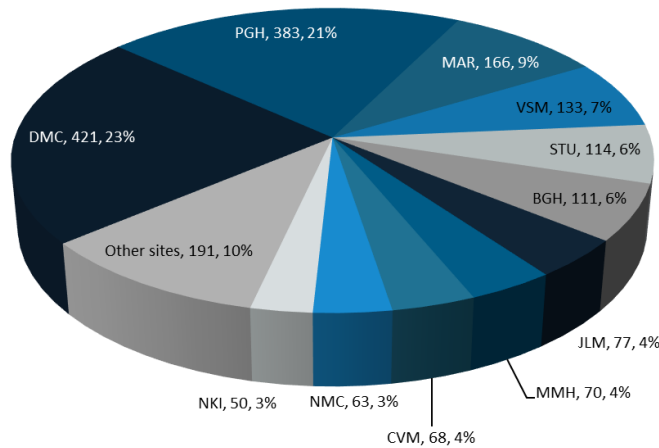


Figure 35. Percent sentinel site contribution for *Enterococcus faecalis*, DOH ARSP, 2018

Most of the *Enterococcus faecalis* isolates were from urine (51%) and many (47%) were presumptively community-acquired (**Figure 36**). Most of the isolates were from female patients (55%) and from age group 20-64 years (61%). By island group, 59% were from Luzon with 33% from Metro Manila, 13% from the Visayas and 28% from Mindanao.

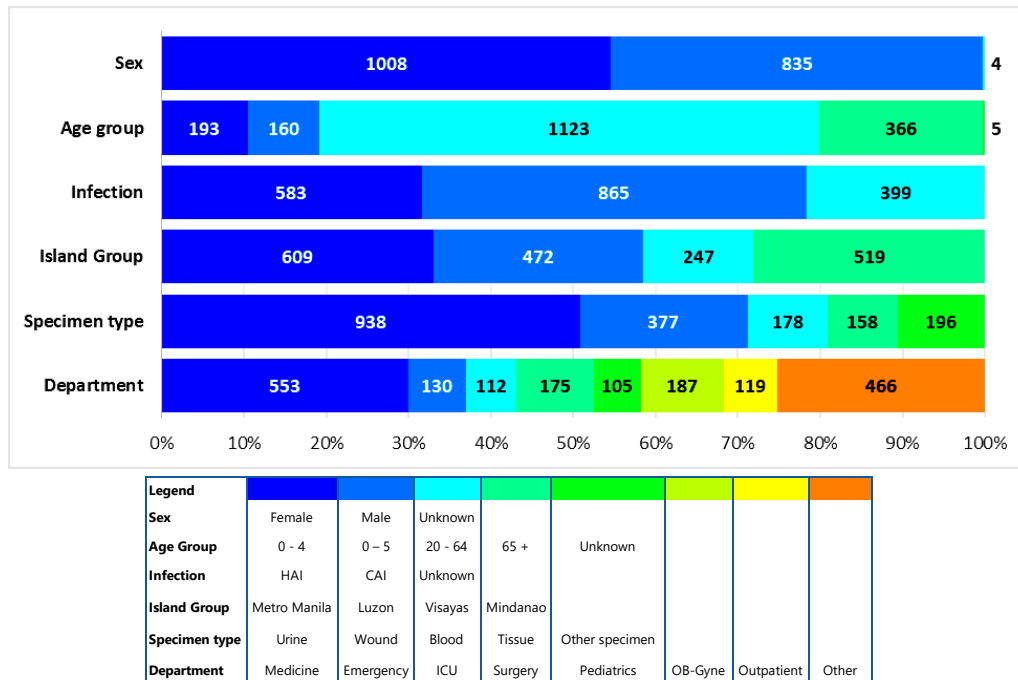


Figure 36. Patients characteristics for *Enterococcus faecalis*, DOH ARSP, 2018

Antimicrobial Resistance

1. All specimens

Table 25 shows the overall percent resistance for *Enterococcus faecalis* for 2018. Resistance to both linezolid and vancomycin were at 2% while high level resistance to gentamicin and streptomycin were at 32% and 25%, respectively.

Table 25. Percent resistance for *Enterococcus faecalis* for all specimens, DOH ARSP 2018

Antibiotic name	Number	%R	%R 95%C.I.
Penicillin G	1636	14	12.4-15.8
Ampicillin	1681	8	6.5-9.1
Gentamicin-High	1329	32	29.4-34.5
Streptomycin-High	929	25	22.0-27.6
Daptomycin	17	0	0.0-22.9
Linezolid	1590	2	1.2-2.6
Vancomycin	1697	2	1.0-2.2

2. Blood

Among *E. faecalis* from blood specimens, linezolid resistance was only 1% and 3% for vancomycin (**Table 26**). High-level resistance to gentamicin and streptomycin were at 32% and 27%, respectively.

There were two reported linezolid- and vancomycin-resistant *E. faecalis* from blood isolates from Luzon. Both isolates were from females, one from a newborn and the other from a 56 years old, and both were presumptively community-acquired. These isolates were not confirmed as linezolid- nor vancomycin-resistant at the reference laboratory.

There were two presumptively community-acquired blood isolates from Metro Manila confirmed to be vancomycin-resistant in the reference laboratory. These were from one adult male and one adult female. Both isolates were MDR but were susceptible to linezolid.

Table 26. Percent resistance for *Enterococcus faecalis* for blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Penicillin G	162	10	5.9-15.8
Ampicillin	172	8	4.3-12.9
Gentamicin-High	139	32	24.9-40.9
Streptomycin-High	123	27	19.4-35.7
Linezolid	157	1	0.2-5.0
Vancomycin	170	3	1.1-7.0

3. Urine

Among urine *E. faecalis* isolates, linezolid, vancomycin and nitrofurantoin resistance were all at 2% (Table 27). Of the 11 linezolid-resistant *E. faecalis* urine isolates reported, 9 were from Luzon with 6 from Metro Manila; two were from Mindanao. All patients were adults with 8 patients from age group 20-64 years and 3 were from age group 65 years and above. Ten were from females and one was from a male whose urine colony count was significant. Only one out of the 11 isolates were presumptively nosocomial. Six of the isolates were possible XDRs with two of the isolates also resistant to vancomycin. Only one of the eleven isolate was confirmed by the reference laboratory as linezolid-resistant and this isolate was from Luzon.

There were two presumptively nosocomial urine isolates from the Visayas confirmed to be vancomycin-resistant at the reference laboratory. One was from a 14 year old male and the other was from a 51 year old female. Both isolates were confirmed to be linezolid-susceptible.

Table 27. Percent resistance for *Enterococcus faecalis* for urine, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	836	8.7	6.9-10.9
Penicillin G	827	19	16.4-21.9
Daptomycin	11	0	0.0-32.1
Linezolid	791	1.4	0.7-2.6
Vancomycin	840	1.4	0.8-2.5
Gentamicin-High	674	37.7	34.1-41.6
Streptomycin-High	466	28.5	24.5-32.9
Ciprofloxacin	637	41.6	37.8-45.5
Levofloxacin	594	40.7	36.7-44.8
Nitrofurantoin	802	1.5	0.8-2.7
Tetracycline	626	81.8	78.5-84.7

The Isolates

2. *Enterococcus faecium*

Sentinel site contribution for *Enterococcus faecium* is shown in Figure 37. Highest contribution (35%) came from DMC.

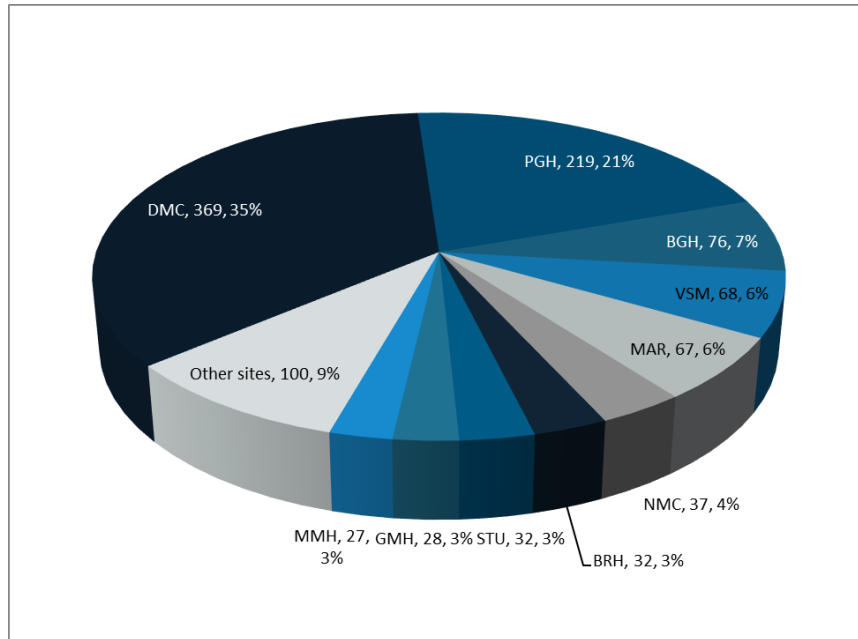


Figure 37. Percent sentinel site contribution for *Enterococcus faecium*, DOH ARSP, 2018

Most of the *Enterococcus faecium* isolates were likewise from urine (68%)(Figure 38). However, many (48%) were presumptively hospital-acquired (isolates from specimens taken from patients who were within second hospital day or less, or from OPD or ER patients). Most of the isolates were from female patients (57%) and many (44%) were from age group 20-64 years. By island group, 47% were from Luzon with 27% from Metro Manila, 12% from the Visayas and 40% from Mindanao.

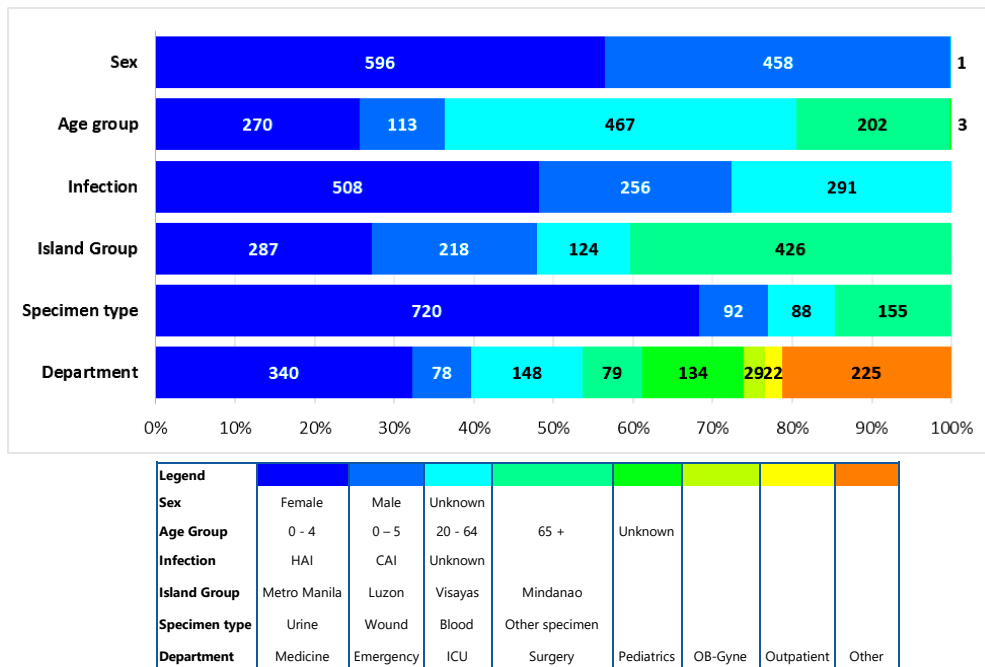


Figure 38. Patients characteristics for *Enterococcus faecium*, DOH ARSP, 2018

Antimicrobial Resistance

1. All specimens

Table 28 shows the overall percent resistance for *Enterococcus faecium* for 2018. Resistance to vancomycin was at 7% while resistance to linezolid was at 1%. High-level resistance to gentamicin and streptomycin were at 66% and 49%, respectively.

Table 28. Percent resistance for *Enterococcus faecium* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	993	87	84.2-88.5
Penicillin G	946	90	87.8-91.7
Daptomycin	1	0	5.5-100
Linezolid	967	1	0.6-2.2
Vancomycin	939	7	5.6-9.0
Gentamicin-High	811	66	62.4-69.0
Streptomycin-High	479	49	44.7-53.9

2. Blood and Urine specimens

High-level resistance to gentamicin and streptomycin were high for both subsets of *E. faecium* isolates (**Table 29** and **Table 30**). Vancomycin resistance was at 4% for isolates from blood while it was at 7% for isolates from urine specimens. Linezolid resistance were at 1% for *E. faecium* isolates from blood and for those from urine specimens. The reported linezolid-resistant isolates were not confirmed at the reference laboratory.

Table 29. Percent resistance for *Enterococcus faecium* for blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	90	91	82.7-95.8
Penicillin G	80	91	82.2-96.1
Linezolid	83	1	0.1-7.5
Vancomycin	70	4	1.1-12.9
Gentamicin-High	73	70	57.9-79.8
Streptomycin-High	61	51	37.8-63.7

Table 30. Percent resistance for *Enterococcus faecium* for urine, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	678	88.9	86.2-91.1
Penicillin G	659	92.9	90.6-94.7
Daptomycin	1	0	5.5-100
Linezolid	672	1	0.4-2.2
Vancomycin	657	7.8	5.9-10.2
Gentamicin-High	572	69.6	65.6-73.3
Streptomycin-High	298	49	43.2-54.8
Ciprofloxacin	567	90.5	87.7-92.7
Levofloxacin	560	90	87.1-92.3
Nitrofurantoin	659	21.7	18.7-25.1
Tetracycline	549	43.4	39.2-47.7

Escherichia coli

The Isolates

A total of 10,801 *Escherichia coli* isolates were reported for 2018. Percentage range of sentinel site contribution was fairly narrow, ranging from 2% (NMC) to 16% (PGH) (Figure 39). Based on island group, 59% were from Luzon with 34% from Metro Manila, 21% were Visayas and 20% were from Mindanao (Figure 40).

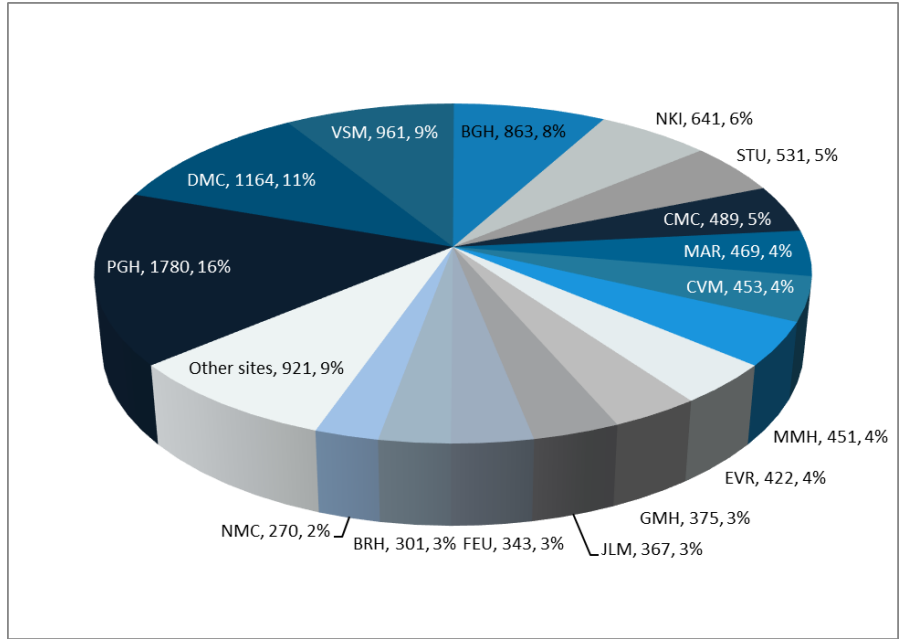
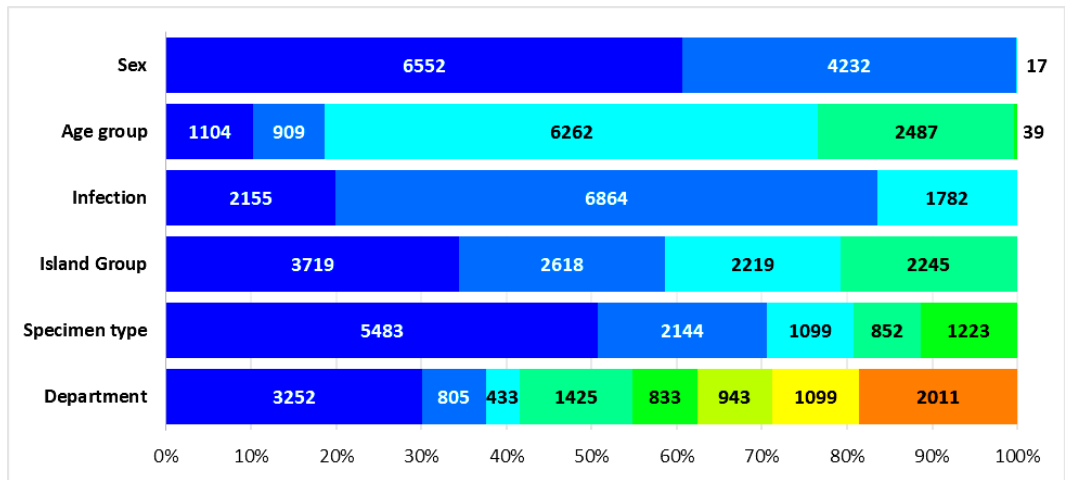


Figure 39. Percent sentinel site contribution for *Escherichia coli*, DOH ARSP, 2018



Legend	Female	Male	Unknown	0 - 4	0 - 5	20 - 64	65 +	Unknown					
Sex													
Age Group													
Infection													
Island Group													
Specimen type													
Department													

Figure 40. Patients characteristics for *Escherichia coli*, DOH ARSP, 2018

Antimicrobial Resistance

1. All specimens

Cumulative resistance of *Escherichia coli* from all specimens are shown in **Table 31**. Resistance rates of *E. coli* to most of the antibiotics were 20% or above. Among the antibiotics for which resistance were relatively low are amikacin (4%), piperacillin/tazobactam (11%) and the carbapenems: doripenem (3%), ertapenem (4%), imipenem (5%) and meropenem (5%).

Table 31. Percent resistance for *Escherichia coli* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	9223	81	80.6-82.2
Cefazolin	4578	46	44.9-47.9
Gentamicin	9222	20	19.4-21.0
Tobramycin	2481	20	18.3-21.4
Amikacin	9265	4	3.3-4.1
Amoxicillin/Clavulanic acid	9575	29	28.1-29.9
Ampicillin/Sulbactam	3892	35	33.5-36.5
Piperacillin/Tazobactam	9042	11	10.4-11.7
Cefuroxime	6012	38	37.0-39.4
Cefepime	9417	24	23.4-25.2
Cefotaxime	5424	43	41.4-44.0
Ceftriaxone	9755	38	37.1-39.1
Ciprofloxacin	9263	40	39.1-41.1
Levofloxacin	4376	39	37.2-40.1
Doripenem	176	3	1.0-6.8
Ertapenem	7031	4	3.9-4.9
Imipenem	8173	5	4.7-5.7
Meropenem	9565	5	4.9-5.8
Trimethoprim/Sulfamethoxazole	9393	61	60.1-62.1
Ceftazidime	9640	31	29.7-31.5

Resistance rates for 2018 and the past 10 years to the antimicrobial agents tested against *E. coli* are seen in **Figures 41 and 42**.

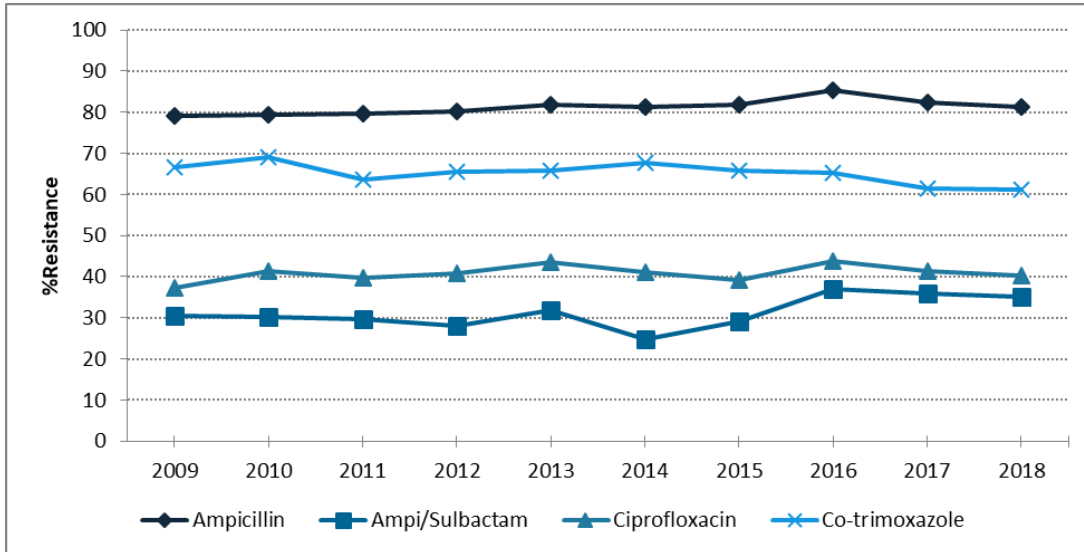


Figure 41. Yearly ampicillin, ampicillin/sulbactam, ciprofloxacin and co-trimoxazole resistance rates of *Escherichia coli* for all specimen, DOH ARSP, 2009-2018

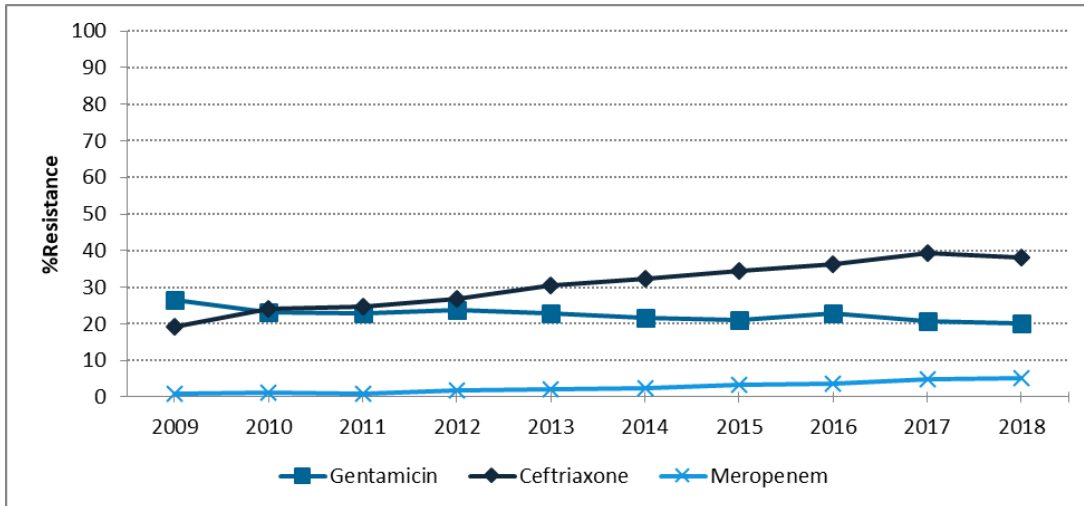


Figure 42. Yearly ceftriaxone, gentamicin & meropenem resistance rates of *Escherichia coli* for all specimen, DOH ARSP, 2009-2018

2. Blood

Resistance to amikacin, piperacillin/tazobactam, and the carbapenems were lower for *E. coli* isolates from blood specimens (Table 32) compared to the overall rates from combined resistance from all types of specimen.

Table 32. Percent resistance for *Escherichia coli* for blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin	1105	79	76.9-81.7
Cefazolin	636	43	38.6-46.5
Gentamicin	1108	20	17.4-22.2
Tobramycin	267	23	18.0-28.4
Amikacin	1107	2	1.1-2.7
Amoxicillin/Clavulanic acid	1146	25	22.1-27.1
Ampicillin/Sulbactam	431	32	27.9-37.0
Piperacillin/Tazobactam	1070	9	7.6-11.1
Cefuroxime	783	32	28.5-35.1
Cefepime	1127	20	17.9-22.7
Cefotaxime	590	41	37.0-45.1
Ceftriaxone	1160	34	30.9-36.4
Ciprofloxacin	1121	34	31.1-36.8
Levofloxacin	474	37	32.8-41.6
Doripenem	12*	8	0.4-40.2
Ertapenem	824	3	1.8-4.2
Imipenem	960	4	2.6-5.0
Meropenem	1130	4	2.8-5.1
Trimethoprim/Sulfamethoxazole	1092	64	61.1-66.8
Ceftazidime	1144	26	23.5-28.7

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

There is global recognition of multidrug-resistance (MDR) among pathogens including *E. coli*. Terminologies related to categories of multiple resistance are summarized in Table 33. Among *E. coli* isolates from blood, it was noted that MDR rate was 46%, possible XDR was at 7% and possible PDR was at 1% (Table 34).

Table 33. Definition of multidrug-resistant, extensively-drug resistant and pandrug-resistant bacteria

Term	Definition
MDR (Multidrug-resistant)	Acquired non-susceptibility to at least one agent in three or more antimicrobial categories
XDR (Extensively drug-resistant)	Non-susceptibility to at least one agent in all but two or fewer antimicrobial categories (i.e. bacterial isolates remain susceptible to only one or two categories)
PDR (Pandrug-resistant)	Non-susceptibility to all agents in all antimicrobial categories.

Table 34. Multidrug-resistant *E. coli* for blood specimens (n = 1,212), DOH ARSP, 2018

Blood (n=1212)	Number of isolates	Percentage
MDR	551	46%
possible XDR	90	7%
possible PDR	8	1%

3. Urine

There were 5,482 urinary *Escherichia coli* isolates reported for 2018 making this organism the most common bacterial isolate from urine specimens. Resistance data of outpatient and inpatient urinary *E. coli* isolates against commonly used oral antibiotics for urinary tract infections are shown in [Table 35](#).

Among out-patients, lowest resistance rate was against nitrofurantoin at 5% and highest for ampicillin (78%). 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 5% and highest for ceftriaxone (45%).

Table 35. Percent resistance of urinary *Escherichia coli*, all ARSP sites, Jan-Dec 2018

Antimicrobial	Outpatient			Inpatient		
	N	%R	%R 95%C.I.	N	%R	%R 95%C.I.
Ampicillin	1924	78.1	76.2-79.9	2778	84.1	82.7-85.4
Co-amoxiclav	2080	24	22.2-25.9	2863	29.7	28.0-31.4
Cefuroxime	1448	36.5	34.0-39.0	1684	43.5	41.1-45.9
Ciprofloxacin	1906	45.1	42.9-47.4	2817	45.9	44.1-47.9
Co-trimoxazole	1970	57.8	55.6-60.0	2854	63.5	61.7-65.3
Nitrofurantoin	1371	4.8	3.8-6.1	1814	4.6	3.7-5.7
Intravenous Agents						
Piperacillin/Tazobactam	1922	4.8	3.9-5.9	2779	11.8	10.7-13.2
Ceftriaxone	2034	34.4	32.3-36.5	2941	45.4	43.6-47.2
Ertapenem	1629	0.9	0.5-1.5	2138	5.6	4.7-6.7
Amikacin	1938	3.7	2.9-4.7	2801	4.6	3.9-5.5

4. Extended-Spectrum Beta-Lactamase (ESBL) *Escherichia coli*

From the subset of the 2018 isolates screened phenotypically for ESBL production, cumulative rate was at 59% (n=3,948). There was significant variability noted for the different sentinel sites with presumptive ESBL rates ranging from 11% in FEU to 53% in DMC among those that tested at least 30 isolates for the analysis period. Rates of ESBL-suspect *E. coli* by sentinel site are seen in [Figure 43](#).

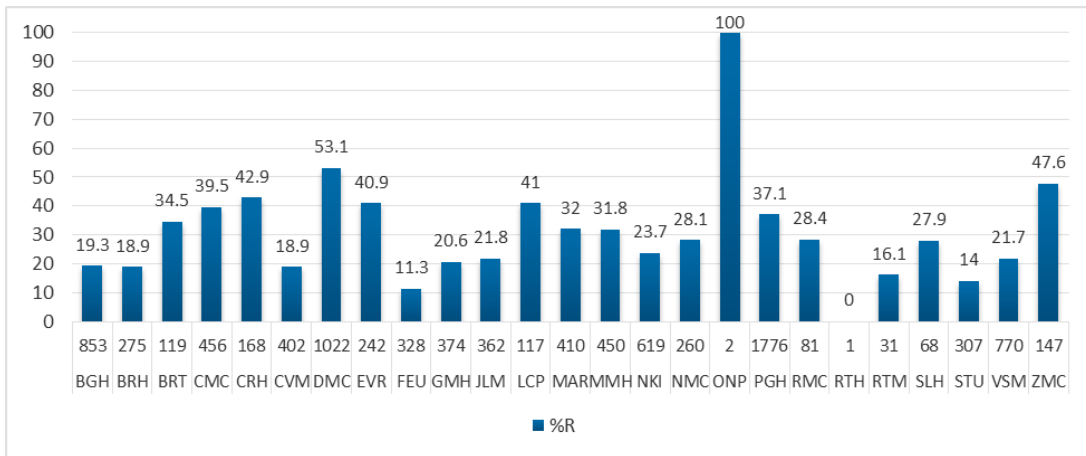


Figure 43. Percentage resistance of ESBL-producing *E. coli*, DOH ARSP, 2018

Klebsiella pneumoniae

The Isolates

A total of 13,952 *Klebsiella pneumoniae* isolates were reported for 2018. Percentage range of sentinel site contributions was fairly narrow, ranging from 2% (BRT) to 13% (PGH) (Figure 44). Based on island group, 50% were from Luzon with 26% from Metro Manila, 32% were from Visayas and 18% were from Mindanao (Figure 45).

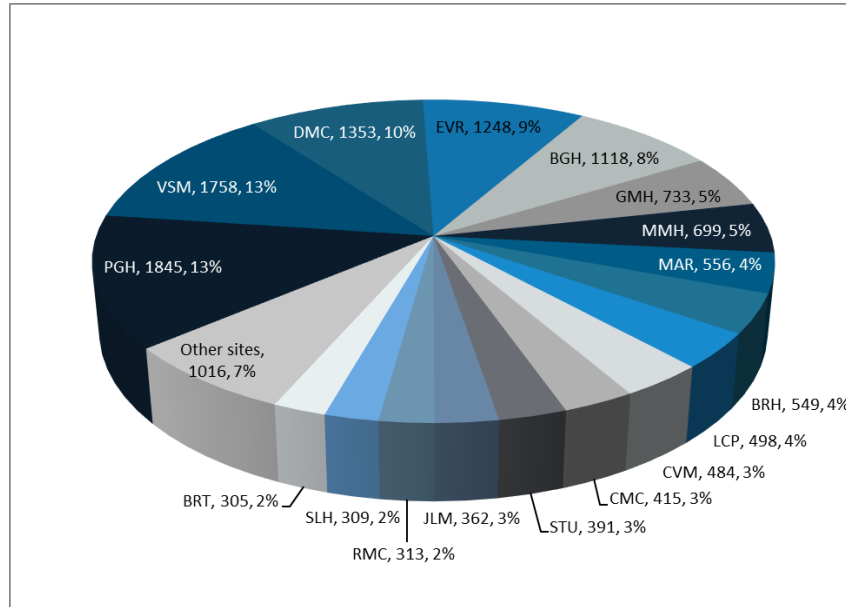


Figure 44. Percent sentinel site contribution for *Klebsiella pneumoniae*, DOH ARSP, 2018

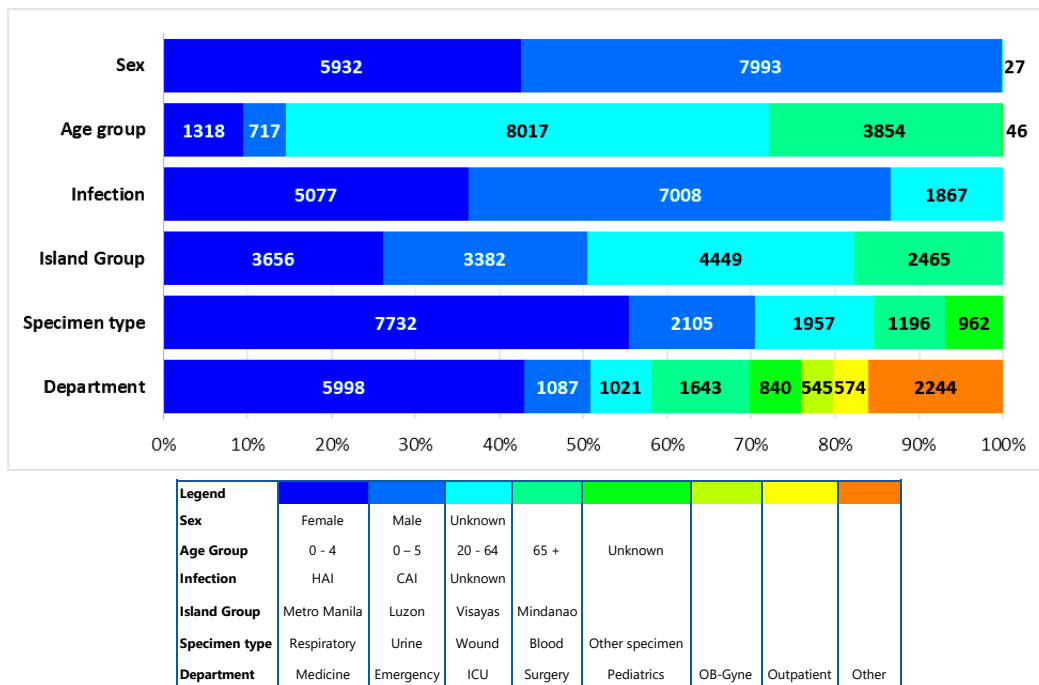


Figure 45. Patients characteristics for *Klebsiella pneumoniae*, DOH ARSP, 2018

Majority of the isolates were from respiratory specimens (55%) and most (50%) were presumptively community-acquired (Figure 45). Most were from male patients (57%) and from 20-64 years age group (58%).

Antimicrobial Resistance

1. All specimens

Cumulative resistance of *Klebsiella pneumoniae* from all specimens are shown in **Table 36**. Known to be more commonly resistant to multiple classes of antibiotics, *K. pneumoniae* resistance rates to most of the antibiotics in 2018 were 20% or above. Among the antibiotics for which *K. pneumoniae* resistance were relatively low are amikacin (6%) and the carbapenems: doripenem (7%) and ertapenem (9%). Resistance to imipenem was at 10% and 12% for meropenem.

Table 36. Percent resistance for *Klebsiella pneumoniae* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Cefazolin	6024	51	49.5-52.1
Gentamicin	11621	23	21.9-23.5
Tobramycin	3772	22	20.6-23.3
Amikacin	12268	6	5.2-6.0
Amoxicillin/Clavulanic acid	12322	36	34.7-36.4
Piperacillin/Tazobactam	11816	22	21.0-22.5
Cefuroxime	6734	48	46.8-49.2
Cefepime	12279	34	32.8-34.4
Cefotaxime	7648	49	47.6-49.8
Ceftriaxone	12617	45	44.0-45.8
Ciprofloxacin	12101	22	21.3-22.8
Levofloxacin	5491	20	18.6-20.7

Resistance rates for 2018 and the past 10 years to the representative antimicrobial agents tested against *K. pneumoniae* are seen in **Figures 46, 47 and 48**.

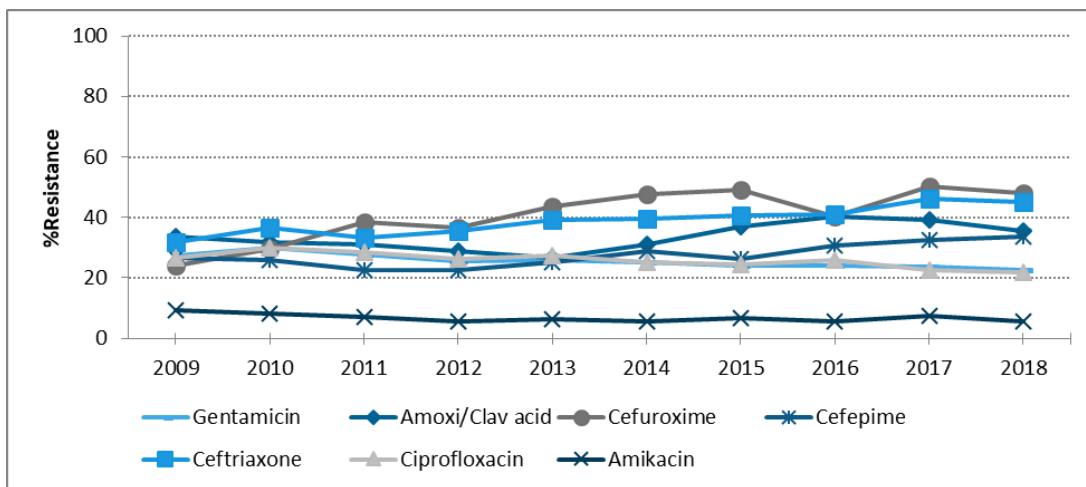


Figure 46. Yearly gentamicin, amoxicillin-clavulanic acid, cefuroxime, cefepime, ceftriaxone, ciprofloxacin, and amikacin resistance rates of *Klebsiella pneumoniae*, DOH ARSP, 2009-2018

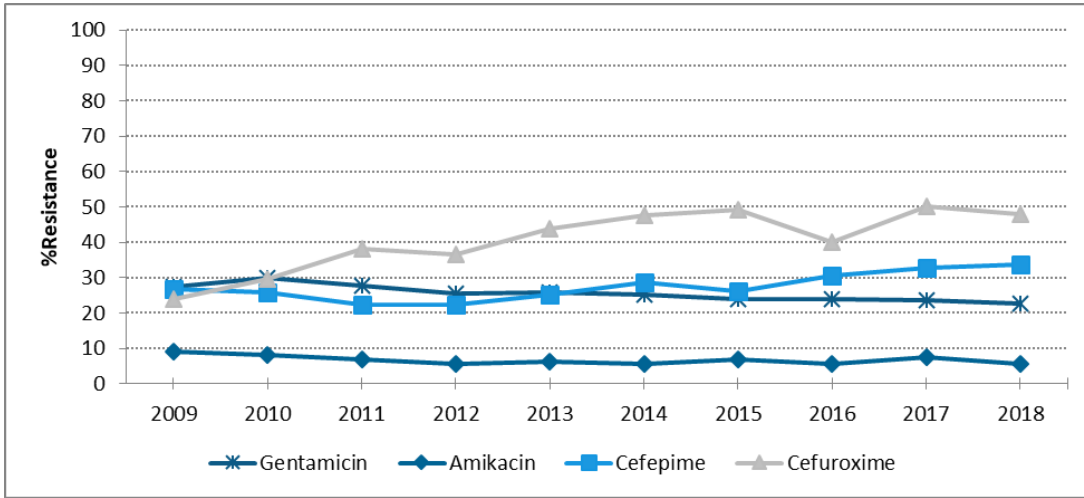


Figure 47. Yearly amikacin, cefepime, cefuroxime, & gentamicin resistance rates of *Klebsiella pneumoniae*, DOH ARSP, 2009-2018

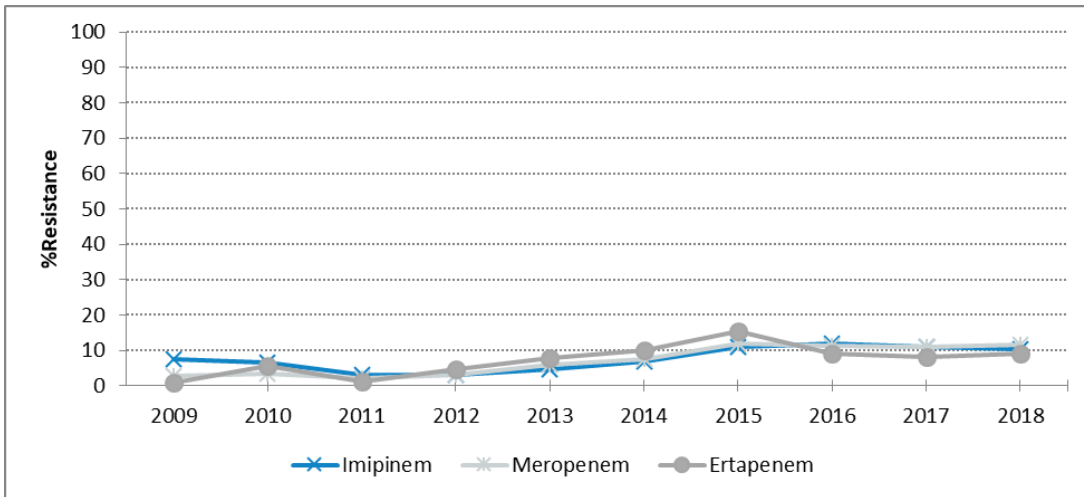


Figure 48. Yearly carbapenem resistance rates of *Klebsiella pneumoniae*, DOH ARSP, 2009-2018

2. Blood

There is global recognition of multidrug-resistance among pathogens including *K. pneumoniae*. Multidrug-resistance for *K. pneumoniae* isolates from blood was at 59%, while possible extremely drug-resistant isolates was at 26% and possible pan-drug-resistance was at 4% (Table 37).

Table 37. Multidrug-resistant *Klebsiella pneumoniae* from blood (n = 1,316), DOH ARSP, 2018

Blood (n=1316)	Number of isolates	Percentage
MDR	775	59%
possible XDR	343	26%
possible PDR	51	4%

Compared to the overall rates from combined resistance from all types of specimen, resistance rates among *K. pneumoniae* isolates from blood and urine were noted to be higher (Table 38 and 39). Resistance to amikacin was at 12%, ertapenem at 12%, imipenem was at 14% and 19% for meropenem.

Table 38. Percent resistance for *Klebsiella pneumoniae* from blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Cefazolin	654	59	55.0-62.7
Gentamicin	1151	35	32.5-38.0
Tobramycin	364	30	25.3-34.9
Amikacin	1209	12	10.5-14.3
Amoxicillin/Clavulanic acid	1200	43	40.1-45.8
Piperacillin/Tazobactam	1101	28	25.1-30.5
Cefuroxime	805	56	52.0-59.0
Cefepime	1216	44	41.4-47.0
Cefotaxime	710	58	54.0-61.4
Ceftriaxone	1207	55	52.1-57.8
Ciprofloxacin	1171	24	21.8-26.8
Levofloxacin	566	21	17.6-24.4
Doripenem	14*	21	5.7-51.2
Ertapenem	742	12	9.8-14.6
Imipenem	1009	14	12.3-16.8
Meropenem	1192	19	16.4-20.8
Trimethoprim/Sulfamethoxazole	1133	56	53.3-59.1
Ceftazidime	1200	51	47.9-53.7

*Very few isolates were tested (N <30); percentage of resistance should be interpreted with caution

3. Urine

Table 39. Percent resistance for *Klebsiella pneumoniae* from urine, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Amoxicillin/Clavulanic acid	1893	45	42.2-46.8
Piperacillin/Tazobactam	1849	28	25.8-29.9
Cefazolin	1022	61	58.0-64.1
Cefuroxime	1176	57	53.7-59.4
Ceftazidime	1876	54	51.5-56.1
Ceftriaxone	1932	56	54.2-58.6
Cefotaxime	1015	61	58.2-64.3
Cefepime	1883	45	42.3-46.9
Doripenem	42	7	1.8-20.5
Ertapenem	1386	11	9.8-13.2
Imipenem	1628	14	12.5-15.9
Meropenem	1919	16	14.1-17.4
Amikacin	1881	9	7.7-10.3
Gentamicin	1832	29	26.8-31.0
Tobramycin	500	26	22.1-29.9
Ciprofloxacin	1858	36	33.4-37.8
Levofloxacin	1084	32	28.8-34.4
Trimethoprim/Sulfamethoxazole	1852	60	57.6-62.1
Nitrofurantoin	1165	30	27.2-32.5

4. Extended-Spectrum Beta-Lactamase *Klebsiella pneumoniae*

From the subset of the 2018 *Klebsiella pneumoniae* isolates screened phenotypically for ESBL production, cumulative rate was at 58% (n=6,168). There was significant variability noted for the different sentinel sites with presumptive ESBL rates ranging from 22% in RTM to 64% in DMC among those that tested at least 30 isolates for the analysis period. Suspected ESBL *K. pneumoniae* rates by sentinel site are seen in **Figure 49**.

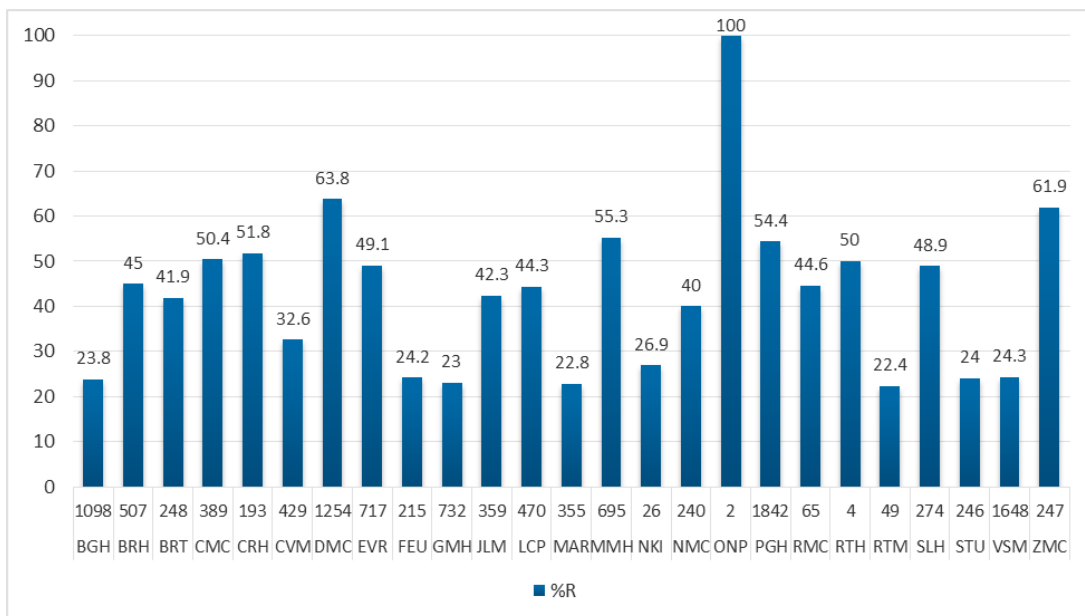


Figure 49. Percentage ESBL producing *Klebsiella pneumoniae*, DOH ARSP, 2018

Pseudomonas aeruginosa

The Isolates

For 2018, there were 7,495 *P. aeruginosa* isolates reported with sentinel sites contribution ranging from 2% (CMC to 16% (PGH) (Figure 50). Contributions from Luzon was at 58% with 34% coming from Metro Manila sites, 22% from Visayas and 20% from Mindanao (Figure 51).

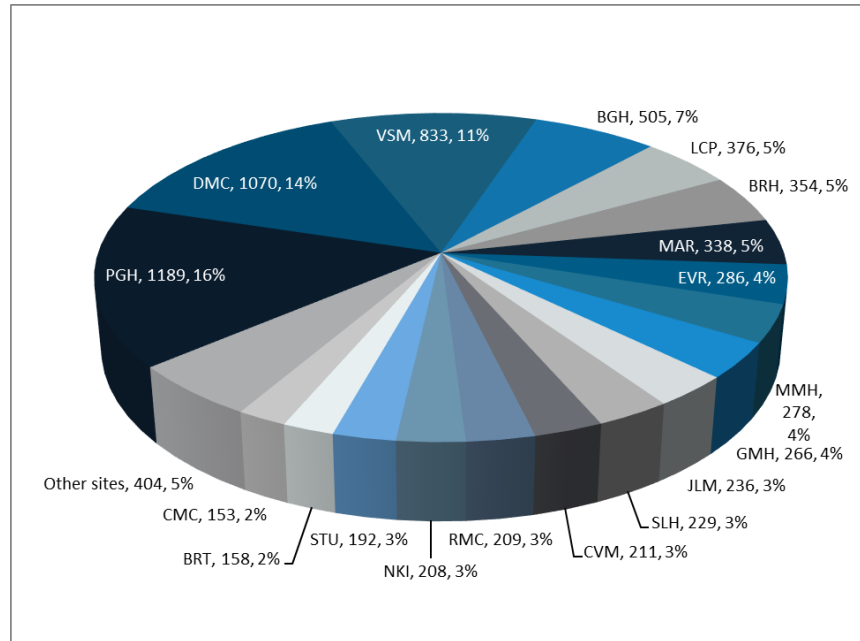


Figure 50. Percent sentinel site contribution for *Pseudomonas aeruginosa*, DOH ARSP, 2018

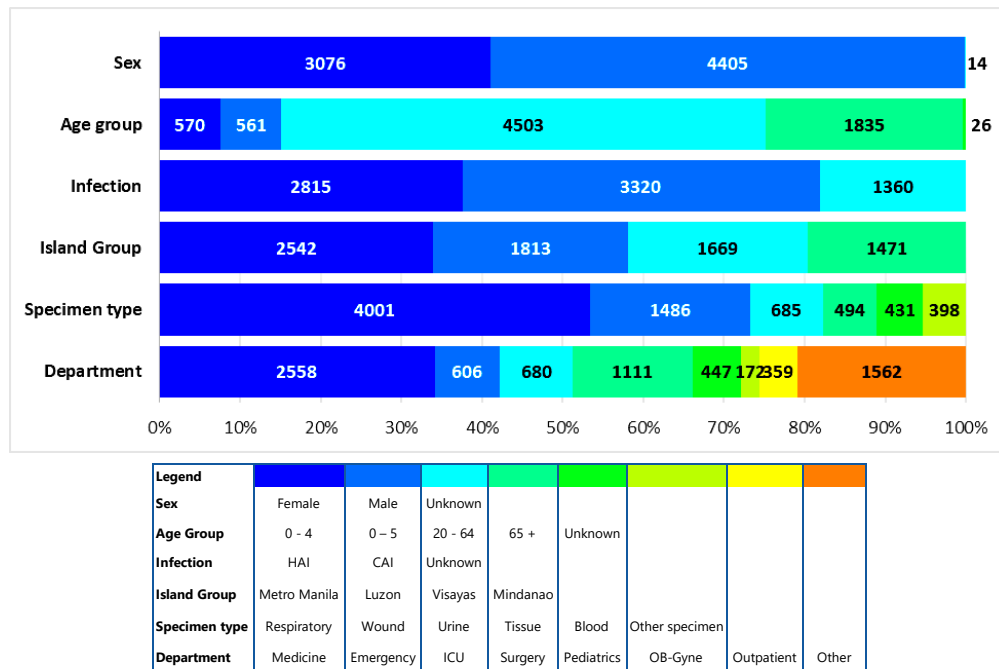


Figure 51. Patients characteristics for *Pseudomonas aeruginosa*, DOH ARSP, 2018

Most isolates were from respiratory specimens (53%) and were presumptively community-acquired (44%). Most of the patients were male (59%) and of the age group 20-64 years (60%).

Antimicrobial Resistance

1. All specimens

Overall cumulative resistance for *P. aeruginosa* isolates ranged from 3% for colistin to 19% for imipenem (Table 39).

Table 39. Percent resistance for *Pseudomonas aeruginosa* (all specimens), DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Piperacillin	967	18	15.4-20.3
Piperacillin/Tazobactam	6371	14	13.4-15.1
Ceftazidime	6940	16	14.9-16.6
Cefepime	6811	14	12.7-14.3
Aztreonam	3217	14	12.3-14.7
Doripenem	112	6	2.7-12.8
Imipenem	5897	19	17.8-19.8
Meropenem	6767	16	15.2-17.0
Amikacin	6768	7	6.6-7.8
Gentamicin	6562	12	10.7-12.3
Tobramycin	2179	10	9.2-11.8
Ciprofloxacin	6598	13	11.9-13.5
Levofloxacin	3461	14	13.3-15.6
Colistin	3688	3	2.5-3.6

Although a few isolated reports of colistin-resistant isolates were reported for 2018, none of these were identified and confirmed using the only recommended phenotypic testing, broth microdilution.

Resistance rates of *P. aeruginosa* for 2018 and the past 10 years are illustrated in Figures 52, 53 and 54. There was a decrease in resistance to aztreonam from 17% in 2017 to 14% in 2018 and to amikacin from 8% in 2017 to 7% in 2018. An increase in resistance were noted for the carbapenems. Imipenem resistance increased from 17% in 2017 to 19% in 2018 while resistance to meropenem increased from 14% in 2017 to 16% in 2018. These changes were statistically significant.

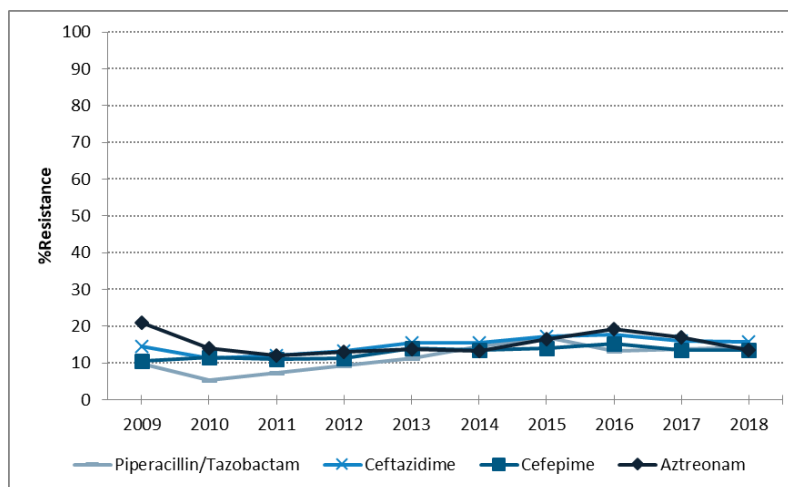


Figure 52. Yearly aztreonam, cephalosporin and piperacillin/tazobactam resistance rates of *P. aeruginosa*, DOH ARSP, 2009-2018

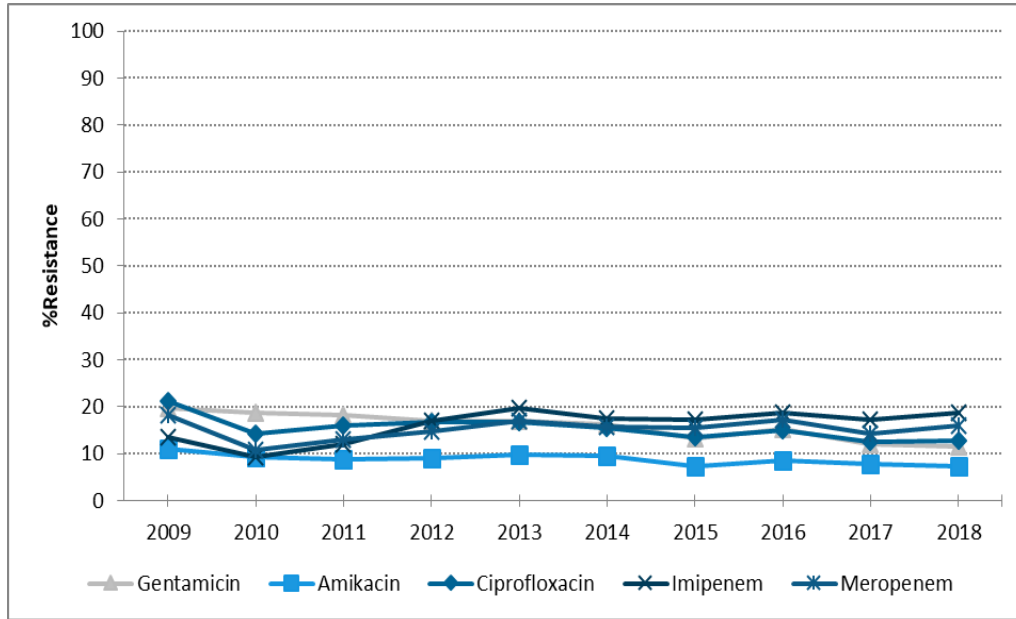


Figure 53. Yearly aminoglycosides, ciprofloxacin and carbapenem resistance rates of *P. aeruginosa*, DOH ARSP, 2009-2018

2. Blood

Among isolates from blood, resistance rates to piperacillin, imipenem, meropenem and levofloxacin were lower compared to overall (all specimens) cumulative resistance rates (Table 40). Resistance ranged from 10% for levofloxacin to 23% for tobramycin.

Table 40. Percent resistance for *Pseudomonas aeruginosa* from blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Piperacillin	39	15	6.4-31.2
Piperacillin/Tazobactam	422	15	12.0-19.1
Ceftazidime	445	17	13.3-20.5
Cefepime	441	14	11.2-18.0
Aztreonam	226	18	13.4-23.9
Doripenem	13	23	6.2-54.0
Imipenem	358	17	13.3-21.4
Meropenem	427	15	12.0-19.0
Amikacin	433	13	10.4-17.1
Gentamicin	428	18	14.4-21.8
Tobramycin	129	23	16.5-31.7
Ciprofloxacin	425	13	9.9-16.6
Levofloxacin	207	10	6.2-14.8
Colistin	191	4	1.6-7.8

Acinetobacter baumannii

The Isolates

For 2018, there were 5,180 *A. baumannii* isolates with sentinel sites contribution ranging from 3% (CMC) to 21% (PGH) (Figure 54). Contributions from Luzon was at 60% with 35% coming from Metro Manila sentinel sites, 17% from Visayas and 23% from Mindanao (Figure 55)

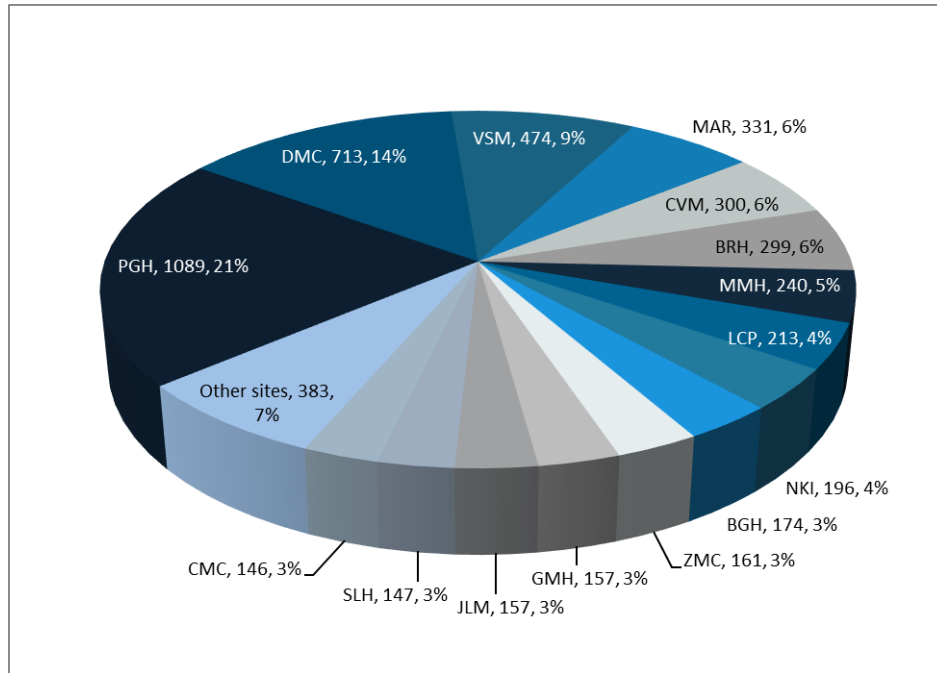


Figure 54. Percent sentinel site contribution for *Acinetobacter baumannii*, DOH ARSP, 2018

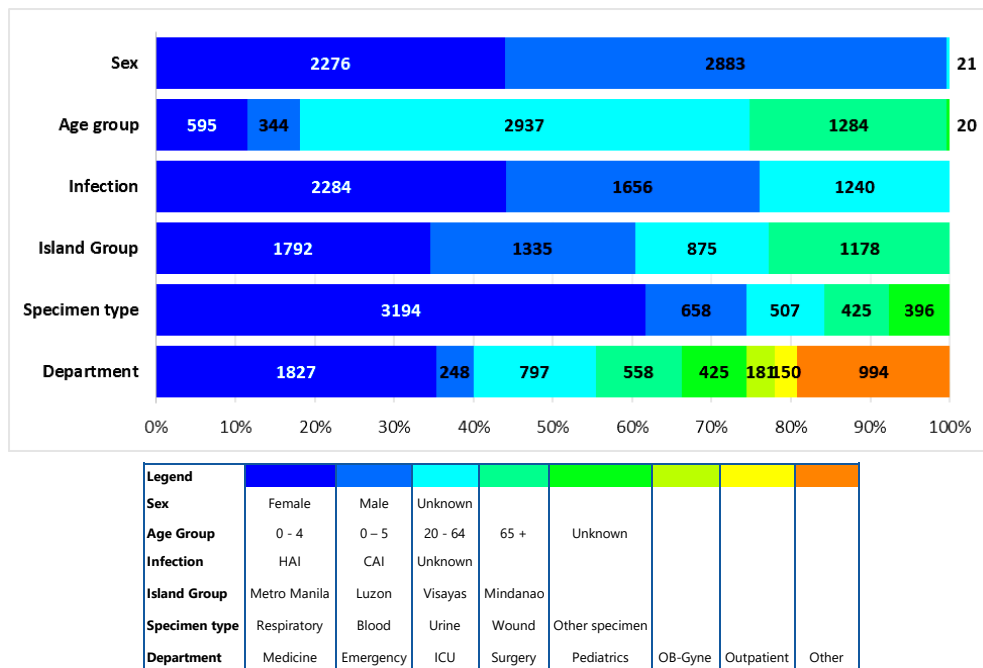


Figure 55. Patients characteristics for *Acinetobacter baumannii*, DOH ARSP, 2018

As in the previous year, 2018 *A. baumannii* isolates were most commonly isolated from respiratory specimens (62%), blood (13%), urine (10%) and cutaneous/wound specimens (6%) (Figure 67). Most (44%) were presumptively hospital-acquired. Majority of the patients were males (56%) and from 20-64 years age group (57%) (Figure 55).

Antimicrobial Resistance

1. All specimens

Overall cumulative resistance for *A. baumannii* isolates ranged from 0% for colistin to 63% for cefotaxime (Table 41). More than 50% resistance were observed for ampicillin/sulbactam, ceftazidime, ciprofloxacin, imipenem, meropenem, piperacillin/tazobactam, cefepime, cefotaxime, ceftriaxone and co-trimoxazole.

Table 41. Percent resistance for *Acinetobacter baumannii* for all specimens, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95% C.I.
Ampicillin/Sulbactam	2874	54	52.0-55.6
Ceftazidime	4741	53	52.0-54.8
Ciprofloxacin	4556	55	53.5-56.5
Levofloxacin	2082	47	45.0-49.4
Doripenem	57	35	23.3-49.0
Imipenem	3978	56	54.8-57.9
Meropenem	4541	56	54.5-57.4
Gentamicin	4554	43	41.9-44.8
Tobramycin	994	38	35.1-41.2
Amikacin	2530	30	28.4-32.0
Piperacillin/Tazobactam	4388	58	56.9-59.9
Cefepime	4619	56	55.0-57.8
Cefotaxime	1537	63	60.2-65.1
Ceftriaxone	3773	56	54.4-57.6
Minocycline	1374	4	3.4-5.7
Trimethoprim/Sulfamethoxazole	4261	53	51.0-54.0
Polymixin B	1	0	0.0-94.5
Colistin	2902	0	0.2-0.7

Yearly resistance rates of *A. baumannii* for the past 10 years are illustrated in Figures 56 and 57. When 2018 data were compared to reported rates for 2017, statistically significant decrease in resistance rates were noted for cefepime (from 59% in 2017 to 56% in 2018). A decrease in imipenem resistance (from 57% in 2017 to 56% in 2018) was also noted but was not statistically significant. A statistically significant increase in rates were noted for ampicillin/sulbactam (from 49% in 2017 to 54% in 2018) and for gentamicin (from 40% in 2017 to 43% in 2018). No significant changes in resistance were observed for the rest of the antibiotics.

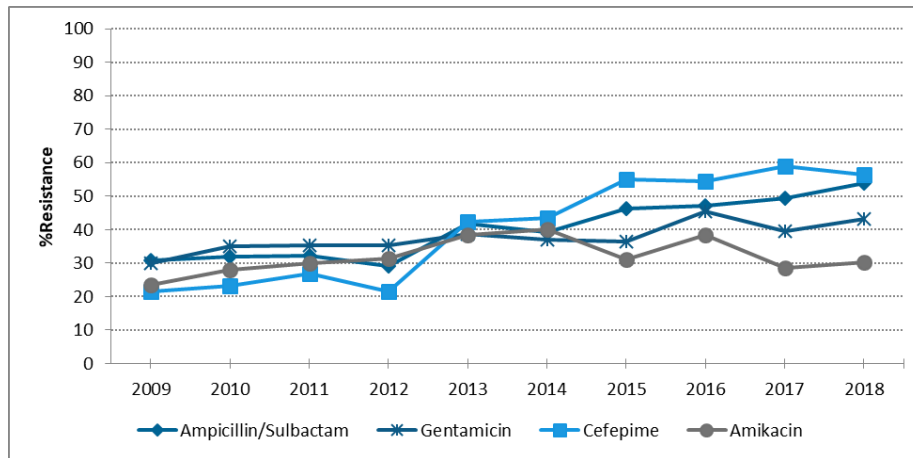


Figure 56. Yearly ampicillin/sulbactam, cefepime and aminoglycosides resistance rates of *A. baumannii*, DOH ARSP, 2009-2018

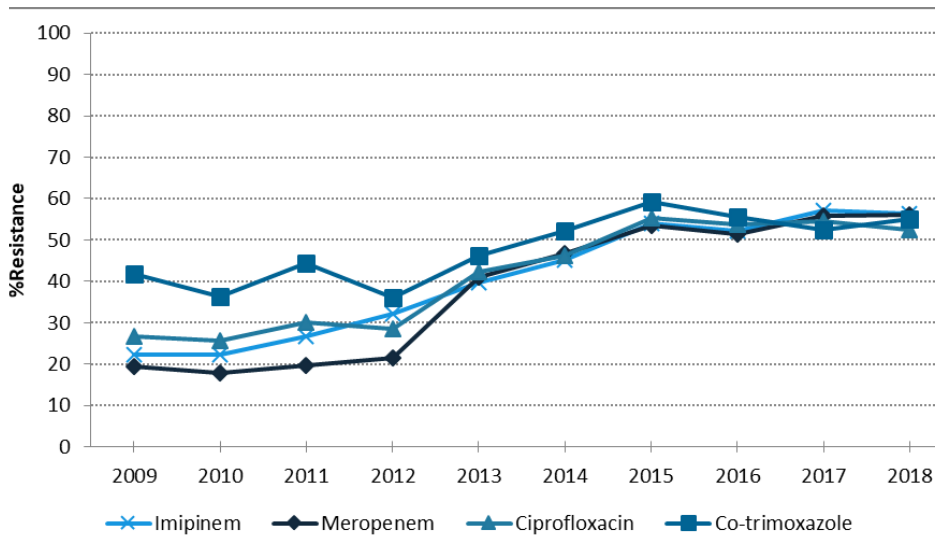


Figure 57. Yearly ciprofloxacin, co-trimoxazole and carbapenem resistance rates of *A. baumannii*, DOH ARSP, 2009-2018

2. Blood

Among isolates from blood, most resistance rates were lower compared to overall (all specimens) cumulative resistance rates (Table 42). Resistance ranged from 1% for colistin to 49% for ampicillin/sulbactam.

Table 42. Percent resistance for *Acinetobacter baumannii* for blood, DOH ARSP, 2018

Antibiotic name	Number	%R	%R 95%C.I.
Ampicillin/Sulbactam	365	49	43.6-54.0
Ceftazidime	677	41	37.5-45.0
Ciprofloxacin	639	38	34.1-41.8
Levofloxacin	253	33	27.1-39.0
Doripenem	7	14	0.8-58.0
Imipenem	553	43	38.6-47.0
Meropenem	631	44	39.8-47.7
Gentamicin	659	36	32.6-40.1
Tobramycin	167	30	23.2-37.5
Amikacin	385	28	23.2-32.3
Piperacillin/Tazobactam	600	47	42.8-50.9
Cefepime	664	43	39.4-47.1
Cefotaxime	224	31	25.3-37.8
Ceftriaxone	560	45	40.8-49.2
Minocycline	159	3	1.1-7.5
Trimethoprim/Sulfamethoxazole	616	42	37.8-45.7
Colistin	346	1	0.1-2.3

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 2018 DATA

Infections secondary to *Streptococcus pneumoniae* can still be covered with penicillin, although there is a need to closely monitor the changing trends of resistance among pneumococci. Improving the surveillance to include clinical outcomes data for invasive isolates as well as routine pneumococcal serotyping will allow for better monitoring and evaluation of the government's vaccination strategy for this vaccine preventable pathogen.

Although there was a decreased 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. 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 were available on *Neisseria gonorrhoeae* in recent years, although based on the 2018 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 and confirmatory testing at the reference laboratory. Enhanced clinical data could also provide evidence for possible stratified recommendations for therapy. Surveillance among stable population such as symptomatic males may help provide further information on the development of antibiotic resistance among *Neisseria gonorrhoeae*.

Statistically significant decrease in MRSA rates was noted for 2018. Linking laboratory information with clinical data as well as genotyping to identify strains of prevalent MRSA isolates will allow for targeted and comprehensive strategies in MRSA containment.

Multidrug-resistance among the bacterial organisms *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* continues to be a public health concern because of the limited treatment options and infection control challenge in containment. Real time data analysis and genotyping to establish linkages will allow for timely isolation and infection control interventions. Stratified, institute specific antibiograms will allow clinicians to identify the best empiric antibiotic options for suspected infections.

PROGRAM FUTURE DIRECTION

- Continued efforts to ensure quality of surveillance data by sentinel site and reference laboratory capacity building through training, efforts to improve facilities, equipment and services.
- Together with partner agencies from Department of Health and Department of Agriculture, work towards realization of the National Action Plan to Combat AMR: One Health Approach. Harmonize with the national antibiotic use data and antimicrobial resistance surveillance data on animal specimens with ARSP data by collaborating with the Pharmaceutical Division of the Department of Health and the Department of Agriculture to enhance the relevance and significance of the surveillance information generated and present a more cohesive picture of the local state of AMR.
- Advocate for needed fund resource necessary to incorporate molecular epidemiology into the surveillance to enhance information and understanding of AMR in the country.
- Enhance reference laboratory capacity by enhancing technical staff expertise and skills in molecular diagnostics.
- Integrate a community-based antimicrobial resistance surveillance to the program.
- Revive and expand the Gonorrhoeae Surveillance Network and harmonize with available clinical data by working with the Bureau of Epidemiology.
- 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.
- Work with Epidemiology Bureau to develop a protocol for notification of reportable drug-resistant pathogens
- Pursue ISO 15189 accreditation for the reference laboratory.
- Generate more relevant collaborative and investigator-initiated researches.

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ANTIMICROBIAL RESISTANCE SURVEILLANCE PROGRAM



(02) 8099763 | (02) 8072631 local 241/243
fax : (632) 809-9763



secretariat@arsp.com.ph



www.ritm.gov.ph | www.arsp.com.ph



9002 Research Drive, Filinvest Corporate City, Alabang, Muntinlupa City