ORIGINAL ARTICLE

Bali Medical Journal (*Bali Med J*) 2019, Volume 8, Number 2: 474-479
P-ISSN.2089-1180, E-ISSN.2302-2914

Published by DiscoverSys

The surveillance of antibiotics resistance in Indonesia: a current reports

Andaru Dahesihdewi,[1*] Adhi Kristianto Sugianli,[2] Ida Parwati[2]

ABSTRACT

Background: Antimicrobial resistance (AMR) has become a serious problem globally. Surveillance AMR is important to be part of the quality indicator in antimicrobial stewardship program (ASP). This study aims to evaluate the AMR

Method: Surveillance of microbial pattern and their antibiotics susceptibility in Indonesia 2017 was developed by the Indonesian Association of Clinical Pathology and Laboratory Medicine. Data aggregation was sourced from 31 hospitals antibiogram report which was joined the system of national data collection in forlabinfeksi.or.id with standardized inclusion criteria. Data were analyzed descriptively, based on hospital type-A-B-C.

Result: There were 15.302 isolates included, 4.761 (31,1%) were positive Gram and 10.541 (68,9%) were negative Gram, 61,6% reported by a type-A hospital, 16,4% by type-B and 22% by type-C. Positive and negative Gram patterns respectively were *E. faecalis* and *E.coli* (blood and urine), *Streptococcus spp* and *K. pneumoniae* (sputum), *S. aureus* and *E.coli* (pus), *E. faecalis* and *E.coli* (wound), *coagulase-negative Staphylococcus* and *Enterobacteriaceae* (CSF). Antibiotic susceptibility pattern was slightly different among various types of hospital and various clinical specimens. Positive Gram bacteria had good *vancomycin* susceptibility in all hospital types, except in sputum from Type-A and B hospital, also in blood and urine from Type-C hospital, similarly with *linezolid* susceptibility. Susceptibility pattern among Gram-negative- bacteria for *carbapenem* and *amikacin* was good, in all hospital types, except on *A. baumannii*. For *A. baumannii,* antibiotic carbapenem, amikacin, and ceftazidime susceptibility were 20-66%, 35-80%, and up to 83%, respectively. For *P. aeruginosa,* antibiotic susceptibility pattern was equal among all hospital types. Their susceptibility against *cephalosporin (ceftazidime)*, *fluoroquinolone (ciprofloxacin)* and aminoglycoside *(amikacin)* were better in higher type-hospital.

Conclusion: This result may become part of national epidemiological data for ASP program evaluation. This data may also be referred for local empirical antibiotic guideline among limited resources appropriate hospital. There will be improvement forward for more representative beneficial data.

Keywords: surveillance, epidemiology data, antimicrobial resistance, empirical treatment

Cite this Article: Dahesihdewi, A., Sugianli, A.K., Parwati, I. 2019. The surveillance of antibiotics resistance in Indonesia: a current reports. *Bali Medical Journal* 8(2): 474-479. DOI:10.15562/bmj.v8i2.1386

[1]Department of Clinical Pathology and Laboratory Medicine, Dr. Sardjito Hospital/Faculty of Medicine, Public Health and Nursing, Universitas Gadjahmada, Yogyakarta, Indonesia
[2]Department of Clinical Pathology and Laboratory Medicine Dr. Hasan Sadikin Hospital/Faculty of Medicine, Universitas Padjajaran, Bandung, Indonesia

*Correspondence to:
Andaru Dahesihdewi;
Department of Clinical Pathology and Laboratory Medicine, Dr. Sardjito Hospital/Faculty of Medicine, Public Health and Nursing, Universitas Gadjahmada, Yogyakarta, Indonesia;
adahesihdewi@yahoo.com

Received: 2018-11-19
Accepted: 2019-05-08
Published: 2019-08-01

BACKGROUND

Antimicrobial resistance is microbial ability to survive on antimicrobial exposure according to the anti-infection dosage.[1] Antibiotic resistance is a part of specific antimicrobial resistance in bacterial infection. Antibiotic resistance has become WHO's concern, not only in every level of health service but also in various other sectors including livestock, agriculture, and communities.[1]

The 2014 antimicrobial resistance surveillance reported by WHO shows that antibiotic resistance is a serious problem and has threatened the world to enter the post-antibiotic era.[2] In that era, it was feared that infectious diseases could no longer be treated with available antibiotics. Treatment failure of the third generation of *cephalosporins*, *fluoroquinolones*, and *carbapenems* have reported in several countries and have impacted in increased morbidity, and mortality.[2] Data reports on bacterial pattern and it's sensitivity in several hospitals in Indonesia have found *methicillin-resistance of S. aureus* (MRSA) was 13-26%, ESBL producing *E.coli* and *K .pneumonia* were 25-57% and 32-56%, respectively.[3]

Antimicrobial stewardship program is developed to prevent the emergence and spread of resistant microbial, so the infectious diseases treatment is expected can be optimal. The Global and National Action Plan have been launched, approaching as *One Health* which is covered various aspects related to antimicrobial problems. An outcome indicator is needed to become program evaluation and improvement, both at global and national levels.[4]

Antibiograms in the hospital are developed periodically, standardized at least once a year, based on PMK 8, 2015 national regulation regarding the hospital Anti-Microbial Resistance Control Program (PPRA). Based on the National Standard of Hospital Accreditation 2017, antibiogram must be prepared as one of the measurement elements in the ASP standard (National Program Standard Group). This antibiogram is considered as the local Empirical Antibiotics Guideline.[5]

Many large hospitals, especially vertical hospitals in Indonesia, have carried out the best standards microbiology laboratory service in accordance with the International Guideline (the latest CLSI) and National (Ministry of Health). Development of hospital microbial patterns and antibiogram thus can be maximal according to the best guidelines and the needs of the local ASP team. Meanwhile, some other hospital, B-type and C-type hospital that located across various regions and islands in Indonesia (more than 2000 hospitals) provide microbiology laboratory services at varying levels of methods according to limited resources, especially in facilities. Human resources of clinical laboratory specialist who have comprehensive competencies in laboratory medicine, including microbiology laboratory service, are spread in all hospitals throughout Indonesia to date.[4] They have local microbial pattern data and antibiograms according to the particular resources. The limitation of local antibiograms usually is caused by a low number of examinations. The number of isolates tested for antibiogram reporting in one period is not representative enough, minimal, and analysis is very simple.

The data of microbial patterns and antibiograms reported by clinical pathology specialists in various hospitals in Indonesia have to be potential standardized and aggregated as national data to complete the other data from various national programs that have been and will be developed. Report of microbial patterns and microbial sensitivity of antibiotics 2017, was aggregated from 31 hospitals.[4,5] Based on those mentioned above, this report is the beginning of a continuous process by Clinical Pathology and Laboratory Medicine Association for National AMR surveillance. This report can also be a part of the basic considerations for monitoring, evaluating and improving the National Programs.

MATERIAL AND METHODS

Data is aggregated from the microbial pattern and antibiogram report that is made by Clinical Pathology Specialists incorporated in the antimicrobial resistance data management system 'forlabinfeksi.or.id.' PDS PatKLin in 2017. Hospital identities are grouped by a system based on the type of hospital and region (laboratory based). Aggregation and analysis data are anonymous; identities are only stored in a confidential data management system and used when needed to confirm validity. There are no institution identities in data analysis. There were several inclusion criteria for aggregated data in each report used such as 1) Result of culture examination and antibiotic sensitivity test in suspected or clinical infection patients (colonization screening was excluded); 2) Valid specimens (according to each type of the specimen); 3) Microbial are considered as pathogens that cause infection (based on comprehensive expertise); and 4) Test method: manual or automatic method, with identification probability criteria ≥ 80% and the result of antibiotic sensitivity test is consistent.

The microbial pattern and hospital antibiogram at Indonesia in 2017 are grouped according to hospital type; those are a type-A hospital, type-B hospital, and type-C hospital. Based on the location/wards of patient care, the report is grouped into Intensive and Non-Intensive, except for type-C hospitals. Type-C hospitals' data were analyzed in total wards due to limited available data. Based on the specimen, the report is grouped into blood, sputum, urine, feces, pus/abscess, cerebrospinal fluid (CSF), wound, and other body fluids.

Data aggregation involved Clinical Pathology Specialists in 31 hospitals (22 government hospitals, 9 private hospitals), as follows: a) 5 vertical hospitals of health ministry; b) 2 hospitals in Sumatera; c) 4 hospitals in Jabotabek; d) 4 hospitals in West Java; e) 6 hospital in Central Java and DIY; f) 6 hospitals in East Java; g) 3 hospitals in Central Indonesia; and h) 1 hospital in East Indonesia

The report was a bacterial pattern and antibiotic sensitivity pattern. The bacterial percentage is a percentage (%) of the specific bacterial amount to total bacterial included. Sensitivity percentage is a percentage (%) of particular isolate amount that sensitive to certain antibiotics among all the same isolates tested. Data were analyzed using Microsoft Excel for windows and presented in percentage.

RESULTS

Microbial Pattern in Surveillance 2017

The number of isolates reported was 15,302 consisting of 4,761 Gram-positive isolates (31.1%) and 10.541 Gram-negative isolates (68.9%). The number

Table 1 Distribution of the number of isolates according to hospital type (2017 Surveillance Report)

Characteristic	Type-A Hospital (n=9,423)		Type-B Hospital (n=2,516)		Type-C Hospital (n=3,363)	Amount
	Non-Intensive N (%)	Intensive N (%)	Non-Intensive N (%)	Intensive N (%)	Total N (%)	
Gram (+)	2,037 (29.4)	708 (28.3)	746 (38.1)	142 (25.4)	1,128 (33.5)	15,302 (100)
Gram (-)	4,882(70.6)	1,796(71.7)	1,212 (61.9)	416 (74.6)	2,235 (66.5)	

Table 2 Distribution of the number of isolate types that are reported based on hospital types (2017 Surveillance Report).

Characteristic	Type-A Hospital (n=76)		Type-B Hospital (n=42)		Type-C Hospital (n=44)
	Non-Intensive N (%)	Intensive N (%)	Non-Intensive N (%)	Intensive N (%)	Total N (%)
Gram (+)	20 (41.17)	13 (46.42)	15 (53.52)	8 (57.14)	15 (34.1)
Gram (-)	28 (58.83)	15 (53.52)	13 (46.42)	6 (42.86)	29 (65.9)

Table 3 The highest pattern of Gram (+) sensitivity based on hospital type (2017 Surveillance Report)

		Type-A Hospital						Type-B Hospital		Type-C Hospital	
		NI			INT			NI	INT	Total	
		B	U	S	B	U	S	S	S	B	U
BACTERIA	AB	%S	%S	%S	%S	%S	%S	%S	%S	%S	%S
E.faecalis	AMP		63.2	76.6		63.3	73.2	80		90	76.2
	SAM	92.3	63.7	76.6	88.9	74	80.4	100		90	78.9
	VAN	92.3	90.3	46.9	80	82.4	45.6	80		100	80
	CIP	50	18.9	18.8	27.3	17.6	35.7	60		75	27.8
	MXF	50		30.4	37.5		61.2	50			
	LVX	46.2	23.1	30.4	65	34	66	100		85	33.3
	LNZ	100	91	30	80	90.9	67.3			100	91.7
S.aureus	SAM	87.1	62.5	79.7	91.7		77.5	91.4	89.5	68.8	
	AMK						80	100		66.7	
	VAN	90.9	90	82.4	90.9		91.7	97,2	100	66,7	
	CRO	74.5	75	78.1	83.3		69.6	91.4	89.5	67.6	
	CZO	75		80.6		0.7					
	CAZ	74.5		78.8	83.3		66.7	91.4	89.5		
	CIP	78.6	66.7	75	75		58.3	83.3	81	72.7	
	MXF	85.7		87.9	75			88.6	85.7		
	DOR	90.6		92.3	93.8		100	91.4	89.5	71.4	
	LVX	90.2	61.4	79.4	87.5		80.5	88.6	81	68.6	
	LNZ	96.4	100	100	100		100	97.1	100	100	
S.coag neg	SAM		15.6	15		.	35.5				3.2
	AMK			60			36				88.9
	VAN		87.7	73.7			51.6				45.5
	CIP		36.4	0			6.5				42.3
	LVX		38.8	6.7			15.4				38.2
	TMP			10.5			66.7				
	LNZ		96.9	88.9			93.5				85.7

B=blood ; U=urine ; S=sputum ; INT=intensive ; NI=non-intensive ; AMP=*ampicillin* ; SAM=*ampicillin sulbactam* ; AMK=*amikacin* ; VAN=*vancomycin* ; CIP=*ciprofloxacin* ; LVX=*levofloxacin* ; MXF=*moxifloxacin* ; LNZ=*linezolid*

isolates reported from type-A hospitals were 9,423 (61.6%), from type-B hospitals were 2516 (16.4%) and from type-C hospitals were 3,363 (22%). The aggregate data distribution from 31 hospitals that contribute to this report is shown in Table 1. The distribution of isolates and subsequent analysis for the type-C hospital cannot be specified due to limited information.

The number of isolates based on Gram characteristics in the three types of 31 hospitals is shown in Table 2. Gram-negative bacteria are more commonly reported than Gram-positive, especially

Published by DiscoverSys | *Bali Med J* 2019; 8(2): 474-479 | doi: 10.15562/bmj.v8i2.1386

Table 4 The highest pattern of Gram (-) sensitivity based on hospital type(2017 Surveillance Report)

		Type-A Hospital						Type-B Hospital				Type-C Hospital		
		NI			INT			NI			INT	TOTAL		
		B	U	S	B	U	S	B	U	S	S	B	U	S
BACTERIA	**AB**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**	**%S**
E. coli	AMP	12.5	16	3.8	11.5	18.2	6.5	88.2	27.3	7.7		14.8	12.2	2.3
	SAM	30.8	26.6	34.3	26	39.7	34.15	41.2	39.4	30.8		29.2	19.9	15.4
	AMK	99.3	92.4	92.2	100	85.7	88	100	100	100		100	97.4	93.2
	SXT	34.2	35	30.8	38.5	40.6	28.3	52.9				60	32.9	51.4
	CRO	31.5	33	20.3	.	39.4	15,6	70.6	66.7	38.5		53.6	50.8	8.9
	CAZ	32.9	34.8	23.1	15.4	38.2	20	70.6	66.7	38.5				
	CIP	30.1	29.8	34.6	26.9	29.4	33.3	66.7	51.5	30.8		60	41.3	17.5
	MRP	95.9	95.7	93.7	88.5	96.9	91.3	100	97	92.3		96.4	96.4	86.7
	DOR	100		100	100		96.9					100		100
	LVX	25	33.3	45.4	0	0	55.3					25	21.2	33.3
	FOS		100	100			83.3						100	
A. baumanii	SAM	32	50.5	47.7	8.8	30.8	27.65			52.4	30.2	30.3	50	23.8
	AMK	35.8	79.1	57.2	40.5	76.9	54.7			63.5	56.8	46.3	66.7	34.9
	SXT	68.3	70.4	74.4	45.7	61.5	61.4			.	46.5	42.3	42.9	
	CRO	2.4	4.2	8,5	5,7	0	2.1			27	7	6,1	0	5.1
	CAZ	14.6	14.9	35	5.7	7.7	15.9			83.3	18.6			
	CIP	19.5	20.5	39,2	8,6	7,7	17,6			49,2	18,2	21,2	28,6	23,8
	MRP	42.9	66,2	53	20	30,8	21,9			52,4	29,5	27,3	46,7	21,4
	DOR	20		44,8	33,3		31,6							15,4
	LVX	21.4	66,7	32,4	25		34,5					100	0	25
P. aeruginosa	AMK	75	65,9	78,1	76,5	80	69,3			75,7	57,9		65	61,2
	SXT		0	6	0	10	3,9				0		54,5	52,7
	CRO	0	4,2	6,5	20	0	10,9			0	0		0	0
	CAZ	66,7	61,4	69,6	52,9	80	50,3			7,3	52,6			
	CIP	62,5	60,2	64,8	64,7	80	48,6			60,8	47,4		44,4	47,7
	MRP	72	75,9	64,5	52,9	50	59			56,8	43,9		61,1	42,5
	DOR			85	100		83,3							33,3
	LVX	50	42,9	51,7	66,7	50	54,8						33,3	37,5
	FOS	100	62.5	59.3	0	100	45.8						100	
K. pneumonia	SAM	15.4	32.7	34.7	1.4	36.1	18.8	17.1	40	67.5	51	9.5	22.1	26.3
	AMK	58.1	76.8	77.4	55.5	49.1	66.8	97.1	100	97.5	93.9	72.3	93.6	82.4
	SXT	37.5	42.9	57.3	1.2	26.9	26.8	20	50	.	55.1	41	38.7	41.2
	CRO	12.3	35.3	41.4	6.4	38.5	12.5	20	60	70.8	51	16.4	28.8	26.5
	CAZ	12.3	35.5	43.1	10.6	29.6	15.1	20	60	70.8	51			
	CIP	64.6	41.9	63.3	51.1	37	38.9	25.7	70	74.2	55.1	44.4	48.7	47
	MRP	88.9	89.1	93.6	8.2	76.9	78	48.6	90	95	91.8	65.7	91.5	69.2
	DOR			78	75		58.7					100		91,7
	LVX	52	47.7	58.2	40	80	53.2					75	33.3	76.2
	FOS		40	78.6	100	100	76.2						100	

B=blood ; U=urin ; S=sputum ; INT=intensive ; NI=non-intensive ; AMP=*ampicillin* ; SAM=*ampicillin sulbactam* ; AMK=*amikacin* ; SXT=*cotrimoxasol* ; CIP=*ciprofloxacin* ; CRO=*ceftriaxone* ; CAZ=*ceftazidime* ; LVX=*levofloxacin* ; MRP=*meropenem* ; DOR=*doripenem* ; FOS=*fosfomycin*

from urine. Major types of Gram-positive bacteria are reported from sputum and blood.

The highest number of Gram-positive and negative bacteria in this study were *E. faecalis* and *E. coli* (blood and urine), *Streptococcus spp* and *K. pneumoniae* (sputum), *S. aureus* and *E.coli* (abscess/pus), *E. faecalis* and *E.coli* (wounds), *coagulase-negative Staphylococcus* and *Enterobacteriaceae* (LCS). *S. Typhi* and *S. para-typhi* isolates were found in type-A and type-B hospitals, mainly from blood and urine. The sensitivity of both types of bacteria is good (≥ 80%) for many drugs including *ampicillin, ciprofloxacin, and cotrimoxazole*.

Antibiotic Sensitivity Pattern in Surveillance 2017

The bacterial susceptibility to antibiotics pattern, in general, is slightly different between Type-A, B, C and between specimens. The pattern of resistant bacteria is more commonly reported in type-A hospitals than the types below, both for Gram-positive and Gram-negative bacteria. Table 3 and Table 4 show the most bacterial sensitivity patterns based on Gram characteristics, hospital type, wards, and specimen.

The sensitivity of Gram-positive bacteria to vancomycin is good in all hospital-types, except for sputum in Type-A and Type-B hospitals, as well as the blood and urine in Type-C Hospitals. Similarly for *linezolid* antibiotics. The sensitivity of Gram-positive bacteria to the *beta-lactamase* combination antibiotics, *ciprofloxacin*, and *levofloxacin* tend to be low, up to Type-C Hospitals (Table 3).

DISCUSSION

The Gram-positive bacterial pattern of infection in non-intensive rooms of Type-A Hospital is the same as in intensive rooms; most of them are *E. faecalis* and *coagulase-negative Staphylococcus*. These Gram-positive bacteria are mainly-sourced from urine, sputum, and blood.[6-8] Meanwhile, Gram-negative bacteria that cause the most infections in intensive rooms are *K. pneumoniae* and *Acinetobacter spp*, while in non-intensive rooms are *E. coli* and *K.pneumoniae*. Gram-negative bacteria are mainly-sourced from urine, sputum and wound swabs.[6-8]

Gram-positive bacteria with the highest number of infections in non-intensive rooms of Type-B Hospital were dominated by *coagulase-negative Staphylococcus* and *Streptococcus spp*, slightly different from the pattern in intensive rooms, that were *coagulase-negative Staphylococcus* and *S.aureus*. This is partly due to differences specimens. In intensive rooms, the main specimens were sputum and blood, while specimens that were mainly received from non-intensive rooms were sputum and wound in addition to urine.[9,10] The most Gram-negative caused bacteria in the intensive room were *K. pneumoniae, Pseudomonas spp,* and *Acinetobacter spp*, whereas in non-intensive rooms were *E. coli* and *K. pneumoniae*. The most Gram-negative bacterial pattern in a non-intensive type-B hospital is not different from Type-A hospital, whereas in intensive rooms analog patterns are found which are slightly different in proportion.[9,10] The highest source of material for Gram-negative bacteria from intensive rooms remains sputum and blood, while for non-intensive rooms is more evenly sputum, wounds and pus, and urine and feces.

At Type-C Hospital, a description of the bacterial pattern is carried out in total (without seeing the treatment room). The pattern of Gram-negative bacteria that causes infection is still analogous to the upper-type hospital, mostly *K. pneumoniae*, followed by *E. coli* and *Acinetobacter sp*. The most clinical material sources are sputum, urine, pus, and blood. The Gram-positive bacterial pattern of the most common causes of infection is *S. aureus* and *S. epidermidis* with the highest source of specimens are blood, pus, sputum, and urine.[9-12]

The *carbapenem* and *amikacin* sensitivity of Gram-negative bacteria were relatively good in all hospital Type, except in *A. baumanii*. Among the other Gram-negative bacteria, the *carbapenem* sensitivity range is 42.5-100%, while *amikacin* 60-100%. In this surveillance report, *A. baumanii* showed a range of sensitivity to 20-66% carbapenem, to 83-80% amikacin and 83% to ceftazidime in B-type hospitals. *Pseudomonas aeruginosa* sensitivity to various classes of antibiotics is relatively equivalent among various types of hospitals. Its sensitivity to a *cephalosporin* (*ceftazidime), fluoroquinolone (ciprofloxacin)* and *aminoglycoside (amikacin)* were even better reported in higher type hospitals. The preferred antibiotics for *P. aeruginosa* infection were *aminoglycosides* except for *kanamycin* and *quinolones* except *moxifloxacin*.[9-12]

However, this study met several limitations such as 1) representation of Clinical Pathology Specialist contributions is still limited to 31 hospitals; 2) The analysis category is very general because of limited information. MDRO pattern (multi-drug resistant bacteria) and its sensitivity to antibiotics cannot be reported yet, and 3) Patterns were described based on various capabilities in each laboratory.

Although there were many limitations, national surveillance report 2017 is still useful to be part of national epidemiological data. That is expected

to complement and enrich data which is already existed or being developed. Hospital-type based sensitivity patterns are also expected to be useful as a reference for the development of the antibiotic treatment guidelines. Hospitals that are still experiencing limited resources of microbiological laboratory services or the number of analyzes are not yet representative may refer to this report

CONCLUSION

The surveillance result which is aggregated from Clinical Pathology Specialist in 31 hospitals' reports is useful as part of epidemiological data on bacterial and antibiotic resistance pattern in Indonesia. This data can be part of the evaluation and improvement of antimicrobial resistance control program as well as a reference for the development of empirical treatment guidelines for hospitals that still have limited local data.

CONFLICT OF INTEREST

The authors declare that there was no conflict of interest regarding manuscript.

ETHICAL CLEARANCE

Ethical approval has been obtained by the ethics of the committee prior to the study conducted.

FUNDING

The authors are responsible for the study funding without the involvement of grant, scholarship, or any other resource of funding.

AUTHORS CONTRIBUTION

The authors are equally contributed to the manuscript from data collection, statistical analysis, until reporting the result of the study.

REFERENCE

1. Akova M. Epidemiology of antimicrobial resistance in bloodstream infections. Virulence. 2016 Apr; 7(3): 252–266.
2. World Health Organization Antimicrobial resistance: global report on surveillance 2014. Geneva, Switzerland: WHO; 2014.
3. Kakkar M, Chatterjee P, Chauhan AS, Grace D, Lindahl J, Beeche A et al. Antimicrobial resistance in South East Asia: time to ask the rightquestions. Glob Health Action. 2018;11(1):1483637
4. Dahesihdewi A, Sugianli AK, Parwati I, et al. Surveilans Pola Mikroba dan Kepekaannya terhadap Antibiotik Berdasarkan Tipe Rumah Sakit di Indonesia Tahun 2017, Perhimpunan Dokter Spesialis Patologi Klinik dan Kedokteran Laboratorium Indonesia. 2018
5. Komite Pengendalian Resistensi Antimikroba. Modul Workshop Implementasi PPRA di Rumah Sakit, edisi-3. Direktorat Jenderal Pelayanan Kesehatan Kementerian Kesehatan RI. 2016
6. World Health Organization. Global Action Plan on Antimicrobial Resistance, 2015
7. Kohlmann R, Gatermann SG. Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data – The Influence of Different Parameters in a Routine Clinical Microbiology Laboratory. PLoS One. 2016; 11(1): e0147965
8. Ministry of Health. National Action Plan on Antimicrobial Resistance Indonesia. Jakarta: Ministry of Health. 2017. Available from: http://www.kemenkes.or.id
9. WHO. Guide for establishing laboratory-based surveillance for antimicrobial resistance. Brazzaville, Congo: WHO Regional Office for Africa; 2013
10. WHO. Laboratory-based surveillance of antimicrobial resistance: Report of a biregional workshp Chennai, India, New Delhi, KIndia. 2011
11. Grundmann H, Klugman KP, Walsh T, Ramon-Pardo P, Sigauque B, Khan W, et al. A framework for global surveillance of antibiotic resistance. Drug Resist Update. 2011; 14(2):79-87
12. Clinical and Laboratory Standard Institute (CLSI). Performance standards for antimicrobial susceptibility testing; Twenty-sixth informational supplement. CLSI document M100-S26. Wayne,PA: Clinical and Laboratory Standards Institute. 2016