WHONET

Introduction



WHO Collaborating Centre for Surveillance of Antimicrobial Resistance

Boston, July 2022

WHONET – Introduction

This tutorial includes the following sections.

- Part 1. What is WHONET?
- Part 2. What can WHONET do?
- Part 3. What is BacLink?
- Part 4. What's next?

Part 1. What is WHONET?

WHONET is a free software developed by the WHO Collaborating Centre for Surveillance of Antimicrobial Resistance for laboratory-based surveillance of infectious diseases and antimicrobial resistance.

The principal goals of the software are:

- to enhance local use of laboratory data; and
- to promote national and international collaboration through the exchange of data.

WHONET can be used by individual laboratories or as part of a national and international surveillance network. At present, the software, available in 44 languages, is used in over 130 countries around the world managing data from over 2300 clinical, public health, veterinary, and food laboratories.

WHONET analytical tools facilitate:

- the understanding of the local epidemiology of microbial populations;
- · the selection of antimicrobial agents;
- · the identification of hospital and community outbreaks; and
- the recognition of quality assurance problems in laboratory testing.

<u>Note</u>: At present, WHONET can handle results from the testing of bacteria, fungi, and parasites. WHONET does not yet have virological tests incorporated, but this is a priority area of programming in the upcoming year.

Part 2. What can WHONET do?

WHONET has three main components.

Laboratory configuration

WHONET permits the customization of the software for use in your institution. You can indicate which antimicrobials you test in the laboratory, patient care areas served, data fields that you want to include in the surveillance program, and microbiological alerts of unusual or important organisms and resistance phenotypes.

- Data entry and clinical reporting WHONET allows the routine entry of susceptibility test results as well as the retrieval, correction and printing of clinical records. During data entry, WHONET can provide immediate feedback to technicians on important strain phenotypes.
- Data analysis

WHONET has a user-friendly interface permitting many types of analysis. Options include isolate line-listings and summaries, such as organism frequencies over time, antimicrobial susceptibility test statistics, zone diameter and MIC histograms, antibiotic scatterplots and regression curves, and antibiotic resistance profile line-listings and summaries. WHONET also has a number of alert features which permit the detection of unlikely or important results as well as possible hospital or community outbreaks of bacterial or non-bacterial species.

Examples of some of the WHONET analysis options are shown below.

rsis Results Edit Data																			alysis Results Edit Data								
								Ounci	an = All org	anima (a	-1210 []	lates]											6	Organism = All organisms (n=1219 (solates)			
opy table Co		E	nint table			1	Continue		on = All org		=1213190	late()									Print table		Continue	Show hidden columns			
sen type: bl																		Spr	ecimen type: bl								
	_												_	_						_							
Identification number	Specime	² Organism	Organism Not	AHK	AMC	AMP	AZL.	ATH	MAN	OWK	CFP	CTX	CTT	FOX	DP0	CFS	CAZ -	-	Identification number	Alert	Priority	Ospanism	1	Izolate alertz	Quality control	Important species	Ing
9689327422_	ы	pae		25		a					23						25		_9689327422_							0	-
9905200321_	ы	pae		20		0	7 26	30			23	15	3			23	27		_9905200321_								_
1570823965	ы	pen			30	3													1570823965								_
	ы	pan			2	2	6																				
0465211053_	ы	pep	a		35	3	5					16	3	5 35					_0468211053_								-
4663870531	ы	pep	a		5		S					S	1	5 S					4663870631	2	High priority	Anaerobes		Non-susceptible to metronidazole			-
4917579739	ы	pep	a		3	3	6					20)	34					_4917579739_								_
	ы	pmi		S	5		S S	S	S	S	S	i S	1 8	i I	S		S				High priority	Enterobacteriaceae		Non-susceptible to calbapanents			_
	ы	pmi		24													29										
0525167712_	ы	pmi		24													27		_0525167712_							0	_
5041423361_	ы	pmi		25	25	2								3 22			32		_5041423361_								_
	ы	pmi		25	25	2	6 26				27	25	3 2	3 22	29		29										_
8243705175	ы	pmi		28	30	3	0 33	35	35	35	3	1 35	3	28			35		.8243705175								_
000003565	ы	pmi		\$		F F	R 1	5	5	\$	\$	5	1	\$			\$		8668890565		Medium priority	All organisms		Discordant penicilin and beta-lactan-inhibitor results	R		_
	ы	500	+		6		ŝ					\$	1	S 8							High priority	Anaerobes		Non-susceptible to metronidazole			-
2446275408	ы	500	+		5		ŝ					\$		1 1	S				2446275408		High priority	Anaerobes		Non-susceptible to metronidazole			_
7232677032	ы	500	+		5		S					S	1 5	s s					7232677032		High priority	Anaerobes		Non-susceptible to metronidazole			_
8826435559	ы	500	+		3	3	5					32	5 3	35					8826435559								_
1623614901	ы	01-		26		2	0 29	31			25	28			26		27		1623614901							0	_
3997663816	ы	01-		33	01	r o	7 14	07	07	14	12	2 07	0	3 07			25		3997663816	0						0	_
8373160264	ы	0.0-		23	25	3	2	35				34					24		8373160264							0	
3010379905	ы	DVU.		S	9	F	8 8	S	8	S	8	S S	9				S		3010379905		High priority	Enterobacteriaceae		Non-suspeptible to carbapanents	D		_
5324322633	ы	zal .		S	6		5 5	S	S	S	S	S	1	S			\$		5324322633		Medium priority	Salmonella sp.		Important species		2	_
7726859634	ы	col .		\$	5		5 S	\$	5	\$	\$	5	1	5			\$		7726858634		Medium priority	Salmonella sp.		Important species		2	_
8069622048	ы	(a)		\$		I F	3 8	\$	5	\$	8	5	1	S S			\$		8069622048		Medium priority	All organisms, Salmonell	sp.	Discordant penicilin and beta-lactan-+inhibitor results, I	r 🗹	2	
1931978635	ы	080	+	25	12														4931978635								_
	ы	100	+	S	5																High priority	Staphelococcus sp., Sta	phelococcus s	Non-susceptible to vancom/cin. teicoplanin. Non-susce	c 🗆		_
	ы	101		21	27														1								_
0022509627	ы	101		25	35														0022509627	0						0	_
	ы	2.04	+	24	35																					0	-
0208207543_	ы	TAU	+	21	24	1													_0208207543_							Ö	_
	ы	284	+	22	2														- · · · ·						Ū.		_
0396463405	ы	180	+	R	F														0396463405		Medium priority	Staphelococcus aureus		MRSA - Methicilin resistant S. auteus			_
	ы	080	+	B	Ē														1	2	Medium priority	Staphelococcus aureus		MRSA - Methicilin-resistant S. auteus			
0403582681	N	100	+	S															0403582681		Medium priority	Staphelococcus aureus		MRSA - Methicilin-resistant S. auteus			
	N .	1000		6	0		-										1	• -		, 01	Modern minder	Charled According to an and		MDCA MobileRecondense C scance.	1	-	-

Figure 1. Portion of an isolate listing for positive blood cultures. The left portion of the listing includes patient demographic data followed by the antibiotic results. The right portion of the listing includes microbiological alerts about important resistance findings or possible laboratory errors. Then underscore "_" around the patient identifier indicates that the original patient identifiers have been encrypted.



Figure 2. Distribution of MRSA isolates by department. Only the first isolate per patient is included. The graph depicts the graph for the department of medicine.



Figure 3. Monthly distribution of patients with *Acinetobacter baumannii* over a two year period.





Figure 4. %RIS and test measurement statistics for *K. pneumoniae*. %Resistant results are shown to the left for all antimicrobials, including the 95% confidence interval. The graph to the right depicts the distribution of disk diffusion zone diameters around the gentamicin disk.



Figure 5. Ciprofloxacin %Resistant results for all Enterobacteriaceae.



Figure 5. Scatterplot comparison of gentamicin and amikacin results for *K. pneumoniae*. To the left is a comparison of the disk diffusion zone diameter results. To the right is the comparison using the test interpretations – resistance, intermediate, and susceptible.



Figure 6. Resistance profiles. Monthly distribution of patients with isolates of *S. aureus* of the indicated resistance phenotype. The isolates are non-susceptible to PEN, OXA, CLI, ERY, GEN, AMK, and TCY, but susceptible to CHL and VAN.

Organisms isms ss cleniaceae cleniaceae cleniaceae cleniaceae cleniaceae cleniaceae	Alert Discordant perioillin and beta-lactam-+inhibitor resu Discordant quinolone and fluoroquinolone results Norr-susceptible to metronidazot Discordant first- second-, and third-generation cept Priobable ESBL producing Enterobacteriaceae	10	Priority Medium priority Medium priority High priority Medium priority Medium priority	Quality control	Important species	Important resistance
isms 28 ccteriaceae ccteriaceae ccteriaceae ccteriaceae	Discordant quinolone and fluoroquinolone results Non-susceptible to metrorridazole Discordant aminoglycoside results Discordant first, second, and third-generation cept Probable ESBL-producing Enterobacteriaceae	10	Medium priority High priority	¥		
es icteriaceae icteriaceae icteriaceae icteriaceae	Non-susceptible to metronidazole Discordant aminoglycoside results Discordant first-, second-, and third-generation cept Probable ESBL-producing Enterobacteriaceae	10) High priority			
icteriaceae icteriaceae icteriaceae icteriaceae	Discordant aminoglycoside results Discordant first-, second-, and third-generation cept Probable ESBL-producing Enterobacteriaceae	4				
cteriaceae icteriaceae icteriaceae	Discordant first-, second-, and third-generation cept Probable ESBL-producing Enterobacteriaceae		Market and a sharehout			
icteriaceae icteriaceae	Probable ESBL-producing Enterobacteriaceae		Meaium priority	v		
cteriaceae		4	Medium priority	Image: A start and a start		
		18	Medium priority			Image: A start of the start
icteriaceae	Non-susceptible to amikacin	Ę	5 Medium priority			 Image: A start of the start of
	Non-susceptible to carbapanems	3	B High priority			
cteriaceae	Non-susceptible to fluoroquinolones	20	Medium priority			 Image: A start of the start of
iccus faecalis	Non-susceptible to penicillins	31	Medium priority	✓		
iccus sp.	VRE - Vancomycin-resistant Enterococcus	15	i Medium priority			 Image: A start of the start of
ionocytogenes	Important species	3	B High priority			
la sp.	Important species	3	8 Medium priority		✓	
sp.	Non-susceptible to colistin, polymyxin	1	Medium priority	Image: A state of the state		
coccus aureus	MRSA - Methicillin-resistant S. aureus	92	Medium priority			 Image: A start of the start of
coccus sp.	Non-susceptible to vancomycin, teicoplanin by disk	210	Medium priority			V
coccus sp.	Non-susceptible to vancomycin, teicoplanin	210	High priority			~
occus pneumoniae	Beta-lactams tested by disk diffusion (except for oxa	16	Medium priority	v		
occus pneumoniae	Non-susceptible to fluoroguinolones	13	B High priority			~
occus pneumoniae	S. pneumoniae Non-susceptible to penicillin, third-g	(2	Medium priority			
	onocytogenes la sp. p. p.coccus sourcus occcus sp. p. coccus preumoniae cocus preumoniae	onacytogenes Important species a sp. Important species p. Non-susceptible to colistin, polymyxin p. aureus MRSA - Methicillin-resistant S. aureus p. Non-susceptible to vancomych, teicoptann by disk paccus sp. Non-susceptible to vancomych, teicoptanin by disk paccus p. Non-susceptible to vancomych. Teicoptanin by disk paccus p. Non-susceptible to vancomychin, teicoptanin paccus p. Non-susceptible to	onacytogenes Important species 3 a sp. Important species 3 Non-susceptible to colistin, polymysin 1 soccus aureus MRSA - Methicillin-resistant S. aureus 39 soccus sp. Non-susceptible to vanconnycin, teicoplanin by disk 211 soccus sp. Non-susceptible to vanconnycin, teicoplanin 211 coccus pneumoniae Betalactans tested by disk diffusion (except for oxe 16 Non-susceptible to Vanconnycin, teicoplanin 6 (except for oxe 16) coccus pneumoniae Non-susceptible to funcorceptible for funcorceptible for the second for oxe 16)	onocytogenes Important species 3 High priority a sp. Important species 3 Medium priority Non-susceptible to colistin, polymyxin 1 Medium priority soccus averus MMSA - Methicillin-resistant S. aueus 32 Medium priority Non-susceptible to vancomycin, teicoplann by disk 2010 Medium priority soccus sp. Non-susceptible to vancomycin, teicoplann by cocus sp. Non-susceptible to vancomycin, teicoplann 2010 High priority cocus pneumoniae Beta-lactams tested by disk diffusion (except for oxe 16 Medium priority) Non-susceptible to functionalones 13 High priority	onacytogenes Important species 3 High priority a sp. Important species 3 Medium priority knorsusceptible to colistin, polynywin 1 Medium priority coccus aneus MMSA - Methicillin-resistant S, aureus 32 Medium priority coccus sp. Non-susceptible to vancorrycin, teicoplanin by disk 210 Medium priority coccus sp. Non-susceptible to vancorrycin, teicoplanin by disk 210 High priority coccus sp. Non-susceptible to vancorrycin, teicoplanin by disk 210 High priority coccus sp. Non-susceptible to vancorrycin, teicoplanin of 16 Medium priority coccus sp. Non-susceptible to vancorrycin, teicoplanin 210 High priority	onacytogenes Important species 3 High priority Important species a sp. Important species 3 Medium priority Important species p. Non-susceptible to colistin, polymysin 1 Medium priority Important species p. Non-susceptible to colistin, polymysin 1 Medium priority Important species p. Non-susceptible to vancomycin, teicoplanin by dink 210 Medium priority Important species p. Non-susceptible to vancomycin, teicoplanin by dink 210 High priority Important species p. Non-susceptible to vancomycin, teicoplanin by dink 210 High priority Important species p. Non-susceptible to vancomycin, teicoplanin by dink 16 Medium priority Important species p. Non-susceptible to vancomycin, teicoplanin by dink 16 Medium priority Important species p. Non-susceptible to vancomycin, teicoplanin by dink 16 Medium priority Important species

Figure 7. A summary of the microbiological alerts observed in the analyzed data. Categories of alert include "Quality control", "Important species", "Important resistance", "Send to a reference laboratory", and "Alert the infection control" among others.

Part 3. What is BacLink?

Many laboratories in the world already have computer systems for managing microbiological data. Examples include:

- 1. Simple desktop softwares such as Microsoft Excel, Access, or Epilnfo
- 2. Laboratory test instruments, such as Vitek, MicroScan, and SensiTitre
- 3. Commercial or in-house laboratory information systems.

Most of these systems were developed for purposes of clinical reporting, billing, and day-to-day specimen processing needs. Unfortunately, most systems have limited capabilities for analyzing data. This is where WHONET can be a valuable add-on to your existing system.

One way of getting data from your computer system into WHONET is through the manual re-entry of results directly into WHONET. But this can be a significant waste of valuable staff time and is subject to typing errors during the reentry of results.

To avoid reentering results into WHONET, we have developed the BacLink software. The purpose of the BacLink software is to facilitate the conversion of data from your computer system into WHONET. You could do this interactively on a weekly, monthly, or *ad hoc* basis. In a number of institutions, it has also been possible to automate and schedule the entire process. BacLink is available free-of-charge from the World Health Organization as part of the WHONET package.

By using BacLink, you can thus avoid the manual entry of results into WHONET. A related benefit in the context of multi-center collaborations is the standardization of data from a number of incompatible data sources into one common structure that can be analyzed with WHONET.

To learn more about BacLink and its use, go through the "BacLink – Getting Started".

Part 4. What's next?

Now that you have installed WHONET, you are ready for the next steps.

If you plan on using WHONET for manual data entry, proceed with the WHONET tutorial on "Laboratory Configuration" followed by the tutorial on "Data Entry".

If you want to download and convert data from an existing computer system, then it would be useful to continue with "BacLink – Getting Started".

If you want to explore WHONET's data analysis features using the sample data that comes with WHONET or if you already have some WHONET data of your own, you may wish to skip directly to the tutorial "Data Analysis 1".