

WHONET

Advanced analysis



**WHO Collaborating Centre for
Surveillance of Antimicrobial Resistance**

Boston, July 2022

WHONET Tutorial – Expert system

The WHONET 5.4 Expert System consists of a number of components:

- Part 1. Isolate alerts
 - Microbiological alerts
 - Statistical alerts
- Part 2. Expert antimicrobial interpretation rules
- Part 3. Selective antimicrobial reporting

Part 1. Isolate alerts

WHONET now permits the user to take advantage of pre-defined or user-defined expert rules that can benefit the user in data entry and in clinical reporting. An additional unique feature of the WHONET expert system is the integrated use of expert rules in data analysis.

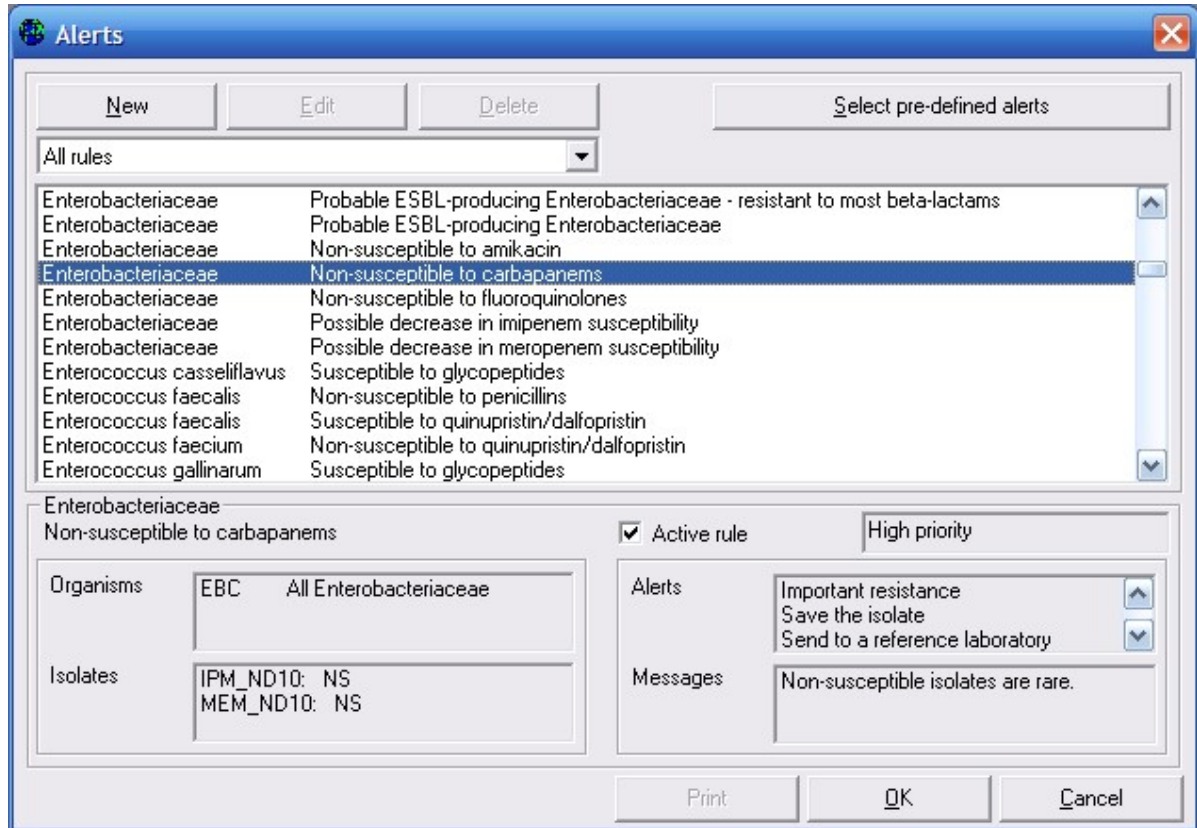
At present, WHONET 5.4 includes approximately 200 microbiological rules. In this first version of the expert system, pre-defined expert rules cannot be edited, but individual rules can be turned on or off by the user. In addition, users are also free to develop their own expert rules for reporting and analysis.

Rules are flagged according to the following alert categories.

- Quality assurance
 - Unlikely resistance
 - Unlikely susceptible
 - Unlikely phenotype
 - Disk diffusion is not recommended for this organism and antibiotic
 - Other problem
- Microbiological alerts
 - Important microbial species
 - Important antimicrobial resistance
 - Save the isolate
 - Send the isolate to a reference laboratory
 - Other alert
- Clinical alerts
 - Alert the infection control team
 - Therapy comment
- Priority
 - High priority
 - Medium priority
 - Low priority

1A. Configuration of microbiological alerts

Begin WHONET, select your laboratory, and click on “Modify Laboratory”. You will see a new button on the screen for “Alerts”. Click on this button, and you will see the following screen.



Predefined alerts

In the example, a rule for *Enterobacteriaceae* non-susceptible to carbapenems has been selected. Details of the rule appear below. The software customizes the rules depending on the antimicrobials which you test in your laboratory. You can click on “Active rule” to activate or deactivate the rule. At the top of the screen, you can decide whether you want to view all rules, or only rules of a particular type, for example Quality control rules.

There is also a button called “Select pre-defined alerts”. At present, there is only one set of expert rules defined in WHONET, but it is anticipated that in the future, some countries or projects may wish to create their own pre-defined sets for use in the surveillance network.

User-defined alerts

Click on “New”, and a screen similar to the following will appear. To define a rule, first give a name to the rule, for example “S. aureus and spa typing”. You can indicate whether this is a high, medium, or low priority rule. In the area “Define the selection criteria”, use the “Organisms” and “Isolates” buttons in the same way that you would in WHONET data analysis to select the organism/isolate criteria for the alert.

User-defined alert

Description: S. aureus and spa typing

☒ Active rule Medium priority

Define the selection criteria

Organisms Isolates

sau Staphylococcus aureus ss. aureus Specimen type: bl
OXA_ND1: R

Define the alerts

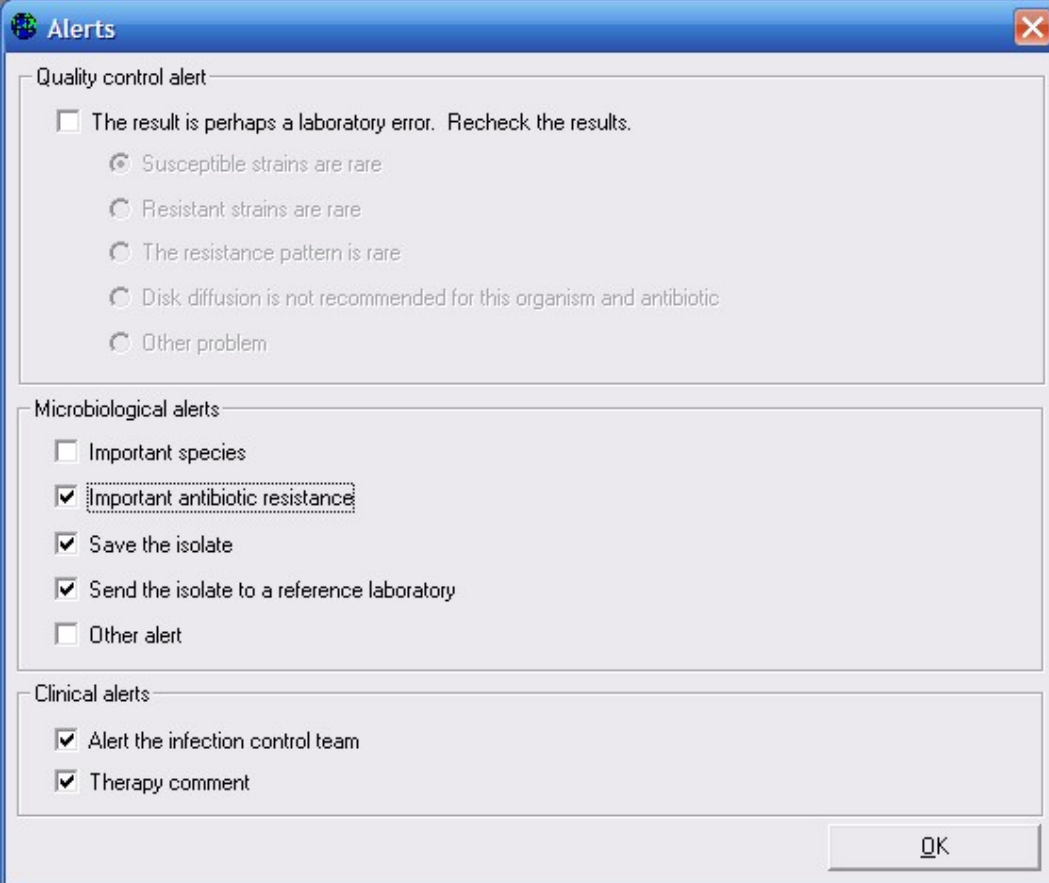
Alerts Messages

Important resistance
Save the isolate
Send to a reference laboratory
Infection control alert
Therapy comment

Microbiologist
Send this isolate to Dr. xxxxxxxx for spa typing.

OK Cancel

Now that you have defined the criteria which will trigger the alert, you can indicate that details of the alert back to the user. Use “Alerts” to indicate that category and type of alert, and select “Messages” to enter any messages you wish to display back to the microbiologist or to the clinician. If you click “Alert”, you will get the following screen:



Alerts

Quality control alert

☐ The result is perhaps a laboratory error. Recheck the results.

- ☒ Susceptible strains are rare
- ☐ Resistant strains are rare
- ☐ The resistance pattern is rare
- ☐ Disk diffusion is not recommended for this organism and antibiotic
- ☐ Other problem

Microbiological alerts

☐ Important species

☒ Important antibiotic resistance

☒ Save the isolate

☒ Send the isolate to a reference laboratory

☐ Other alert

Clinical alerts

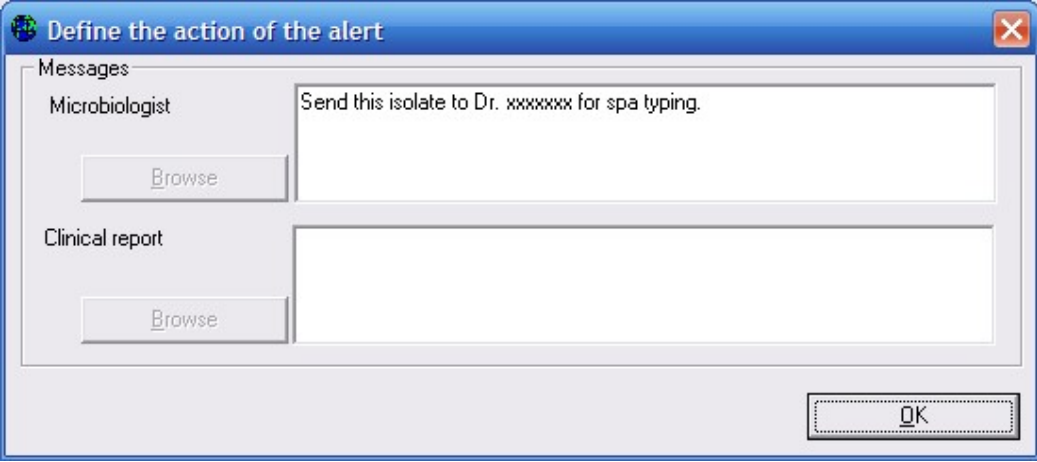
☒ Alert the infection control team

☒ Therapy comment

OK

Indicate the flags which you wish to apply to the new alert, and click “OK”.

If you click on “Messages”, you will get the following. Indicate any messages you wish to send to the microbiologist or clinician, and click “OK”. When you complete all details of your new alert, you can return to the main configuration screen to save your modifications.



Define the action of the alert

Messages

Microbiologist

Browse

Clinical report

Browse

OK

1B. Alerts and Data entry

Alerts are a significant enhancement to the data entry program. They can assist in the identification of typing errors, prompt notification of resistance results, and educational information on recommended laboratory testing practices.

Go to the Data Entry program, and process with normal entry of information. As you begin to enter results, any alerts triggered will appear automatically in the lower right-hand corner of the screen, as in the figure below.

The screenshot shows the 'Data entry' window for 'C:\whonet5\Data\W06ARG.EVI'. The interface is divided into several sections for data entry:

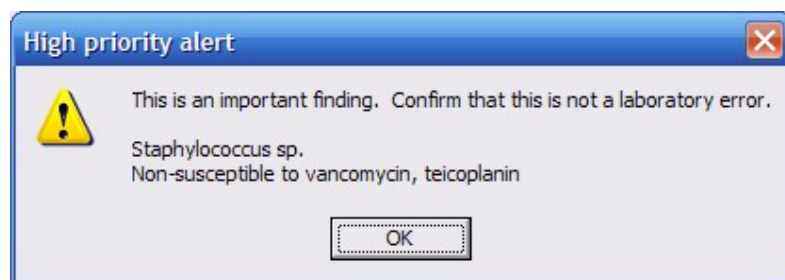
- Origin:** Human (dropdown)
- Identification number:** 12345
- Age:** (empty field)
- Last name:** (empty field)
- Date of birth:** (empty field)
- First name:** (empty field)
- Age category:** (empty field)
- Sex:** (empty field)
- Location:** Location: 5north, Department: med, Institution: evi, Location type: in
- Specimen:** Specimen number: 67890, Specimen type: bl, Specimen date: 1-Jun-2006, Reason: (empty field)
- Microbiology:** Organism: sau (Staphylococcus aureus ss. aureus), Beta-lactamase: (empty field), X_BLEE: (empty field), ESBL: (empty field), Antibiotic panel: Staphylococcus
- Antibiotic Susceptibility:** Radio buttons for Disk, MIC, and Etest. Below are grids of antibiotic results (e.g., AMK, CHL, OXA, etc.) with values like '6' or 'R'.
- Other:** Comment: (empty field), X_SCD, X_SCV, X_INF, X_MLS (checkboxes).

On the right side, there are buttons: Save isolate, View database, BacTrack summary, Print, Exit, Caliper, and Clear.

The bottom right corner displays a list of alerts:

- Clinical reports:**
 - <F8> Include or exclude an antibiotic
 - <F9> Include all tested antibiotics
- Oxacillin_CLSI_Disk_1ug:**
 - OXA_ND1
 - Maximum: 2 characters
 - Oxacillin
 - CLSI
 - 1ug
 - 11-12
- Alerts:**
 - EVI-1 Medium priority
 - Staphylococcus aureus ss. aureus
 - S. aureus and spa typing
 - Important resistance
 - Save the isolate
 - Send to a reference laboratory
 - Infection control alert
 - Therapy comment
 - Send this isolate to Dr. xxxxxxxx for spa typing.
 - WHONET-12 Medium priority
 - All organisms

If there is a "High priority" alert, you will receive an alert similar to the following.



When you save the isolate, you will get a summary of all of the alert messages.

Save the isolate

Do you want to save this isolate?

☒ Save the isolate

☐ Save the isolate and continue with the same specimen

☐ Save the isolate and continue with the same patient

Alerts

☐ Quality control alert

☐ Important species

☒ Important resistance

☒ Save the isolate

☒ Send to a reference laboratory

☒ Infection control alert

☒ Therapy comment

☐ Other alert

S. aureus and spa typing
Send this isolate to Dr. xxxxxxxx for spa typing.

Non-susceptible to all antibiotics tested
The isolate is resistant to all tested antibiotics. You may wish to send the isolate

OK

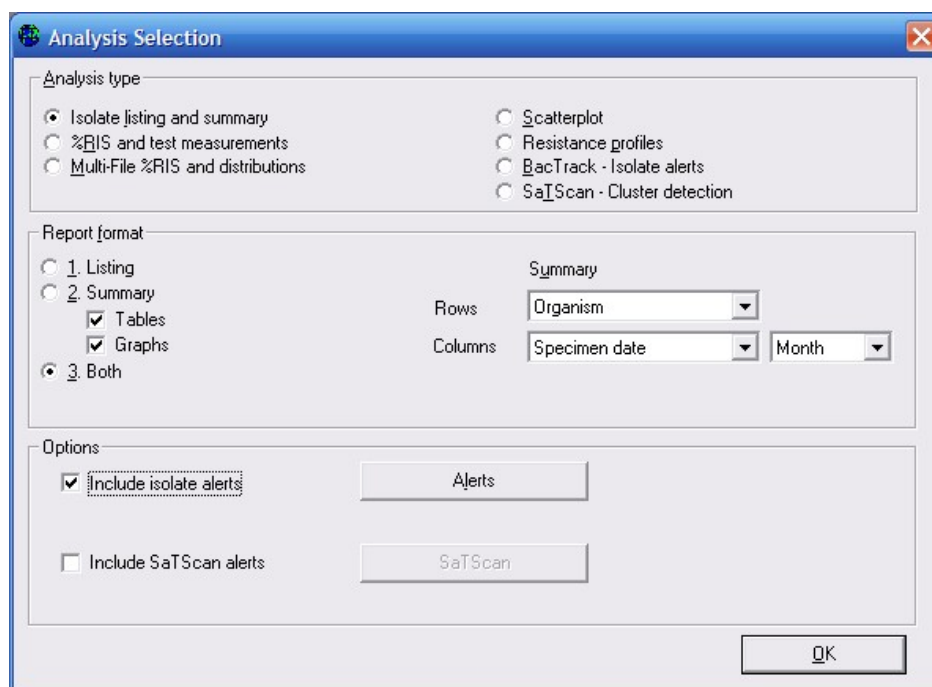
Cancel

1C. Alerts and Data analysis

One of the powerful features of the expert system is the integration of microbiological alerts into analysis tools. This will facilitate a quick review of large amounts of data, highlighting possible laboratory errors or important resistance findings. For national data managers, this feature can facilitate the prompt feedback to laboratory participants and further identification of problems identified.

In Data Analysis, microbiological alerts are integrated into a two main areas: 1. isolate listings and 2. BacTrack – Isolate alerts. To test out the new features, you may use the WHO Test Hospital sample database or your own. The following screens were prepared with the WHO Test Hospital data.

Isolate listings: Go to Data Analysis, and choose “Analysis Type”. Click on “Isolate listing and summary”. Click on the new option: “Include isolate alerts”.



Analysis Selection

Analysis type

- ☒ Isolate listing and summary
- ☐ %RIS and test measurements
- ☐ Multi-File %RIS and distributions
- ☐ Scatterplot
- ☐ Resistance profiles
- ☐ BacTrack - Isolate alerts
- ☐ SaTScan - Cluster detection

Report format

- ☐ 1. Listing
- ☐ 2. Summary
 - ☒ Tables
 - ☒ Graphs
- ☒ 3. Both

Summary

Rows: Organism

Columns: Specimen date Month

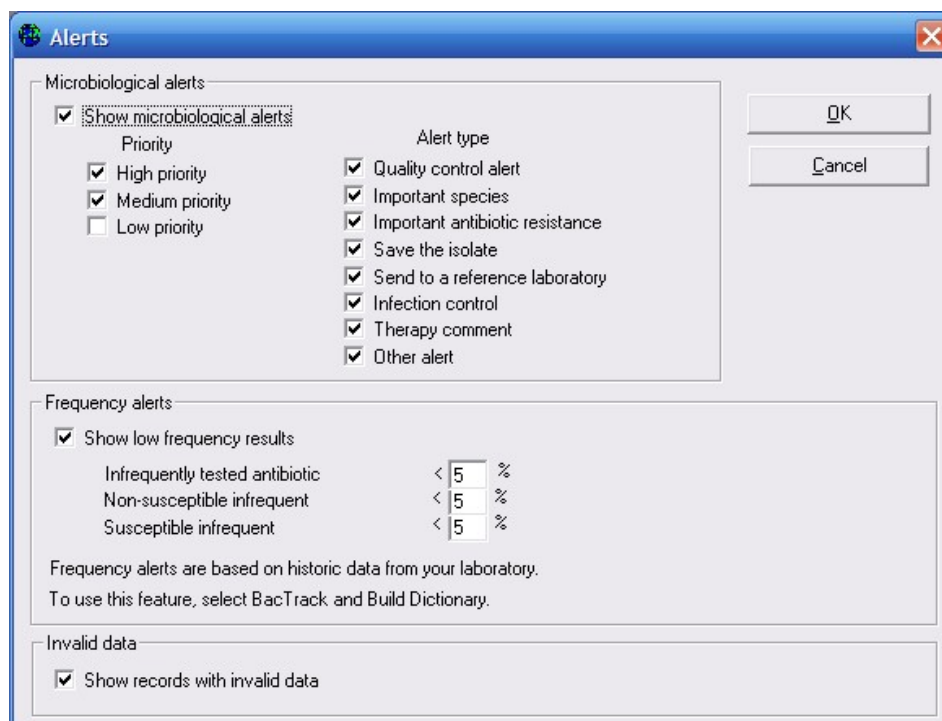
Options

☒ Include isolate alerts Alerts

☐ Include SaTScan alerts SaTScan

OK

Click on “Alerts” to see additional options. As you can see in the below screen, you can include all alerts in the analysis, or only certain categories of alerts of interest to you. By default, WHONET will include all High and Medium priority isolate alerts from all alert types. Indicate the alerts that you want included in your analysis. Then click “OK”, and then “OK” again to return to the main analysis screen.



Alerts

Microbiological alerts

☒ Show microbiological alerts

Priority

- ☒ High priority
- ☒ Medium priority
- ☐ Low priority

Alert type

- ☒ Quality control alert
- ☒ Important species
- ☒ Important antibiotic resistance
- ☒ Save the isolate
- ☒ Send to a reference laboratory
- ☒ Infection control
- ☒ Therapy comment
- ☒ Other alert

OK

Cancel

Frequency alerts

☒ Show low frequency results

Infrequently tested antibiotic < 5 %

Non-susceptible infrequent < 5 %

Susceptible infrequent < 5 %

Frequency alerts are based on historic data from your laboratory.
To use this feature, select BacTrack and Build Dictionary.

Invalid data

☒ Show records with invalid data

For “Organisms”, select “ALL” organisms. For “Data files”, select “w0195who.tst”. Then “Begin analysis”.

The left portion of the screen will look like the below. This is unchanged from earlier versions of WHONET. WHONET will display test interpretations for this analysis rather than zone diameters of MIC values.

Analysis Results

File Edit Data

Copy table Copy graph Print table Print graph Continue Organism = All organisms (n=622 isolates)

Show hidden columns

Identification number	Location	Specimen number	Specimen date	Specimen type	Organism	Organism type	PEN	ERY	TCY	CHL	NIT	TOB	CLI	CEP	AML
288636	op	134	1/31/1995	sp	aba	-									R
309444	ws	6388	1/12/1995	an	aba	-									R
	ws	6389	1/12/1995	ti	aba	-									R
	ws	8838	1/16/1995	wd	aba	-									R
359114	4b	7316	1/27/1995	wd	aba	-									R
	4b	7317	1/27/1995	wd	aba	-									R
548465	op	4130	1/9/1995	wd	aba	-									R
549244	op	5757	1/25/1995	wd	aba	-									R
224753	4w	7985	1/28/1995	sp	ach	-									R
269195	op	9010	1/16/1995	sp	bbr	-									R
	op	9010	1/16/1995	sp	bbr	-									R
	op	8507	1/26/1995	sp	bbr	-					I		S		R
	op	8507	1/26/1995	sp	bbr	-							S		R
202686	op	4106	1/9/1995	sp	bca	-			S		R		S		
224753	4w	7985	1/28/1995	sp	bca	-			S						
247890	4w	2703	1/7/1995	sp	bca	-			S						
306951	fm	7969	1/14/1995	sp	bca	-			S						
358710	ie	9180	1/2/1995	sp	bca	-			S						
416295	op	9395	1/30/1995	sp	bca	-			S						
473433	op	2241	1/6/1995	sp	bca	-			S						
625607	op	7239	1/13/1995	sp	bca	-			S						
531115	4b	6655	1/12/1995	sp	bca	-			S						
533493	ws	3875	1/9/1995	sp	bca	-			S						
547237	su	9787	1/3/1995	sp	bca	-			S						
	su	2377	1/6/1995	sp	bca	-			S						
548074	er	8628	1/1/1995	sp	bca	-			S						
548159	er	9832	1/3/1995	th	bca	-			S						
459877	op	3929	1/9/1995	ur	bs+	+		S	I			S		S	S
549817	4b	2922	1/21/1995	an	bta+	+		S	S		S	S		S	S
204613	op	5789	1/25/1995	an	bta+	+		S	S		R	S		S	S
340968	er	681	1/4/1995	ur	bta+	+		S	S			S		S	S
531949	op	6584	1/26/1995	ur	bta+	+		S	S		R	S		S	S
542932	er	1217	1/5/1995	ur	bta+	+		S	S			S		S	S
549472	er	253	1/31/1995	wd	bta+	+		S	S		R	S		S	S
406304	wn	4274	1/23/1995	lu	bta+	+		S	S		S	S		S	S
548465	op	4130	1/9/1995	wd	bta+	+		S	S					S	S
212399	4b	2793	1/21/1995	bl	cdp	+		R	R					R	S
287998	op	5517	1/25/1995	ur	cdp	+		S	S					S	S
	ws	5517	1/25/1995	ur	cdp	+		S	S					S	S
309444	ws	6388	1/12/1995	an	cdp	+		R	S					I	
	ws	6389	1/12/1995	ti	cdp	+		R	S					I	

The right portion of the screen looks like the following.

Analysis Results

File Edit Data

Copy table Copy graph Print table Print graph Continue Organism = All organisms (n=622 isolates)

Show hidden columns

Identification number	Alert	Priority	Organisms	Isolate alerts	Quality control	Important species	Important resistance	Save the isolate
549212	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
252180	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
280946	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
460939	<input checked="" type="checkbox"/>	Medium priority	All organisms, Enterobacteriaceae	Discordant penicillin and beta-lactam-inhibitor results	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
252180	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
00000	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
504334	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
518246	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
549060	<input checked="" type="checkbox"/>	Medium priority	All organisms	Discordant penicillin results	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
237010	<input checked="" type="checkbox"/>	Medium priority	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	Medium priority	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
275268	<input checked="" type="checkbox"/>	Medium priority	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
301006	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
368857	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
441326	<input checked="" type="checkbox"/>	Medium priority	All organisms	Discordant penicillin and beta-lactam-inhibitor results	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
517997	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
221791	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
237010	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	Medium priority	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
309021	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
368857	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
376733	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
444621	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
444624	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
508335	<input checked="" type="checkbox"/>	Medium priority	All organisms	Discordant penicillin and beta-lactam-inhibitor results	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
546931	<input checked="" type="checkbox"/>	Medium priority	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	Medium priority	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
547237	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
204613	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
212246	<input type="checkbox"/>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The usual line-listing from earlier versions of WHONET has now been supplemented with microbiological comments about potentially incorrect or important results. By clicking on any column heading, the results table can be sorted by that column. In this way, it would be easy to see a list of isolates that should perhaps be repeated and sent to a reference laboratory if necessary.

BacTrack – Isolate alerts

In the isolate listing and summary, this user view results from all isolates, many of which may have alert comments. In the “Isolate alerts” feature, only strains with alerts are presented to the user. Alerts include a combination of microbiological rules, as described above, as well as statistical alerts for isolates occurring in low frequency according to the historical data of that laboratory.

To take advantage of the statistical “low frequency” alerts, you should first create a BacTrack reference dictionary with historical data from this laboratory – for example, the 2005 data file. You will then compare your new data file against this historical data. Alternatively, you could create the BacTrack dictionary using the new data file.

For this example, choose “BacTrack – Isolate alerts” and “Create dictionary”. Then click “OK”. For Organisms, WHONET will automatically include “ALL” isolates. For data files, select “w0195who.tst”. Then “Begin Analysis”. When the analysis is finished, you will receive a message “BacTrack has completed the dictionary.”

The screenshot shows the 'Analysis Selection' dialog box with the following configuration:

- Analysis type:**
 - ☐ Isolate listing and summary
 - ☐ %RIS and test measurements
 - ☐ Multi-File %RIS and distributions
 - ☐ Scatterplot
 - ☐ Resistance profiles
 - ☒ BacTrack - Isolate alerts
 - ☐ SaIScan - Cluster detection
- Report format:**
 - ☒ 1. Create dictionary
 - ☐ 2. Isolate alerts
 - ☒ Listing
 - ☒ Summary
- Alerts:** A button labeled 'Alerts' is present.

An 'OK' button is located at the bottom right of the dialog.

Now return to “Analysis Type” and select “BacTrack – Isolate alerts”, “Isolate alerts”. As earlier, you can click on “Alerts” to select those alerts you would like included in the analysis. You may also set the percent of isolates to be used as a threshold for the determination of “infrequent” results. The default is 5% for each option. To increase the number of flagged isolates, you can increase this percentage. To decrease the number of flagged isolates, then lower the percentage. You can put the percentage at 0% if you want to turn a particular feature off.

Alerts

☒ Show microbiological alerts

Priority

- ☒ High priority
- ☒ Medium priority
- ☐ Low priority

Alert type

- ☒ Quality control alert
- ☒ Important species
- ☒ Important antibiotic resistance
- ☒ Save the isolate
- ☒ Send to a reference laboratory
- ☒ Infection control
- ☒ Therapy comment
- ☒ Other alert

Frequency alerts

☒ Show low frequency results

Infrequently tested antibiotic < 5 %

Non-susceptible infrequent < 5 %

Susceptible infrequent < 5 %

Frequency alerts are based on historic data from your laboratory.
To use this feature, select BacTrack and Build Dictionary.

Invalid data

☒ Show records with invalid data

OK Cancel

When finished your selections, click “OK” to return to the main analysis screen, and “Begin analysis”.

Analysis Results

File Edit Data

Copy table Copy graph Print table Print graph Continue Organism = All organisms (n=57 isolates)

Show hidden columns

Identification number	Organism	Organism type	PEN	ERY	TCY	CHL	NIT	TOB	CLI	CEP	AMP	AMK	DXA	GEN	CRB	VAN	SXT	FL
531349	btb	+	S	S	R	S	S		S		S		R			S	?	
549472	btb	+	S	S	R	S			S		S		R			S	?	
408304	bst	+	S	S	S	S			S		S		R			S	?	
460939	cfr	-					S			R	I			S			S	
549060	dve	+	S	S	S	S			S		S		R			S	?	
237010	eae	-								R	R			S			S	
	eae	-								R	R			S			S	
275268	eae	-					S			R	R			S			S	
441326	eae	+					I			R	R			S			S	
237010	ecd	-								R	R			S			S	
508335	ecd	-					R			R	R			S			S	
546931	ecd	-								R	R			S			S	
	eco	-								R	R			S			S	
204613	eco	-								R	R			S			S	
243833	eco	-					S			I	S			S			S	
546471	eco	-					S			R	R			R ⁺			R	
549471	eco	-					S			S	S			R ⁺			S	
358710	efa	+	S	I					R	R	S		S			I		
204613	ent	+	S	I					R	R	S			I				
	ent	+	S	I					R	R	S			S				
232196	ent	+	S	R			S		R	R	S			S		I		
243746	ent	+	S	I					R	R	S			S		I		
324858	ent	+	S	I					R	R	S			I				
	ent	+	S	I					R	R	S			I				
334873	ent	+	S	R			S		R	R	S			R		I		
401142	ent	+	S	S					S [#]	R	S					S		
482498	ent	+	S	R			S		R	I	S					I		
533493	ent	+	S	I			S		R	R	S		S			I		
546339	ent	+	S	I					R	R	S		S			I		
508619	hpn	-												S				R ⁺
542522	hpn	-								S	R			S				I ⁺
437077	mmo	-					R				R			S				S
530709	mmo	-					R				R			S				S
413521	rme	-												S				S
544160	rme	-												S				S
203262	pae	-			I						S							R
221791	pae	-				R		S					R ⁺	R	I			S
337951	pmi	-				S					S	S		I ⁺				S
50835	pmi	-				R				S	S			R ⁺				S
376140	pr	-				R				R	R			S				S
	pr	-				R				R	R			S				S

Every isolate included in this printout has at least one alert flag. Statistical “low frequency alerts” are found to the left of the listing, and are marked by a special symbol: 1. “*” – the observed resistance is infrequent, based on the hospital’s local data; 2. “#” – the observed susceptible result is infrequent, based on the hospitals’ data; and 3. “+” – the antibiotic indicated is not frequently tested for this organism, based on the hospital’s data.

In this particular example, examples of “infrequent” results include: *E. coli* resistant to gentamicin; *Enterococcus* spp. susceptible to clindamycin; *H. influenzae* resistant to trimethoprim/sulfamethoxazole; *P. aeruginosa* resistant to amikacin; *P. aeruginosa* resistant to tobramycin; and *P. mirabilis* resistant to ampicillin. While such findings may be common in other institutions, the alerts indicate that these findings are rare (<5%) for the results of organisms in this laboratory. Findings of low frequency may perhaps be due to laboratory error, so should be confirmed; or they may reflect important new resistant strains still present at low levels in the institution.

In contrast to the fixed, pre-defined, globally relevant microbiological expert rules described earlier, a great advantage of the “low frequency” alerts is that alerts are automatically adjusted to the past experience of this particular laboratory for all tested organisms and antibiotics.

After viewing the isolate alert listing, click “Continue” to proceed to the isolate alert summary. The summary tabulates every alert that was encountered in the scanned data. Totals are provided, as well as the type of alert – “quality assurance”, “send to a reference laboratory”, etc. If results from more than one laboratory are scanned, the summary also includes the breakdown of alerts by laboratory, as illustrated in the screen below.

Analysis Results

File Edit Data

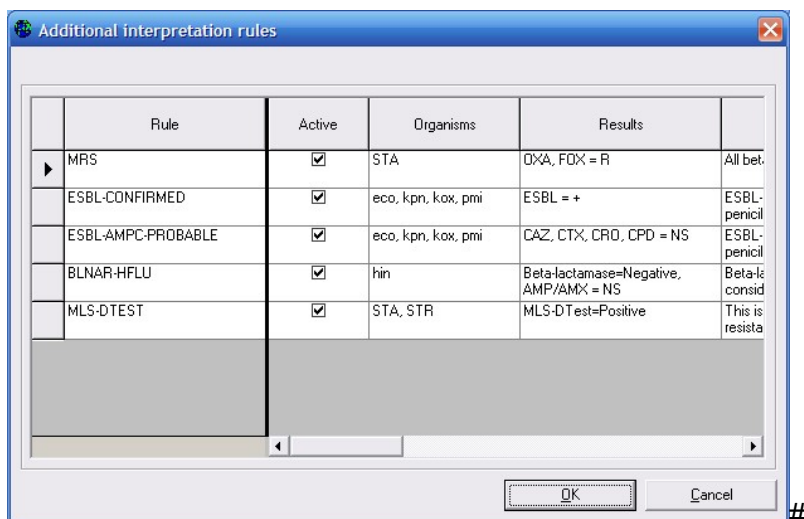
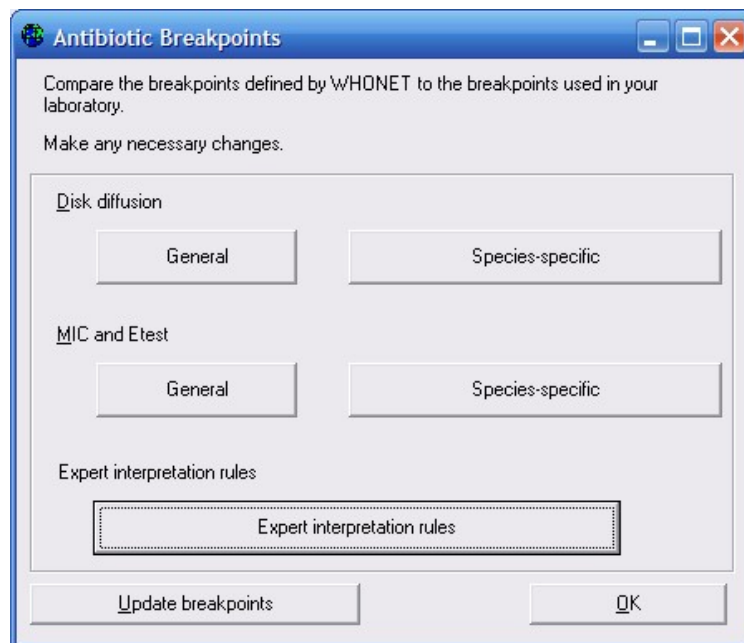
Copy tableCopy graphPrint tablePrint graphContinueOrganism = All organisms (n=835 Isolates)

	Number	Organisms	Alert	Number of isolates	Priority	061	TST	FFF	GEP	Quality control	Imp sp
▶	8	All organisms	Discordant penicillin and beta-lactam-inhibitor result	12	Medium priority		12			<input checked="" type="checkbox"/>	
	25	Enterobacteriaceae	Probable ESBL-producing Enterobacteriaceae	249	Medium priority	131	6	104	6	<input type="checkbox"/>	
	26	Enterobacteriaceae	Non-susceptible to amikacin	1	Medium priority		1			<input type="checkbox"/>	
	28	Enterobacteriaceae	Non-susceptible to fluoroquinolones	4	Medium priority		4			<input type="checkbox"/>	
	30	Enterococcus casseliflavus	Susceptible to glycopeptides	12	Medium priority	12				<input checked="" type="checkbox"/>	
	31	Enterococcus faecalis	Non-susceptible to penicillins	43	Medium priority	41		2		<input checked="" type="checkbox"/>	
	32	Enterococcus gallinarum	Susceptible to glycopeptides	10	Medium priority	10				<input checked="" type="checkbox"/>	
	33	Enterococcus sp.	VRE - Vancomycin-resistant Enterococcus	15	Medium priority	1	11	3		<input type="checkbox"/>	
	54	Listeria monocytogenes	Important species	3	High priority			3		<input type="checkbox"/>	
	58	Neisseria gonorrhoeae	Important species	29	High priority	13		16		<input type="checkbox"/>	
	62	Neisseria meningitidis	Important species	3	High priority		2	1		<input type="checkbox"/>	
	75	Pseudomonas aeruginosa	Discordant amikacin and aminoglycoside results	1	Medium priority		1			<input checked="" type="checkbox"/>	
	81	Salmonella sp.	Important species	33	Medium priority	20		13		<input type="checkbox"/>	
	84	Salmonella sp.	Non-susceptible to third-generation cephalosporins	1	High priority	1				<input type="checkbox"/>	
	94	Staphylococcus aureus	MRSA - Methicillin-resistant S. aureus	9	Medium priority		9			<input type="checkbox"/>	
	98	Staphylococcus aureus	VISA - Vancomycin-intermediate S. aureus / Glycop	6	High priority	5		1		<input type="checkbox"/>	
	99	Staphylococcus sp.	Intermediate to vancomycin, teicoplanin	7	High priority	6		1		<input type="checkbox"/>	
	100	Staphylococcus sp.	Non-susceptible to vancomycin, teicoplanin by disk	1	Medium priority		1			<input type="checkbox"/>	
	104	Staphylococcus sp.	Non-susceptible to vancomycin, teicoplanin	10	High priority	7	2	1		<input type="checkbox"/>	
	111	Streptococcus pneumoniae	Beta-lactams tested by disk diffusion (except for oxa	2	Medium priority		2			<input checked="" type="checkbox"/>	
	114	Streptococcus pneumoniae	PNSSP - S. pneumoniae Non-susceptible to penicill	358	Medium priority	222		130	6	<input type="checkbox"/>	
	118	Streptococcus sp.	Non-susceptible to vancomycin, teicoplanin	3	High priority	2	1			<input type="checkbox"/>	
	120	Streptococcus viridans	Non-susceptible to penicillin, ampicillin	22	Medium priority	20		2		<input type="checkbox"/>	
	123	Streptococcus, beta-hemolytic	Non-susceptible to penicillins	21	High priority	16	2	1		<input type="checkbox"/>	
	124	Streptococcus, beta-hemolytic	Non-susceptible to third-generation cephalosporins	6	High priority	5				<input type="checkbox"/>	

Part 2. Expert interpretation rules

The microbiological rules described above provide alerts of various sorts to the user. These rules do not change the antimicrobial test interpretation. There are a few additional rules which actually do change test interpretations given certain findings, for example, an isolate of MRSA should be considered resistant to all beta-lactam agents, irrespective of the *in vitro* test measurements.

To review the current expert interpretation rules, choose “Modify laboratory” to enter the configuration area, “Antibiotics”, “Breakpoints”. You will see the following screen. Click on “Expert interpretation rules”.



#

You will see the five expert interpretation rules currently defined, adapted from CLSI recommendations: 1. methicillin-resistant *Staphylococcus*; 2. confirmed ESBL-producing *E. coli*, *K. pneumoniae*, *K. oxytoca*, or *P. mirabilis*; 3. probable ESBL-producing *E. coli*, *K. pneumoniae*, *K. oxytoca*, or *P. mirabilis*; 4. beta-lactamase negative ampicillin-resistant *H. influenzae*; and 5. DTest positive strains of *Staphylococcus* and *Streptococcus*.

At the present time, users cannot create new interpretation rules or edit existing ones. Rules can be activated or deactivated by the user.

It is important to understand when WHONET applies these expert rules. For Data Entry and clinical reporting, **these rules are always applied** (unless specifically deactivated by the user). In Data Analysis, **these rules are never applied until the option is turned on by the user**.

In the Data Analysis program, if you want to apply these expert interpretation rules, go to “Options” and click on “Use expert interpretation rules”. It is the first option listed on the screen.

The screenshot shows the 'Analysis Options' dialog box with the following settings:

- Test interpretations:**
 - ☐ Use expert interpretation rules
 - ☐ Combine disk, MIC, and Etest results
 - Priority: Etest > MIC > Disk
 - MIC and Etest - Interpretation of half-dilutions:
 - ☒ Round up to full dilution (Recommended)
 - ☐ Do not round up
- Isolate listing and summary:**
 - ☒ Test results
 - ☐ Test interpretations
 - ☐ Encrypt patient information
 - Summary:
 - ☒ Number of patients
 - ☐ Number of isolates
- %RIS and histograms:**
 - ☒ Percentage of isolates
 - ☐ Number of isolates
 - Disk diffusion: 6 -- 35 mm
 - MIC and Etest: .002 -- 256 ug/ml
- Histograms:**
 - ☒ Breakpoints
 - ☐ Quality control: ATCC 25922 (eco)
- Scatterplot:**
 - ☒ Percentage of isolates
 - ☐ Number of isolates
 - ☐ Regression line
- Resistance profile:**
 - ☒ Group intermediate with resistant
 - ☐ Group intermediate with susceptible
 - ☒ Include all isolates
 - ☐ Omit isolate if profile antibiotics are missing
 - How many antibiotics? = 1
- Summary:**
 - ☒ Number of patients
 - ☐ Number of isolates

OK

Part 3. Selective antimicrobial reporting

For laboratories using WHONET as a clinical reporting system, the ability to selectively report or suppress certain antimicrobials can be important in supporting rational drug use and guiding clinical therapy decisions.

To configure the selective reporting rules, click on “Modify laboratory”, “Antibiotics”, “Panels”, and click on “Conditional antibiotic reporting”.

Antibiotic Panels (Optional)

Indicate which antibiotics you usually test for each organism group.

Antibiotic	Staphylococcus	Streptococcus	Streptococcus pneumoniae	Streptococcus viridans	Enterobacteriaceae
Penicillin G_CLSI_Disk_10units	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Erythromycin_CLSI_Disk_15ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Tetracycline_CLSI_Disk_30ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Chloramphenicol_CLSI_Disk_30ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Nitrofurantoin_CLSI_Disk_300ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Sulfonamides_CLSI_Disk_200-300ug	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tobramycin_CLSI_Disk_10ug	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Clindamycin_CLSI_Disk_2ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cephalothin_CLSI_Disk_30ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Ampicillin_CLSI_Disk_10ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Amikacin_CLSI_Disk_30ug	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oxacillin_CLSI_Disk_1ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Gentamicin_CLSI_Disk_10ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Carbenicillin_CLSI_Disk_100ug	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vancomycin_CLSI_Disk_30ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Trimethoprim/Sulfamethoxazole_CLSI_Disk_23-25ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cefoxitin_CLSI_Disk_30ug	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ciprofloxacin_CLSI_Disk_5ug	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Antibiotic sequence Conditional antibiotic reporting OK Cancel

In the screen below, you can indicate your standard First-line agents, which should typically be reported for all isolates. You can indicate Second-line agents, which will be included in the clinical report under certain conditions (if the result itself is resistant or if the isolate is resistant to multiple First-line agents). For drugs that are principally used only for organism identification (optochin, novobiocin, etc.), you can choose "Do not print" to exclude these isolates from clinical reports.

Antibiotics for the clinical report - Gram negative

Antibiotic panel: Gram negative

Antibiotics	First-line antibiotics	Second-line antibiotics	Do not print
Ampicillin_CLSI_Disk_10ug	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gentamicin_CLSI_Disk_10ug	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Trimethoprim/Sulfamethoxazole_CLSI_Disk_23-25ug	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cefoxitin_CLSI_Disk_30ug	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cefotaxime_CLSI_Disk_30ug	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Ceftazidime_CLSI_Disk_30ug	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Imipenem_CLSI_Disk_10ug	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cefuroxime_CLSI_Disk_30ug	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Mezlocillin_CLSI_Disk_75ug	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Ciprofloxacin_CLSI_Disk_5ug	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Second line antibiotics

☒ Print all second-line antibiotics with a result of Resistant or Intermediate.

☒ Print all second-line antibiotics if the isolate is resistant to multiple first-line antibiotics.

Resistant or intermediate to how many antibiotics?

☐ Additional rules

OK Cancel

In addition to the results described on this screen, you can enter "Additional rules" to define additional reporting criteria.

The responses that you enter in these screens will set the default behavior for clinical reporting. During data entry, you can change these selections manually by including or excluding additional antimicrobials by using the F8 and F9 keys. In the below screens, antibiotics appearing in gray to not appear in the clinical report.

Data entry: C:\whowin32\vb6\Data\W06USA.TST

Origin:

Origin:
Identification number:
First name:
Last name:
Sex:

Date of birth:
Age:
Age category:

Location:
Location:
Institution:

Department:
Department:
Location type:

Specimen:
Specimen number:
Specimen date:

Specimen type:
Reason:

Microbiology:
Organism: Escherichia coli
Beta-lactamase:
Antibiotic panel:

☒ Disk ☐ MIC ☐ E-test

CEP	<input type="text" value="30"/>	S	AMP	<input type="text" value="30"/>	S	GEN	<input type="text" value="30"/>	S	SXT	<input type="text" value="30"/>	S
FOX	<input type="text" value="30"/>	S	CTX	<input type="text" value="30"/>	S	CAZ	<input type="text" value="30"/>	S	IPM	<input type="text" value="30"/>	S
CXM	<input type="text" value="30"/>	S	MEZ	<input type="text" value="30"/>	S	CIP	<input type="text" value="30"/>	S	ATM	<input type="text" value="30"/>	S

Other:
Comment:

Buttons:
Save isolate
View database
BacTrack summary
Print
Exit
Caliper
Clear

Clinical reports:
<F8> Include or exclude an antibiotic
<F9> Include all tested antibiotics

Cephalothin_CLSI_Disk_30ug
CEP_ND30
Maximum: 2 characters
Cephalothin
CLSI
30ug
15-17