

2021 Minnesota Statewide Acute Care Antibigram

Background

Antibiotic resistance is one of our greatest clinical and public health challenges. According to the Centers for Disease Control and Prevention, more than 2.8 million antibiotic-resistant infections occur in the United States each year, and at least 35,000 people die as a result.¹ Minnesota Department of Health (MDH) conducts surveillance for antibiotic-resistant organisms of public health concern and reports on these organisms annually.² Clinical antibiograms summarize the antibiotic susceptibility profiles of a wider range of bacteria isolated from patients in individual health care facilities. Most hospitals and health systems generate these antibiograms annually. The Minnesota One Health Antibiotic Stewardship Collaborative (MOHASC) has worked with MDH to develop an annual statewide antibiogram initiative, compiling susceptibility data from hospitals across Minnesota.

Annual statewide antibiograms provide MDH with a tool to track trends in the percent of clinical bacterial isolates susceptible to selected antibiotic drugs. Antibiograms are available at [Minnesota Antibiotic Stewardship Data \(www.health.state.mn.us/diseases/antibioticresistance/data.html\)](http://www.health.state.mn.us/diseases/antibioticresistance/data.html), with data first compiled for isolates collected in 2018.

In 2022, submission of the most recent hospital antibiogram was made a requirement to attain Gold-level recognition on the [Minnesota Antibiotic Stewardship Acute Care and Critical Access Honor Roll \(www.health.state.mn.us/communities/onehealthabx/honor/honorac.html\)](http://www.health.state.mn.us/communities/onehealthabx/honor/honorac.html). Gold-level hospitals are recognized for looking beyond their facility to practice antibiotic stewardship in a collaborative way, including through contributing to the statewide acute care antibiogram. Likely driven by this change, the number of 2021 antibiogram submissions was 21% greater than the number in 2020.

Methodology

A total of 61 antibiograms reflecting isolates collected during 2021, were submitted to MDH. Of these, 46 were included in the statewide antibiogram. Antibiograms were submitted in a variety of formats, including PDF, Microsoft Word, and Microsoft Excel. Submitted antibiograms were excluded from the statewide summary if they did not include isolate counts, had an unclear date range, or included only data collected outside of the year of interest. Selected data from included antibiograms were excluded if the number of isolates tested for an individual organism-antibiotic drug combination could not be determined. Antibiogram submitters were contacted by email up to three times for clarification. If the data in question could not be confirmed through those queries, they were excluded from the statewide summary.

Data were compiled for a set of organism-antibiotic drug combinations of interest to MDH and MOHASC partners. Not every hospital antibiogram included susceptibility results for all organism-antibiotic drug combinations. When necessary, results at the species level were compiled into a genus group (e.g., *Citrobacter* organisms grouped as a single "*Citrobacter* spp." category) and a weighted average susceptibility was calculated for submitted antibiograms.

The total number of isolates tested and percent susceptible were used to compute a weighted average of percent susceptible across institutions. This was done by 1) determining the number of susceptible isolates at each institution for each organism-antibiotic combination (number of isolates x percent susceptible); 2) summing the number of susceptible isolates across all institutions for each organism-antibiotic combination; 3) summing the total number of isolates across all institutions for each organism-antibiotic combination; and 4) dividing the summed number of susceptible isolates by the total number of isolates to get an overall percent susceptible for each organism-antibiotic combination.

The range of percent susceptible across hospitals was determined for each organism-antibiotic drug combination. Hospitals that reported percent susceptible for fewer than 30 isolates were included in generation of the weighted average of percent susceptible, facility number, and number of isolates, but were excluded from the percent susceptible range. The number of hospitals contributing to each weighted percent and percent range is noted in the tables.

¹ CDC. Antibiotic Resistance Threats in the United States, 2019. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2019. Available at <https://www.cdc.gov/antimicrobial-resistance/media/pdfs/2019-ar-threats-report-508.pdf>.

² Minnesota Department of Health. Annual Summary of Disease Activity: Disease Control Newsletter. Available at <https://health.mn.gov/diseases/reportable/dcn/index.html>.

Limitations

This statewide antibiogram has several limitations. Because of these limitations and geographic variation that cannot be accounted for in this antibiogram, information in this document should not be used to inform clinical treatment decisions. The report and data included in subsequent statewide antibiograms will be used to understand changes in the susceptibility patterns of clinically important bacterial organisms over time.

- Data reflect isolates from a subset of hospitals and might not be generalizable to all of Minnesota.
- The 2021 statewide antibiogram includes data from 74 hospitals, some of which are not in Minnesota. Small and critical-access hospitals make up approximately 60% of Minnesota’s 127 hospitals. These hospitals often utilize antibiograms that have been compiled by a health system or laboratory to include isolates from several small hospitals and, in some cases, other settings.
- Five submitted antibiograms (11%) included results from multiple hospitals. Antibiogram data for organism-antibiotic combinations reflect the number of submitted antibiograms rather than the number of contributing hospitals.
- Some submitted antibiograms include isolates collected from outside of the January–December 2021 time frame, because additional time was needed to reach 30 isolates.
- Susceptibility testing methodologies differed across submitted antibiograms. CLSI breakpoints for all organism-antibiotic combinations were used by 22/46 (48%) laboratories that generated included antibiograms, and 7/46 (15%) used CLSI breakpoints for most combinations. Of the laboratories using CLSI breakpoints, 17/46 (59%) used current breakpoints for all organism-antibiotic combinations. Some submitters (11, 24%) did not know if CLSI breakpoints were used.
- Not all contributing hospitals followed CLSI M39³ guidelines for generating their facility antibiogram. The table below summarizes select antibiogram compilation characteristics for submitted antibiograms.

Antibiogram Characteristics, Based on CLSI M39 Guidelines	Count (%) N=46
Includes only final, verified results.	39 (85%)
Includes only the first isolate of a given species per patient per antibiogram period.	25 (54%)
Includes results hidden from clinical view through cascaded reporting.	24 (52%)
Includes only results for organisms with ≥30 isolates.	17 (37%)
Susceptibility percentage calculated using only "susceptible," not "intermediate," interpretation.	31 (67%)
Includes only isolates from a single health care facility (i.e., facility-specific antibiogram).	41 (89%)

³ Clinical and Laboratory Standards Institute. Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data. CLSI guideline M39. 5th ed. Clinical and Laboratory Standards Institute; 2022.

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Gram-Negative

Acinetobacter spp., *Pseudomonas aeruginosa*, and *Stenotrophomonas maltophilia*

		Amikacin	Ampicillin/sulbactam	Aztreonam	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Gentamicin	Imipenem	Levofloxacin	Meropenem	Piperacillin-Tazobactam	Trimethoprim-Sulfamethoxazole	Tobramycin
<i>Acinetobacter</i> spp.	%S	96	86	R	90	81	56	88	87	97	90	97	77	85	87
	Total Isolates	167	223		239	313	155	313	313	65	313	253	134	254	313
	Total Antibiograms	6	9		9	13	8	13	13	4	13	10	7	12	13
	Range % S*	93-100	33-98		82-96	33-96	57-68	33-98	33-100	100	33-97	94-100	33-95	33-97	33-100
	# Antibiograms Included in Range	3	4		4	5	2	5	5	1	5	4	3	4	5
<i>P. aeruginosa</i>	%S	97	R	82	93	92	R	85	92	92	82	91	92	R	98
	Total Isolates	5252		2503	7985	7945		8095	7664	2652	8207	7233	8210		8367
	Total Antibiograms	25		15	43	42		45	44	18	45	37	42		45
	Range % S*	93-100		70-100	74-100	86-100		75-98	74-100	77-100	75-93	88-100	82-100		93-100
	# Antibiograms Included in Range	21		12	34	32		35	34	14	35	29	33		35
<i>S. maltophilia</i>	%S		R	R		32	R		R	R	87	R	R	95	R
	Total Isolates					895					916			946	
	Total Antibiograms					17					18			19	
	Range % S*					18-46					80-97			85-100	
	# Antibiograms Included in Range					11					11			12	

R = intrinsic resistance

* Range only reported when more than one facility and ≥30 isolates per facility

2021 MINNESOTA STATEWIDE ACUTE CARE ANTIBIOGRAM

E. coli

		Amikacin	Amoxicillin/Clavulante	Ampicillin	Ampicillin/Sulbactam	Aztreonam	Cefazolin	Cefepime	Cefotaxime	Cefoxitin	Ceftazidime	Ceftriaxone	Cefuroxime	Ciprofloxacin	Ertapenem	Gentamicin	Imipenem	Levofloxacin	Meropenem	Nitrofurantoin	Piperacillin-Tazobactam	Tetracycline	Trimethoprim-Sulfamethoxazole	Tobramycin	
<i>E. coli</i>	%S	99	88	62	68	96	88	95		93	94	94	96	81	100	94	100	81	99		97		81	94	
	Total Isolates	38201	6723	62630	46997	18296	55702	60520		14274	61364	65705	7141	61165	26105	62692	23985	63728	53630		65449		66090	64300	
	Total Antibiograms	25	9	44	38	14	39	43		13	43	45	4	44	24	44	20	45	37		44		46	44	
	Range % S*	98-100	81-94	45-73	52-78	90-100	67-97	90-100			88-97	84-100	89-100	94-97	71-91	98-100	88-97	99-100	66-99	98-100		85-100		68-90	88-97
	# Antibiograms Included in Range	25	9	44	38	14	39	43			13	43	45	4	44	24	44	20	45	37		44		46	44
<i>E. coli</i> (urine only)	%S	100		59	64	93	89	94			93	93		79	100	93		80	99	97	97		79	93	
	Total Isolates	5096		5378	7309	2936	14352	8358			8361	8361		6484	8361	5377		8361	6973	17249	8359		8362	8362	
	Total Antibiograms	4		5	6	2	11	7			7	7		6	7	5		7	5	13	7		7	7	
	Range % S*	99-100		56-66	61-75	92-94	69-94	93-97				91-96	91-96		73-87	99-100	91-94		76-87	99-100	94-98	97-98		76-84	91-95
	# Antibiograms Included in Range	4		5	6	2	11	7				7	7		6	7	5		7	5	13	7		7	7

* Range only reported when more than one facility and ≥30 isolates per facility

2021 MINNESOTA STATEWIDE ACUTE CARE ANTIBIOGRAM

Klebsiella spp.

		Amikacin	Ampicillin	Ampicillin/ Subbactam	Aztreonam	Cefazolin	Cefepime	Cefoxitin	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Imipenem	Levofloxacin	Meropenem	Nitrofurantoin	Piperacillin- Tazobactam	Trimethoprim- Sulfamethoxazole	Tobramycin
<i>K. aerogenes</i>	%S	100	R	R	82	0	98	R	80	79	98	96	100		96	99	17	79	99	99
	Total Isolates	930			499	710	1501		1430	1501	1501	788	1402		1468	1263	964	1426	1538	1528
	Total Antibiograms	16			9	18	32		30	32	32	20	31		32	23	24	29	33	32
	Range % S*	100-100			64-96	0-0	91-100		65-100	59-100	91-100	85-100	98-100		87-100	96-100	6-23	64-100	96-100	96-100
	# Antibiograms Included in Range	13			7	10	21		20	21	21	11	20		21	18	14	20	22	22
<i>K. oxytoca</i>	%S	100	R	61	94	52	96	98	96	94	96	99	97	99	97	100	85	94	95	97
	Total Isolates	1864		2888	1048	2718	3160	902	3013	3244	3160	1691	3000	1023	3104	2490	2343	3117	3244	3150
	Total Antibiograms	21		34	11	35	40	12	38	41	40	22	39	13	39	30	35	38	41	38
	Range % S*	99-100		38-86	87-100	22-94	90-100	95-100	85-100	88-100	90-100	97-100	90-100	95-100	90-100	98-100	60-96	86-100	89-100	88-100
	# Antibiograms Included in Range	18		27	9	27	31	10	29	32	31	16	30	10	31	24	28	30	32	30
<i>K. pneumoniae</i>	%S	100	R	85	94	92	95	95	94	95	95	99	97	100	92	100	36	96	91	96
	Total Isolates	7123		8885	3104	11168	10533	2976	11295	11772	10533	5041	11238	3724	11683	10012	9977	11886	12008	11752
	Total Antibiograms	24		37	12	43	41	13	43	45	41	24	44	15	45	36	40	44	46	44
	Range % S*	99-100		76-97	91-100	81-100	90-100	94-100	88-100	90-100	90-100	98-100	91-100	98-100	82-100	98-100	14-65	88-100	80-97	90-100
	# Antibiograms Included in Range	23		35	12	42	40	12	41	43	40	23	42	15	43	34	38	42	44	42

R = intrinsic resistance

* Range only reported when more than one facility and ≥30 isolates per facility

** May include isolates from *K. aerogenes*, *K. oxytoca*, and/or *K. pneumoniae*

2021 MINNESOTA STATEWIDE ACUTE CARE ANTIBIOGRAM

Other Gram-Negative Species

		Amikacin	Ampicillin	Ampicillin/ Sulbactam	Aztreonam	Cefepime	Cefoxitin	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Imipenem	Levofloxacin	Meropenem	Nitrofurantoin	Piperacillin- Tazobactam	Trimethoprim- Sulfamethoxazole	Tobramycin
Citrobacter spp. **	%S	100	R		81	98	6	82	80	93	98	96	97	93	99	89	88	90	97
	Total Isolates	1367			645	2235	268	2239	2339	2214	1243	2244	554	2310	1939	1760	2216	2404	2413
	Total Antibiograms	16			8	32	4	32	33	32	20	32	10	33	25	27	30	31	33
	Range % S*	99-100			69-91	90-100	0-36	44-100	44-90	85-100	95-100	80-100	89-100	86-100	93-100	81-97	42-98	77-100	89-100
	# Antibiograms Included in Range	14			6	23	4	24	24	23	14	23	6	24	20	21	23	25	25
Enterobacter spp.	%S	100	R	R	83	95	R	78	75	95	90	98	93	94	99	38	82	92	97
	Total Isolates	1888			1276	3306		3234	3279	3205	1901	3294	886	3461	2944	2071	3451	3571	3475
	Total Antibiograms	21			11	38		38	37	40	23	40	12	41	33	33	39	42	40
	Range % S*	99-100			71-96	78-100		6-96	6-90	86-100	78-98	93-100	85-100	89-100	94-100	8-60	6-96	71-99	92-100
	# Antibiograms Included in Range	16			9	26		26	26	27	16	27	8	28	23	24	28	29	28
M. morganii	%S	100	R	8	93	97	23	83	87	84	99	92	30	84	99	R	94	84	95
	Total Isolates	551		419	273	766	184	817	802	717	393	738	50	769	751		817	817	817
	Total Antibiograms	12		12	6	19	4	21	19	19	12	19	3	20	17		21	21	21
	Range % S*	100-100		4-13	90-94	87-100	0-50	68-100	80-100	74-91	97-100	81-95	0	68-93	97-100		89-100	67-92	91-98
	# Antibiograms Included in Range	9		8	4	16	3	14	14	12	6	12	1	13	13		14	14	14
P. mirabilis	%S	100	85	91	99	98	96	98	98	82	99	92	46	84	100	R	99	85	92
	Total Isolates	3690	5723	4929	1757	5718	1553	5885	6258	5733	2711	5723	471	5961	4817		6053	6228	6114
	Total Antibiograms	24	44	38	13	42	13	43	46	44	24	44	6	45	31		43	45	44
	Range % S*	95-100	60-94	78-100	90-100	87-100	93-100	89-100	95-100	73-100	95-100	79-100	0-100	73-100	93-100		96-100	70-95	86-100
	# Antibiograms Included in Range	22	39	33	11	38	11	38	41	39	21	39	5	40	28		39	41	39
S. marcescens	%S	100	R	R	95	99	R	97	92	93	98	99	100	93	99	R	96	99	90
	Total Isolates	870			367	1204		1158	1207	1159	586	1147	83	1196	1058		934	1189	1241
	Total Antibiograms	18			8	29		27	29	28	16	28	3	29	23		18	28	30
	Range % S*	98-100			91-100	94-100		76-100	78-100	83-100	94-100	90-100	100-100	86-100	97-100		85-100	94-100	71-100
	# Antibiograms Included in Range	14			6	21		20	21	20	10	20	2	21	18		16	21	22

R = intrinsic resistance

* Range only reported when more than one facility and ≥30 isolates per facility

**Susceptibility was calculated across any Citrobacter species reported. Some hospitals reported only *C. freundii*.

Gram-Positive

Enterococcus spp.

		Ampicillin	Daptomycin	Linezolid	Penicillin	Vancomycin
<i>E. faecalis</i>	%S	99	91	99	99	99
	Total Isolates	10990	4293	11059	10043	11903
	Total Antibiograms	45	16	42	39	46
	Range % S*	97-100	62-100	91-100	93-100	98-100
	# Antibiograms Included in Range	41	15	39	36	42
<i>E. faecium</i>	%S	31	94	98	31	53
	Total Isolates	1369	319	1631	1529	1669
	Total Antibiograms	31	8	30	28	32
	Range % S*	19-61	92-100	90-100	16-78	31-76
	# Antibiograms Included in Range	19	4	20	17	20
Enterococcus spp. ***	%S		67	100	85	86
	Total Isolates		669	1224	1207	1224
	Total Antibiograms		1	2	1	2
	Range % S*		67	100	85	87
	# Antibiograms Included in Range		1	1	1	1

* Range only reported when more than one facility and ≥ 30 isolates per facility

*** May include isolates from *E. faecalis* and/or *E. faecium*

2021 MINNESOTA STATEWIDE ACUTE CARE ANTIBIOGRAM

Staphylococcus aureus

		Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Gentamicin	Levofloxacin	Linezolid	Minocycline	Oxacillin	Penicillin	Rifampin	Trimethoprim-Sulfamethoxazole	Tetracycline	Vancomycin
MRSA	%S	37	71	99	89	18	96	40	100	95			99	93	89	100
	Total Isolates	1984	4966	2912	1075	4166	3750	3809	4666	299			3514	5117	4489	5117
	Total Antibiograms	18	31	16	6	28	25	24	29	1			20	32	29	32
	Range % S*	21-54	58-90	95-100	85-93	10-53	72-100	21-63	99-100	95			95-100	83-100	81-96	93-100
	# Antibiograms Included in Range	14	26	14	6	24	21	20	24	1			16	27	24	27
MSSA	%S	91	82	100	96	74	99	92	100	97	100	5	99	97	93	100
	Total Isolates	4782	11069	5756	3216	8793	7218	9387	9274	1086	11115	5947	6643	11115	8843	11115
	Total Antibiograms	18	30	14	6	27	22	24	25	1	30	14	17	30	26	30
	Range % S*	83-95	62-90	98-100	94-98	53-80	95-100	83-100	100-100	97	98-100	0-38	97-100	88-100	85-98	99-100
	# Antibiograms Included in Range	16	28	15	6	25	20	22	24	1	28	13	15	28	25	28
<i>S. aureus</i> ****	%S	76	80	100	94	58	98	77	100	100	70	16	99	95	91	99
	Total Isolates	2698	8690	1954	1432	7979	8242	6422	8011	153	7094	2633	7542	8795	8246	8795
	Total Antibiograms	8	19	6	3	17	17	15	17	1	16	8	15	19	18	19
	Range % S*	70-86	75-91	98-100	92-95	49-66	92-100	71-91	98-100	100	56-84	0-59	98-100	90-100	85-97	94-100
	# Antibiograms Included in Range	7	18	6	3	16	17	14	17	1	15	7	15	18	17	18

R = intrinsic resistance

MRSA = methicillin-resistant *Staphylococcus aureus*

MSSA = methicillin-susceptible *Staphylococcus aureus*

* Range only reported when more than one facility and ≥30 isolates per facility

**** May include MRSA and MSSA isolates

Group B *Streptococcus*

		Ampicillin	Cefotaxime	Ceftriaxone	Clindamycin	Erythromycin	Levofloxacin	Linezolid	Penicillin	Vancomycin
Group B <i>Streptococcus</i>	%S	100	100	100	48	38	99	100	100	100
	Total Isolates	812	644	1133	1158	1148	1053	585	1338	1307
	Total Antibiograms	17	11	19	22	20	20	12	25	24
	Range % S*	100-100	100-100	98-100	0-71	24-59	95-100	100-100	97-100	100-100
	# Antibiograms Included in Range	12	9	17	18	17	16	9	20	19

Streptococcus pneumoniae

		Ceftriaxone	Clindamycin	Doxycycline	Erythromycin	Levofloxacin	Linezolid	Meropenem	Penicillin (meningitis)	Penicillin (non-meningitis)	Trimethoprim-Sulfamethoxazole	Tetracycline	Vancomycin
<i>S. pneumoniae</i>	%S	99	90	87	53	99	100	94	68	96	80	87	100
	Total Isolates	619	451	84	662	647	161	217	665	677	741	445	716
	Total Antibiograms	17	16	1	20	20	7	6	16	14	21	16	19
	Range % S*	92-100	86-96	87	0-72	97-100	100-100	89-100	62-85	72-100	68-100	79-100	100-100
	# Antibiograms Included in Range	11	8	1	11	11	3	4	11	11	12	9	12

* Range only reported when more than one facility and ≥30 isolates per facility