LOUISIANA DEPARTMENT OF HEALTH
Public Health

The LOUISIANA ANTIBIOGRAM Louisiana Antibiotic Resistance 2014

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This report covers bacteria causing severe human infections and the antibiotics used to treat those infections. Resistance to other antimicrobials (antivirals, antifungals and anti-parasitic drugs) are not included for lack of systematic reporting and collection of comprehensive data.

Contents

1-Introduction

1.1-Bacterial resistance to antibiotics is a major threat to human health

Bacterial resistance to antibiotics is becoming a major threat to human health. Bacteria become resistant to antibiotics through mutation or acquisition of genes from other bacteria. Antibiotics work by affecting the cell wall, distorting the cell surface, inhibiting bacterial protein synthesis, or preventing DNA formation. Some bacteria have been able to adopt ways to become resistant to the actions of antibiotics; some have become resistant to several classes of antibiotics. Resistance often emerges first in hospitals because of selective pressure.

As antibiotic resistance was developing, medical science made progresses in treating illnesses that were fatal in older times. Therefore, there are now an increasing number of vulnerable patients with limited ability to fight infections (e.g. patients undergoing chemotherapy for cancer, dialysis for renal failure, and surgery, especially organ transplantation).

1.2-Tracking resistance patterns is a major action in the fight against antibiotic resistance

Most of the data published in the scientific literature on bacterial resistance is heavily influenced by limited surveys, case series and individual case reports. The data presented often comes from research institutions, tertiary care hospitals and other sources that are not representative of the "bacterial universe". These sources are biased toward reporting the unusual and more severe patterns. A report based on population-based data sets provides a more representative picture of drug resistance patterns.

The Louisiana Antibiotic Resistance Surveillance System was started in 1998 to track the emergence of antibiotic resistant organisms. The goal of the program is to estimate the proportion of selected bacteria in the state that are resistant to antibiotics.

2-Methods

2.1-Active surveillance

In the early period of resistance monitoring, an active surveillance system was implemented. A select group of hospitals were called each month to provide information on a brief reporting form. The reports included (1) the number isolates from selected species from their lab for each month, (2) the number of drug resistant or drug intermediate resistant isolates for each one of those micro-organisms. Duplicates were not to be counted. Each report was entered into a Microsoft® Access database and from this annual summary, reports were generated for the participating hospitals. This type of surveillance was cumber-some, therefore limited to a few microorganisms. It was abandoned for the antibiogram collection approach.

2.2-Antibiogram collection

In 2001, a NCCLS (National Committee for Clinical Laboratory Standards which became in 2005 the Clinical and Laboratory Standard Institute CLSI) subcommittee issued guidelines to use in analyzing and presenting cumulative antimicrobial susceptibility test data. They established standardized means of data extraction for all drugs tested and outlined how the data should be presented:

- Percent susceptibility for the first isolate from a patient within an analysis period (generally one year)
- Population tested (inpatient, ICU, or nursing home),
- Specimen source,
- Number of isolates tested (minimum 10 for each organism),
- Separate data for gram-negative, gram-positive, aerobic and anaerobic organisms,
- List drugs alphabetically, or by class,
- Avoid selective reporting (cascading): secondary agents reported only if isolate is resistant to the primary drug class.

Most hospitals issue once a year, an "antibiogram", which is a summary of the most important antibiotic resistance patterns for their hospital for the year. The antibiogram is a table listing the microorganisms in the left-most column and antibiotics in the remaining columns. The percent of organisms found to be resistant to each antibiotic is recorded in the table's cells. Some hospitals generate reports every three, six or 12 months. By issuing these frequent reports, there is a result in small numbers of isolates, and sometimes large variations in percentage from one quarter to the next. These variations are usually not sustained and variations are not significant.

The antibiogram shows the spectrum of sensitivity /resistance among the most common micro-organisms detected by the microbiology laboratory. It provides useful information for the selection of an empiric antibiotic treatment when a presumptive diagnosis of infection with specific bacteria is made. It is no longer useful once the specific bacteria have been identified and an antibiotic resistance established for the patient's specific infection.

There are some limitations when using a hospital antibiogram:

1-Most hospital laboratories do not sort-out community-acquired infections from hospital-acquired. The antibiotic resistance patterns for both groups may be substantially different. Gram-negative rods tend to be more prevalent in hospital infections, and more resistant if they originate from a hospital source.

2-Some laboratories do not thoroughly eliminate duplicate cultures from the same patients, so that resistant strains that tend to be cultured more often, this artificially inflate the proportion of resistance.

If constructed carefully and interpreted with caution, a hospital antibiogram is a useful tool.

The Statewide Louisiana Antibiogram

The Louisiana Antibiogram is not as useful as the individual hospital antibiogram for making empiric treatment decisions. However, it is useful to compare one individual hospital antibiogram to the rest of the state. Hospitals for which a specific antibiotic sensitivity is an outlier should investigate the reason for the discrepancy.

2.3-Analysis

The purpose of this analysis is to determine if there is a significant trend in the rates of antibiotic resistance for these microorganisms from 2000 to 2014, and to present the resistance data for the most recent period from 2013 and 2014.

2.3.1-Trend:

For micro-organisms of interest, a trend table is presented with the first column containing the number of resistant isolates, the second column with the number of isolates tested during the year and the third column with the percentage of resistant strains. Statistical tests presented are:

- The Cochrane-Armitage test for linear trend (CoArm) with χ2-square, degrees of freedom=1, and p-value (Abramson, J.H. Winpepi (Pepi-for-Windows®): computer programs for epidemiologists. Epidemiologic Perspectives & Innovations 2004, 1: 6)
- The simple linear regression analysis equation with rate per 100 = ax + b, a representing the slope of the linear trend line.

2.3.2-Recent data on resistance:

Recent data on resistance show resistance for 2013 with the total number of isolates tested, the average resistance in percentage and the range of resistance percentages observed (lowest and highest resistance observed in any hospital antibiogram).

3-Trends

3.1-Methicillin Susceptible *Staphylococcus aureus* (MSSA)

Staphylococcus aureus (SA), is a Gram-positive catalase-positive cocci typically seen in clusters on Gram stain. *Staphylococcus aureus* is the most important human pathogen of the Staphylococcal group. Its golden yellow pigment gives the species its name, though some isolates are non-pigmented. *S. aureus* is widespread in the population; about 30% are carriers, particularly in the nasal cavity, but also in the perineum, anal area and finger tips, among other areas. The most common infections include carbuncles, furuncles, cellulitis and wound infections. Food poisoning, toxic shock syndrome, acute endocarditis, septic arthritis, meningitis, osteomyelitis, pneumonia and septicemia are also seen. It is often isolated from nosocomial infections (10% to 20% of nosocomial infections), especially bacteremias, skin infections and surgical site infections.

Resistance due to penicillinase (an enzyme of the β-lactamase group) produced by *S.aureus,* developed as soon as penicillin was introduced for clinical use. This enzyme allows staphylococci to cleave the β-lactam ring of penicillin and neutralize its effectiveness. Nowadays, most *S.aureus* isolates are resistant to penicillin. The aminopenicillins (ampicillin, amoxicillin), carboxypenicillins (carbenicillin, ticarcillin), and ureidopenicillins (mezlocillin, piperacillin) are susceptible to neutralization by penicillinase-producing *S.aureus*. The preferred antibiotics for the treatment of MSSA are penicillinase-resistant penicillins. These antibiotics include nafcillin, oxacillin, methicillin, cloxacillin, and dicloxacillin.

Alternative drugs used in the treatment of methicillin sensitive *S.aureus* include:

- Amoxicillin-clavulanate
- Clindamycin if D test negative
- Doxycycline or minocycline plus Rifampin
- Moxifloxacin
- Trimethoprim-Sulfamethoxazole (TMP-SMX) plus rifampin
- Vancomycin, linezolid or daptomycin

Practically any infection caused by *Staphylococcus aureus* is presumed to be resistant to methicillin unless an antibiogram proves methicillin sensitivity.

2014 Methicillin Sensitive *Staph aureus* MSSA

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin	Penicillin G	608	84%	74%	88%
Penicillin Amino	Ampicillin	48	81%	81%	81%
Penicillin R β-lactamase	Oxacillin	3177	1%	0%	68%
Cephalosporin 1	Cefazolin	1207	0%	0%	0%
Penicillin & β-lactam Inhib	Clavulanic-Amoxicillin	822	0%	0%	0%
Lincosamides	Clindamycin	3404	17%	7%	35%
Rifamycin	Rifampin	1549	1%	0%	3%
Cyclines	Tetracycline	3086	7%	0%	13%
Cyclines	Doxycycline	68	15%	15%	15%
Macrolides	Erythromycin	2902	43%	25%	62%
Quinolone	Ciprofloxacin	1259	20%	10%	36%
Quinolone	Moxifloxacin	1046	11%	4%	27%
Aminoglycosides	Gentamicin	2033	1%	0%	4%
Sulfonamide	Trimethoprim-sulfa	3414	1%	0%	6%
Glycopolypeptide	Vancomycin	3414	0%	0%	0%
Lipopeptide	Daptomycin	656	0%	0%	3%
Oxazolidinone	Linezolid	1505	0%	0%	0%
Streptogramin	Quinu/Dalfopristin	505	0%	0%	3%

3.2-*Staphylococcus aureus* resistance to methicillin (oxacillin)

	***S.aureus*/Oxacillin (Methicillin)**		
	Res	**Total**	**% Res**
2000	1391	3798	36.6%
2001	645	1064	60.7%
2002	3076	4831	63.7%
2003	12025	20090	59.9%
2004	3830	7032	54.5%
2005	6047	8776	68.9%
2006	12594	18528	68.0%
2007	11480	17582	65.3%
2008	10790	16231	66.5%
2009	11328	17642	64.2%
2010	6589	11190	58.9%
2011	8310	15085	55.1%
2012	9060	15478	58.5%
2013	7869	13595	57.9%
2014	7694	13440	57.2%
CoArm	X2 42.66	df 1	p 0.000

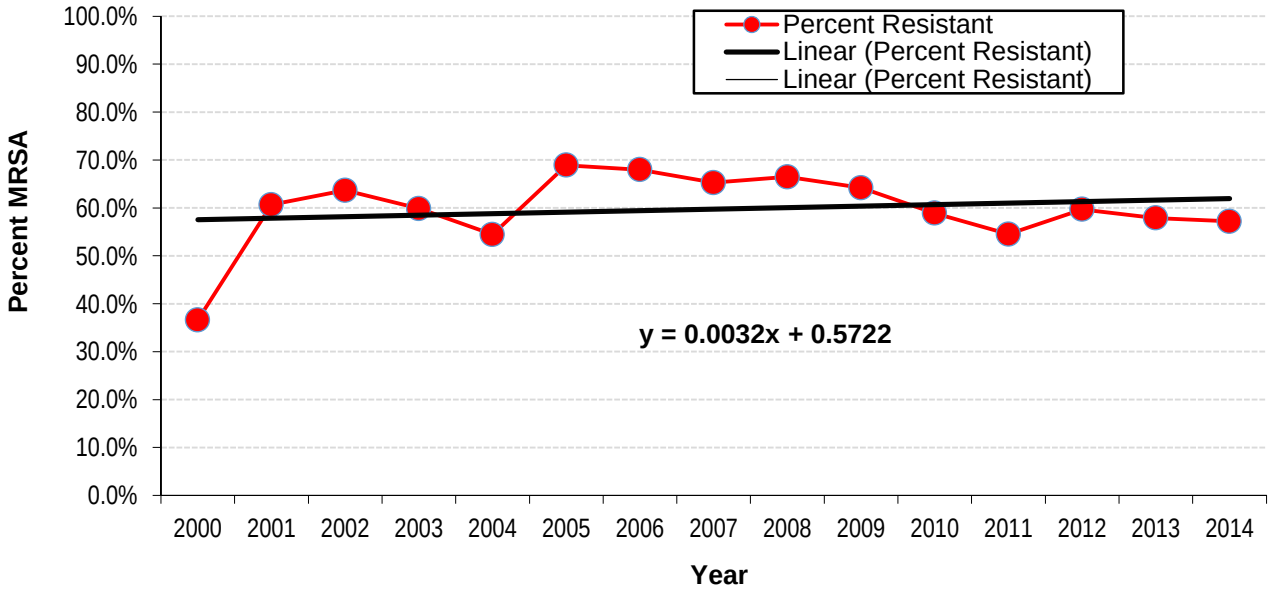
Methicillin Resistant *Staphylococcus aureus* (MRSA) is a growing problem both in the hospital and in the community. Resistance to methicillin is due to altered penicillin binding proteins.

S.aureus methicillin resistance resulted from a different mechanism. To overcome simple penicillin resistance, *S.aureus* was able to modify the site to which methicillin attaches (Penicillin Binding Protein), and thus became resistant to methicillin.

Methicillin results from the addition of large radicals (chemical chains) around the penicillin ring to provide protection against penicillinase. Methicillin is effective on *S.aureus* resistant to penicillin.

Acquisition of MRSA infections was a common concern among both patients and staff in acute and long-term care facilities, and now has become a concern for the general population.

The rates of methicillin-resistant *S. aureus* have increased from 2000 to 2005 from 38% to over 67%, and seemed to be stabilizing around 60% for a few years with a slight decline beginning in 2010.



3.3-History of MRSA: Health care-associated (HA-MRSA) and community-associated MRSA (CA-MRSA).

MRSA infections that are reported in this report have not been differentiated into community-associated (CA) MRSA (or SCC mec Type IV or V PVL positive), and hospital-associated (HA) MRSA (or SCC mec Type II/III). Most Type IV MRSA remains sensitive to TMP-SMX, clindamycin and fluoroquinolones, though some of these antibiotics may not be effective in vivo. Type II/III organisms tend to be sensitive only to vancomycin and newer agents like linezolid.

MRSA first appeared in hospitals, mostly as a nosocomial infection. MRSA was first recognized in 1961; one year after introduction of methicillin, resistant strains started to appear. The first documented MRSA outbreak in the U.S. was described at a Boston hospital in 1968. During the 1970s to the 1990s, most MRSA infections occurred in persons who had contact with hospitals or other health care facilities (HCF), hence the term healthcare-acquired or associated HA-MRSA. In the 1990s and 2000s, MRSA infections became more frequent among previously healthy individuals with no association with HCF. The acquisition of infections seems to have been from the community, hence the term community-acquired MRSA or CA-MRSA.

HA-MRSA causes mostly sporadic cases with the exception of a few strains causing epidemics in hospitals (EMRSA). Most MRSA were simple colonizers. HA-MRSA were not more virulent than other SA: there was no difference in animal lethality, production of enzymes or production of toxins associated with invasiveness. However this strain was resistant to most antibiotics except vancomycin and a few newer antibiotics.

CA-MRSA started to spread in the late 1990s and 2000s and soon was taking over HA-MRSA. CA-MRSA is known to be more virulent, causing frequent skin and soft tissue infections as well as invasive infections (septicemia and pneumonias). Experiments showed that CA-MRSA produces toxins more frequently than its counterpart. CA-MRSA became the dominant MRSA clone in the USA.

MRSA resistance results from four mec genes (named I to IV), consisting in chromosomal elements of 30 to 50-kilobase coding penicillin-binding proteins. The mecA gene encodes a PBP with low affinity for β-lactam antibiotics. The mecA gene complex is carried on specific integrative genetic element (staphylococcal cassette chromosome - SCC). This cassette includes: mec complex + cassette recombinase which integrate and excise SCCmec element on staphylococcal chromosome. Molecular strain typing is done by Pulse Field Gel Electrophoresis (PFGE), arbitrarily primed PCR, randomly amplified polymorphic DNA, plasmid fingerprinting and multilocus sequence typing (MLST).

The difference between CA-MRSA isolates and HA-MRSA isolates is the type of SCCmec. The SCCmec is a cluster of chromosomes in which the mecA gene is carried. Typical CA-MRSA has SCCmec type IV while typical HA_MRSA carries SCCmec types I and II. I and II are larger genes, which may be carrying resistance for trimethoprim-sulfa, clindamycin, and some other antibiotics.

The PFGE classification is widely used. It includes USA 100 and 200 (old CA-MRSA), and strains 300 to 1100. The USA 300 strain has spread into healthcare settings to become the dominant strain. In 2005: 22% community-associated MRSA diagnosed in HCF and 16% hospital-onset invasive MRSA were caused by USA 300 (Klevens RM, Morrison MA, Nadle J, et al. Invasive methicillin-resistant. *Staphylococcus aureus* infections in the United States. JAMA 2007; 298: 1763-1771).

The distinction between these two types of MRSA is becoming increasingly blurry. CA-MRSA, particularly USA 300, is emerging as the dominant MRSA strain in the community and in health care settings; hence the importance of monitoring the sensitivity of MRSA.

3.4-Other Antibiotics to which MRSA is resistant

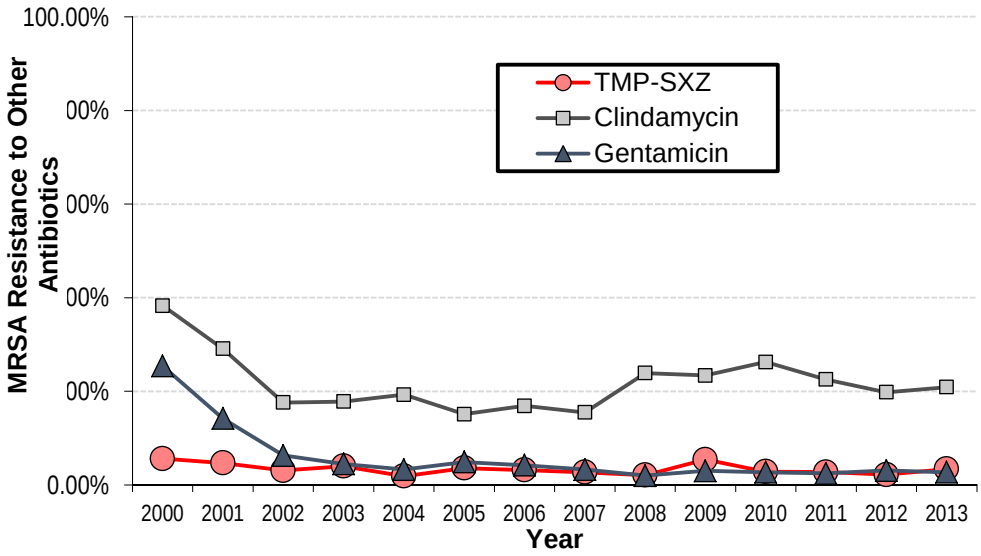
Many cutaneous abscesses respond to drainage alone, and most of the remaining Type IV MRSA infections can be treated with trimethoprim–sulfamethoxazole or a tetracycline, such as doxycycline or minocycline. For serious infections, other antibiotics may be required for treatment. Options include vancomycin, fluoroquinolones, daptomycin, quinupristin–dalfopristin, newer-generation carbapenems, and linezolid.

Quinolones, such as levofloxacin, or moxifloxacin, are effective orally and generally provide adequate coverage for CA-MRSA. Unfortunately, resistance is emerging among both MSSA and MRSA isolates; data suggest that overuse of quinolones promotes emergence of MRSA strains in the community.

Linezolid, an oxazolidinone, is useful for severe refractory MRSA infections and can also be administered orally. In some severely ill patients, linezolid therapy has proved to be more effective than vancomycin, but resistance is emerging and the drug should be reserved for serious infections.

The possibility of inducible clindamycin resistance has discouraged some physicians from prescribing clindamycin. The inducible macrolide-lincosamide-streptogramin B phenotype is related to the erm gene. Strains with inducible resistance will test clindamycin-susceptible in vitro, but are erythromycin-resistant. If inducible resistance is present, there is a potential for treatment failure with clindamycin, despite the culture and sensitivity report indicating susceptibility. Some laboratories issue a report stating that macrolide resistance may be a marker for inducible lincosamide resistance. If the clinician is considering

clindamycin, an erythromycin-clindamycin “D-zone” test is prudent. To perform a D-test, clindamycin and erythromycin disks are placed close together on a culture plate. If inducible lincosamide resistance is present, the zone of inhibition around the clindamycin disk is flattened on the side toward the erythromycin disk. This results in a zone of inhibition resembling a capital letter D instead of an O.



	MRSA								
	Azithromycin			Levofloxacin			Clindamycin*		
	Res	**Total**	**% Res**	**Res**	**Total**	**% Res**	**Res**	**Total**	**% Res**
2000	106	116	91.0%	335	401	83.5%	153	401	38.3%
2001	321	346	92.7%	404	591	68.4%	233	800	29.1%
2002	214	233	91.9%	359	797	45.0%	140	797	17.6%
2003	89	95	93.8%	454	1,224	37.1%	584	3,275	17.8%
2004	446	478	93.4%	649	1,943	33.4%	734	3,808	19.3%
2005	78	78	100.0%	809	1,882	43.0%	667	4,413	15.1%
2006	184	198	93.0%	1,127	2,730	41.3%	1,166	6,902	16.9%
2007	449	471	95.2%	1,302	2,924	44.5%	593	3,829	15.5%
2008	383	431	88.8%	3,044	6,594	46.2%	1,180	4,930	23.9%
2009	336	430	78.1%	1,571	3,233	48.6%	691	2,953	23.4%
2010	355	379	93.6%	2,319	3,843	60.3%	1,527	5,814	26.3%
2011	355	402	88.3%	2,062	3,759	54.9%	1,369	6,077	22.5%
2012	487	550	88.5%	4,000	7,076	56.5%	1,708	8,627	19.8%
2013	203	241	84.2%	2,482	4,012	61.9%	1,282	6,144	20.9%
2014	113	134	84.3%	2,209	3,442	64.2%	1,367	6,066	22.5%
CoArm	X2 30.58	df 1	p 0.000	X2 630.49	df 1	p 0.000	X2 55.00	df 1	p 0.000

*Reports made do not specify if D test was made.

	Gentamycin			Rifampin*			Trimethoprim/Sulfa			Linezolid		
	Res	**Total**	**% Res**	**Res**	**Total**	**% Res**	**Res**	**Total**	**% Res**	**Res**	**Total**	**% Res**
2000	102	401	25.4%	20	401	5.0%	33	598	5.6%			
2001	115	811	14.2%	27	739	3.7%	42	902	4.7%			
2002	39	617	6.3%	5	539	1.0%	24	797	3.1%	0	155	0.0%
2003	125	2,750	4.5%	8	550	1.4%	134	3,355	4.0%	0	340	0.0%
2004	125	3,788	3.3%	40	2,438	1.6%	68	3,608	1.9%	0	1867	0.0%
2005	239	4,830	4.9%	7	692	1.0%	198	5,518	3.6%	0	393	0.0%
2006	308	7,281	4.2%	50	3,067	1.6%	251	7,753	3.2%	0	1556	0.0%
2007	146	4,358	3.3%	57	3,579	1.6%	135	5,058	2.7%	0	3092	0.0%
2008	153	7,629	2.0%	97	6,634	1.5%	173	8,154	2.1%	0	6233	0.0%
2009	116	3,843	3.0%	56	3,355	1.7%	189	3,540	5.4%	0	2892	0.0%
2010	173	6,366	2.7%	117	5,031	2.3%	184	6,461	2.8%	11	4553	0.2%
2011	102	4,149	2.5%	78	5,439	1.4%	164	5,964	2.7%	6	3767	0.2%
2012	229	7,472	3.1%	103	6,376	1.6%	223	9,969	2.2%	14	6055	0.2%
2013	88	3,318	2.7%	68	3,827	1.8%	214	6,336	3.4%	4	4022	0.1%
2014	132	4,005	3.3%	70	4,041	1.7%	188	6,092	3.1%	0	3551	0.0%
CoArm	X2 244.60	df 1	p 0.000	X2 2.35	df 1	p 0.125	X2 8.73	df 1	p 0.003	X2 9.40	df 1	p 0.002

*Always to be used in conjunction with another antibiotic

In Louisiana, TMP-SMX retains a relatively high sensitivity for some MRSA, illustrating the pattern seen in community-acquired organisms. Vancomycin remains effective and is still the first-line drug in the treatment of life-threatening infections caused by MRSA or *S.aureus* of unknown sensitivity.

MRSA strains are consistently sensitive to vancomycin, linezolid and daptomycin. They are resistant to macrolides (75% to 100%), fluoroquinolones (60% to 80%), and clindamycin (20% to 40%). They are less resistant to aminoglycosides (5% to 6% in recent years) and trimethoprim-sulfamethoxazole (2% to 5%).

2014 Methicillin *S. aureus* (MRSA)

Group	**Antibiotic**	**Nbr Isol**	**Avg Res**	**Low Res**	**High Res**
Peniclillin R b-lactamase	Oxacillin	261	33%	33%	33%
Lincosamides	Clindamycin	6066	23%	12%	36%
Rifamycin	Rifampin	4041	2%	0%	12%
Cyclines	Tetracycline	5995	6%	1%	29%
Cyclines	Doxycycline	305	0%	0%	2%
Glycylcycline	Tigecycline	393	0%	0%	0%
Macrolides	Azithromycin	134	84%	84%	84%
Macrolides	Erythromycin	4431	87%	71%	90%
Quinolone	Ciprofloxacin	3009	67%	58%	79%
Quinolone	Moxifloxacin	1506	25%	15%	48%
Aminoglycosides	Gentamicin	4005	3%	0%	21%
Sulfonamide	Trimethoprim-sulfa	6092	3%	0%	9%
Glycopolypeptide	Vancomycin	6092	0%	0%	3%
Lipopeptide	Daptomycin	1674	0%	0%	4%
Oxazolidinone	Linezolid	3551	0%	0%	3%

3.5-Coagulase negative *Staphylococcus* (CONS)

CONS are habitual inhabitants of the skin with very low pathogenic potential. The group includes *S. epidermidis* and *S. saprophyticus*. They are commonly isolated as contaminants, especially in blood cultures, hence the requirements of two blood cultures to define a coagulase-negative staphylococcal blood stream infection. They may cause nosocomial infections in patients with severe underlying medical problems or indwelling prosthetic devices (due to its polysaccharide capsule causing adherence to devices). The great majority of coagulase-negative Staphylococcal nosocomial infections are septicemias in immunocompromised neonates (*S. epidermidis*), followed by conjunctivitis, urinary tract (*S. saprophyticus*), and skin infections. The treatment of coagulase-negative staphylococci depends on the organism and the type of infection. Treatment must ultimately be decided based on susceptibility testing of the isolate.

Coagulase-negative staphylococci from nosocomial infections, particularly *S. epidermidis* and *S. hemolyticus*, are usually resistant to multiple antibiotics, with more than 80% resistant to methicillin. The methicillin-resistance gene (mecA) is identical in *S. aureus* and *S. epidermidis*. Antibiotics to which most coagulase-negative staphylococci are susceptible in vitro include vancomycin, minocycline, linezolid, the combination streptogramin, quinupristin/dalfopristin, and daptomycin

Antibiotics to which most coagulase-negative staphylococci are susceptible in vitro include vancomycin, minocycline, linezolid, the combination streptogramin, quinupristin/dalfopristin, and daptomycin.

2014 *Staphylococcus*-Coagulase negative

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin	Penicillin G	310	85%	85%	85%
Penicillin Amino	Ampicillin	261	85%	85%	86%
Penicillin R b-lactamase	Oxacillin	4231	61%	0%	81%
Penicillin & b-lactam Inhib	Clavulanic-Amoxicillin	752	62%	50%	69%
Penicillin & b-lactam Inhib	Piperacillin/Tazobactam	320	0%	0%	0%
Cephalosporin 4	Cefepime	124	50%	50%	50%
Carbapenem	Imipenem	320	55%	50%	68%
Lincosamides	Clindamycin	4143	48%	25%	79%
Rifamycin	Rifampin	3149	4%	0%	12%
Macrolides	Azithromycin	261	67%	65%	68%
Cyclines	Doxycycline	276	22%	11%	23%
Cyclines	Tetracycline	4143	20%	10%	45%
Glycylcycline	Tigecycline	1414	5%	0%	7%
Quinolone	Ciprofloxacin	2174	53%	41%	68%
Quinolone	Levofloxacin	3382	49%	37%	60%
Quinolone	Moxifloxacin	740	30%	29%	33%
Aminoglycosides	Gentamicin	3860	18%	1%	35%
Sulfonamide	Trimethoprim-sulfa	3082	40%	0%	51%
Glycopolypeptide	Vancomycin	4296	1%	0%	6%
Lipopeptide	Daptomycin	1250	3%	0%	4%
Oxazolidinone	Linezolid	2110	1%	0%	10%
Streptogramin	Quinu/Dalfopristin	596	1%	0%	4%

2014 Methicillin Resistant *S. epidermidis* Coagulase-negative (MRSE)

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Lincosamides	Clindamycin	54	51%	51%	51%
Rifamycin	Rifampin	54	2%	2%	2%
Cyclines	Tetracycline	54	23%	23%	23%
Glycylcycline	Tigecycline	54	0%	0%	0%
Macrolides	Erythromycin	54	81%	81%	81%
Quinolone	Ciprofloxacin	54	74%	74%	74%
Quinolone	Moxifloxacin	54	42%	42%	42%
Aminoglycosides	Gentamicin	54	17%	17%	17%
Sulfonamide	Trimethoprim-sulfa	54	62%	62%	62%
Glycopolypeptide	Vancomycin	54	0%	0%	0%
Lipopeptide	Daptomycin	54	0%	0%	0%
Oxazolidinone	Linezolid	54	0%	0%	0%

3.6-*Streptococcus pneumoniae*

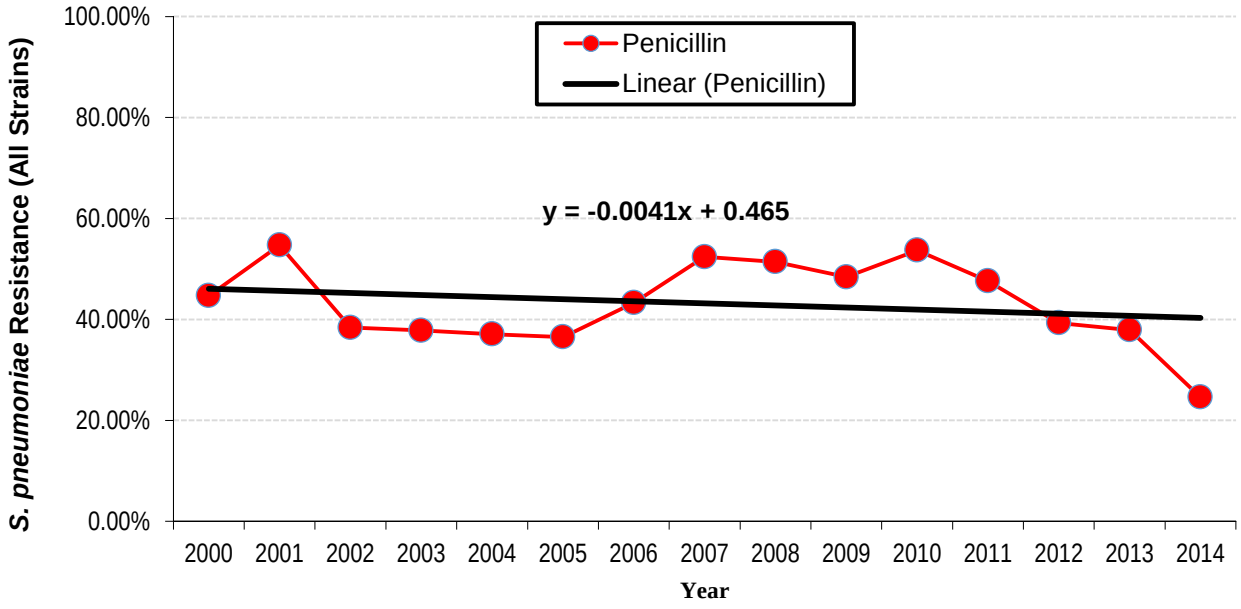
	S.pneumo /Peni		
	Res	**Total**	**% Res**
2000	108	242	44.7%
2001	60	110	54.7%
2002	154	400	38.4%
2003	317	839	37.8%
2004	153	414	37.1%
2005	232	635	36.5%
2006	322	744	43.3%
2007	727	1,388	52.4%
2008	498	970	51.4%
2009	317	655	48.4%
2010	410	764	53.7%
2011	529	1,112	47.6%
2012	683	1,747	39.1%
2013	481	1,269	37.9%
2014	248	1,008	24.6%
CoArm	X2 24.50	df 1	p 0.000

Streptococcus pneumoniae (Pneumococcus) is the most common cause of community-acquired pneumonia both in children and adults. It causes about half of all otitis media cases and it is a frequent cause of meningitis and sepsis. Mortality resulting from pneumococcal infections is high: pneumococcal pneumonia ranks among the 10 leading causes of death in many countries, with a case fatality rate of 5% for pneumonia, 20% for bacteremia and 30% for meningitis.

Many antibiograms do not specify the criteria used to differentiate between intermediate and full resistance and do not specify what is included in their tables. So the percent resistance should be assumed to be a compilation of intermediate and fully resistant.

Because sensitive and rapid diagnostic tests are not available, most pneumococcal infections are treated empirically at first. Until the 1970s, all pneumococcal isolates were sensitive to easily achievable levels of most commonly used antibiotics, including penicillins, macrolides, clindamycin, cephalosporins, rifampin, vancomycin, and trimethoprim-sulfamethoxazole. Beginning in the 1990s, many pneumococcal isolates in the US showed decreased susceptibility to penicillin and other commonly used antibiotics. In 2010, only 10.6% of all isolates obtained showed intermediate or resistant susceptibility patterns to penicillin (down from 24.8% in 2008; 25.6% in 2007). The prevalence of resistance varies greatly among countries, states, counties, and within populations in particular cities and may be as high as 30%-40% in some locations. In Louisiana rates of

resistance have been consistently high. Resistance to penicillin is associated with a decreased affinity of the antibiotic for penicillin-binding proteins present in the bacterial cell wall. Penicillin resistance is thought to be due to horizontal transfer of genes of altered penicillin-binding proteins with lowered affinity to penicillin and other β-lactams. Pneumococci have become resistant by acquiring genetic material from other bacteria with which they coexist in close proximity - presumably viridans streptococci in the nasopharynx. At least 30% of the pneumococcal strains in the U.S. show intermediate resistance to penicillin (MIC 0.1–2.0µg/ml). This type of resistance can be overcome if the antibiotic concentration at the site of infection exceeds the MIC of the organism for 40%-50% of the dosing interval.Except for meningitis patients, these are readily treatable with increased doses of penicillin.



Of more concern is the appearance of pneumococcal isolates that are regarded as highly resistant to penicillin (MIC ≥2.0µg/ml). It is suggested that the extended consumption of oral cephalosporins contributes to pneumococcal resistance to penicillin. If these strains are circulating, it might be more reliable to treat severe pneumococcal infections with vancomycin. However, the rate of resistance to other commonly used antibiotics such as erythromycin, tetracycline and trimethoprim-sulfamethoxazole is much greater in penicillin-resistant strains than in penicillin-sensitive strains

The susceptibility of *S. pneumoniae* to penicillin is currently defined by the NCCLS as follows: Susceptible isolates are inhibited by 0.06 µg/mL (i.e., minimal inhibitory concentration [MIC] ≤0.06 µg/mL). Isolates with reduced susceptibility (also known as intermediate resistance) are inhibited by 0.1 to 1.0 µg/mL, and resistant isolates are inhibited by 2.0 µg/mL or more. This definition was derived based on achievable concentrations of penicillin in CSF during treatment of children for meningitis. From a clinical point of view, the meaning of the MIC depends on the infection being treated. A strain with reduced susceptibility (e.g., MIC of 1.0 µg/mL) behaves as a susceptible organism when it causes pneumonia, but may not when it causes otitis, and does not when it causes meningitis. The recently revised definition of amoxicillin resistance (susceptible, MIC µg/mL; intermediately resistant, MIC 4 g/mL, resistant, MIC >8 g/mL) is based on serum levels, assuming that no physician would knowingly treat meningitis with this oral medication.

3.6-*Streptococcus* group A

Streptococcus Group A						
	Penicillin			Erythromycin		
	Res	Exam	%Res	Res	Exam	%Res
2008	0	588	0.0%	71	588	12.1%
2009	0	632	0.0%	94	632	14.9%
2010	0	608	0.0%	79	608	13.0%
2011	0	645	0.0%	90	645	14.0%
2012	0	529	0.0%	90	529	17.0%
2013	0	744	0.0%	112	744	15.1%
2014	0	716	0.0%	79	716	11.0%
CoArm				X2 0.00	df 1	p 0.967

***Streptococcus pyogenes*, the Group A Strep**, are β-hemolytic and are found in the naso-pharynx of healthy carriers. They may cause pharyngitis, the most common clinical expression. The drug of choice in the treatment of streptococcal infection is penicillin, because of its efficacy in the prevention of rheumatic fever, safety, narrow spectrum, and low cost. Oral cephalosporins are highly effective in the treatment of streptococcal pharyngitis. First-generation oral cephalosporins are acceptable alternatives in the penicillin-allergic patient whose allergy is not of the immediate type.

In penicillin-allergic patients, erythromycin is the therapy of choice. The newer macrolides (azithromycin, clarithromycin) appear to be effective. There have been reports of resistance to macrolides and azalide antibiotics from several countries.

There has also been considerable recent interest in abbreviated courses of antimicrobial therapy. It has been reported that clarithromycin, cefuroxime, cefixime, ceftibuten, cefdinir, cefpodoxime and azithromycin are effective in eradication of group A streptococci from the pharynx when administered for five days or less.

2014 *Streptococcus group A*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin	Penicillin G	716	0%	0%	0%
Cephalosporin 3	Cefotaxime	716	0%	0%	0%
Lincosamides	Clindamycin	716	9%	9%	9%
Macrolides	Erythromycin	716	11%	11%	11%
Glycopolypeptide	Vancomycin	716	0%	0%	0%

3.7-*Streptococcus* group B

Streptococcus agalactiae, the Group B Strep are partially β-hemolytic and can colonize the female genital tract which can lead to infection in the newborn. It is a cause of urinary tract infections (UTI) and IV line infections, especially in diabetics or the elderly. It is also a rare cause of subacute bacterial endocarditis (SBE).

Group B streptococci remain uniformly susceptible to penicillins and cephalosporins in vitro, and penicillin G is the drug of choice once the diagnosis is established. They are also susceptible to ampicillin, vancomycin, and teicoplanin. Meropenem and imipenem also have good in vitro activity. Increasing resistance to erythromycin (48%) and clindamycin (70%) restrict their use as empiric treatment for invasive infection or for intrapartum prophylaxis. Tetracycline resistance has increased to nearly 95%.

	Streptococcus Group B											
	Penicillin			Erythromycin			Tetracycline			Clindamycin		
	Res	Exam	%Res	Res	Exam	%Res	Res	Exam	%Res	Res	Exam	%Res
2000	1	102	1.2%	19	175	11.0%	54	62	87.0%	8	62	12.9%
2001	1	83	1.2%	1	83	1.2%	7	9	78.0%	1	9	11.1%
2002	11	1,047	1.0%	95	1,221	7.8%	1,011	1,130	89.5%	42	331	12.7%
2003	25	3,448	0.7%	996	2,585	38.5%	2,078	2,439	85.2%	485	2758	17.6%
2004	10	854	1.1%	208	563	36.9%	207	218	95.0%	160	677	23.6%
2005	6	935	0.7%	336	824	40.8%	732	873	83.8%	155	902	17.2%
2006	5	2,331	0.2%	1,071	2,143	50.0%	1,677	1,960	85.5%	535	2122	25.2%
2007	55	3,302	1.7%	400	798	50.2%	476	581	81.9%	818	2929	27.9%
2008	2	1,458	0.1%	1,572	2,089	75.3%	1,694	2,032	83.4%	1295	3141	41.2%
2009	3	2,157	0.1%	1,983	2,709	73.2%	2,249	2,628	85.6%	1973	2999	65.8%
2010	4	3,360	0.1%	2,376	2,864	83.0%	2,396	2,749	87.1%	1538	3299	46.6%
2011	5	856	0.6%	447	814	54.9%	568	686	82.8%	539	1216	44.3%
2012	7	1,188	0.6%	346	626	55.3%	532	641	83.0%	316	727	43.5%
2013	8	1,425	0.6%	470	853	55.1%	667	826	80.8%	390	896	43.5%
2014	7	805	0.9%	243	395	61.5%	660	809	81.6%	384	745	51.5%
Co Arm	X2 8.70	df 1	p 0.003	X2 927.12	df 1	p 0.000	X2 8.62	df 1	p 0.000	X2 303.1	df 1	p 0.000

2014 *Streptococcus group B, agalactiae*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin	Penicillin G	805	1%	0%	44%
Penicillin Amino	Ampicillin	992	0%	0%	0%
Cephalosporin 3	Ceftriaxone	575	2%	0%	22%
Cephalosporin 3	Cefotaxime	267	4%	3%	22%
Lincosamides	Clindamycin	745	52%	25%	74%
Cyclines	Tetracycline	809	82%	22%	90%
Chloramphenicol	Chloramphenicol	11	0%	0%	0%
Glycylcycline	Tigecycline	257	0%	0%	0%
Macrolides	Erythromycin	395	62%	48%	78%
Glycopolypeptide	Vancomycin	1157	0%	0%	0%
Quinolone	Levofloxacin	1104	2%	0%	8%
Aminoglycosides	Amikacin	283	1%	1%	1%
Sulfonimide	Trimethoprim-sulfa	11	33%	33%	33%
Oxazolidinone	Linezolid	593	0%	0%	0%
Streptogramin	Quinu/Dalfopristin	35	0%	0%	0%

3.8-*Streptococcus viridans* group

Streptococcus viridans is a group of streptococci which possesses no Lancefield antigens**.** They are most abundant in the mouth. *S. mutans,* is the etiologic agent of dental caries. They may cause other mouth or gingival infections, and if they are introduced into the bloodstream, may cause endocarditis. They are the most common causes of subacute bacterial endocarditis. For severe infections vancomycin and clindamycin remain the medication of choice.

2014 *Streptococcus viridans group*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin	Penicillin G	44	39%	39%	39%
Glycopolypeptide	Vancomycin	44	0%	0%	0%
Cephalosporin 3	Cefotaxime	44	18%	18%	18%
Lincosamides	Clindamycin	44	3%	3%	3%
Macrolides	Erythromycin	44	69%	69%	69%

3.9-*Enterococci* and Vancomycin Resistant *Enterococci*

Enterococci, formerly of the Streptococci are now part of the *Enterococcus* genus. These organisms grow under harsh conditions and are differentiated from the non-enterococcal group D streptococci in part by their ability to grow in 6.5% sodium chloride. Enterococci constitute a sizable portion of the normal flora of the gut. When there is disruption of mucosal or epithelial barriers, they can produce infection, including UTIs, endocarditis and intra-abdominal abscesses. *E. faecalis* is more common than *E. faecium* as a pathogen. Enterococci are difficult to treat because of extensive resistance to antibiotics used against Gram-positive cocci. They are intrinsically resistant to a large number of antibiotics, but can also easily acquire new mechanisms of resistance.

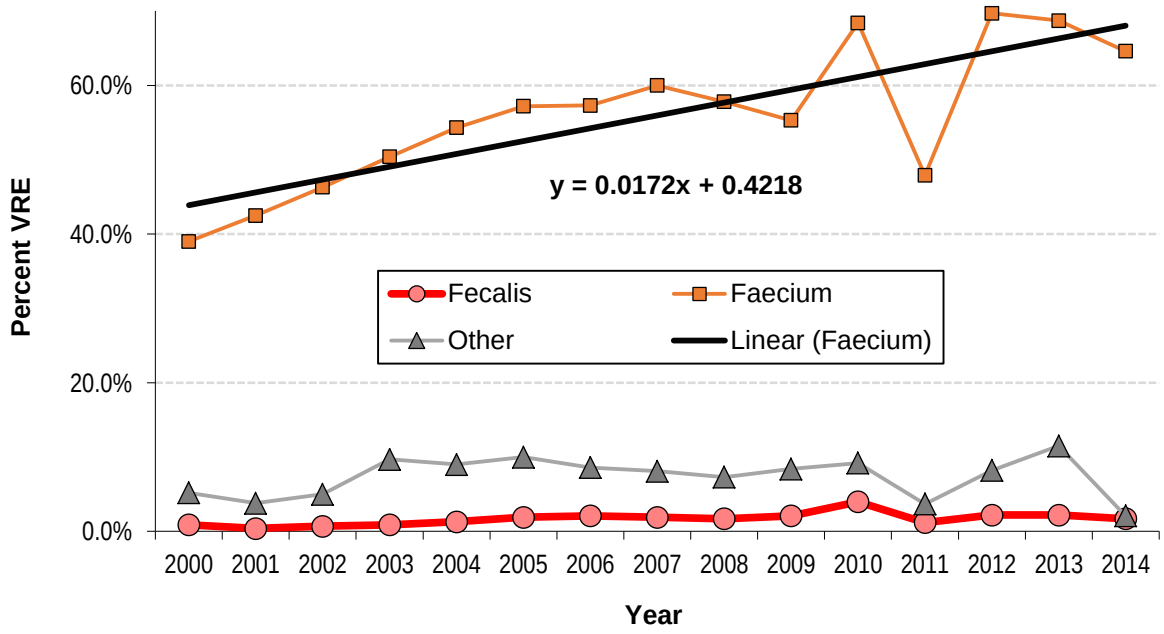
Enterococci are naturally fairly resistant to all β-lactam antibiotics because of the low affinity of their penicillin binding proteins. With the exception of cefoperazone, cephalosporins are not effective on them. They can also develop a more complete resistance to penicillin and ampicillin. Enterococci show a remarkable ability to acquire new mechanisms of resistance. As a result, susceptibility patterns vary considerably according to temporal and geographic variation. Aminoglycosides have difficulty penetrating through the outer envelope of the enterococci, but are used synergistically with penicillin or ampicillin in treatment. Enterococci have developed resistance to vancomycin (VRE) through a genetic mechanism which is also transferable within species, and possibly to other species.

Combinations of penicillin plus aminoglycosides produce bactericidal killing of enterococci. Unfortunately, enterococci can develop high-level resistance to streptomycin via chromosomal mutation. Strains of enterococci with high level resistance to streptomycin are not necessarily highly resistant to gentamicin and other aminoglycosides and, in recent years, penicillin (or ampicillin) plus gentamicin has become the standard of therapy for enterococcal endocarditis, meningitis, and other serious infections requiring bactericidal therapy. Unfortunately, the l980s and 1990s have seen a marked worldwide increase in strains of enterococci with genes that encode a bi-functional phosphor-transferase /acetyl-transferase enzyme that inactivates gentamicin and all other currently available aminoglycosides except streptomycin. Such organisms are not killed synergistically by combinations of gentamicin plus cell-wall-active antibiotics.

2014	Group	Antibiotic	Nbr Isolates	Average Res	Lo Res	High Res
Enterococcus faecalis	Penicillin Amimo	Ampicillin	10,236	2.5	0.0	33.8
	Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	52	5.8	5.8	5.8
	Quinolone	Nitrofurantoin	5,537	1.2	0.0	8.3
	Quinolone	Ciprofloxacin	3,820	39.5	20.0	66.7
	Cyclines	Doxycycline	224	75.9	72.3	79.5
	Glycylcycline	Tigecycline	2,975	0.0	0.0	0.0
	Aminoglycoside	Gentamicin	1,755	31.5	0.0	52.8
	Oxazolidinone	Linezolid	6,636	1.8	0.0	13.6
	Lipopeptide	Daptomycin	3,728	0.2	0.0	3.1
	Glycopolypeptide	Vancomycin	10,989	1.9	0.0	7.7
Enterococcus faecium	Penicillin Amino	Ampicillin	879	71.4	16.7	90.4
	Betalactamase	BetaLactamase	57	0.0	0.0	0
	Quinolone	Nitrofurantoin	549	50.6	0.0	90
	Quinolone	Ciprofloxacin	73	81.8	70.0	90.0
	Cyclines	Doxycycline	20	75.0	70.0	80.0
	Glycylcycline	Tigecycline	472	0.6	0.0	2.9
	Aminoglycoside	Gentamicin	330	13.8	0.0	25.2
	Oxazolidinone	Linezolid	933	2.7	0.0	10.7
	Lipopeptide	Daptomycin	462	7.0	0.0	28.6
	Glycopolypeptide	Vancomycin	1,525	56.8	0.0	84.0

The emergence of Vancomycin resistant strains of enterococci (VRE) in the past 20 years has led to increased risks of invasive VRE infections, with high lethality. Vancomycin resistant enterococcus is ubiquitous in the hospital environment, often found as a contaminant on medical equipment. Most patients are simply colonized and not infected (a ratio of 10:1). Persons at highest risk for VRE infections are those hospitalized with severe underlying or immunosuppressive conditions. These people may be affected by one of two mechanisms: drug resistance developed post-exposure to the antibiotic or via contact with the drug resistant pathogen (person-to-person or environmental).

	***E.Faecalis*/Vancomycin**			***E.Faecieum*/Vancomycin**			**E. spp/Vancomycin**		
	Res	**Exam**	**% Res**	**Res**	**Exam**	**% Res**	**Res**	**Exam**	**% Res**
2000	56	6,187	0.9%	240	615	39.0%	63	1,223	5.2%
2001	33	7,381	0.4%	327	769	42.5%	42	1,118	3.8%
2002	59	7,867	0.7%	378	817	46.3%	54	1,079	5.0%
2003	72	8,024	0.9%	414	821	50.4%	139	1,428	9.7%
2004	85	6,414	1.3%	376	693	54.3%	112	1,239	9.0%
2005	72	3,737	1.9%	289	505	57.2%	104	1,040	10.0%
2006	73	3,491	2.1%	276	482	57.3%	111	1,295	8.6%
2007	88	4,581	1.9%	446	743	60.0%	118	1,458	8.1%
2008	112	6,455	1.7%	524	907	57.8%	93	1,276	7.3%
2009	147	6,898	2.1%	538	973	55.3%	107	1,278	8.4%
2010	422	10,585	4.0%	1,256	1,837	68.4%	127	1,381	9.2%
2011	123	10,505	1.2%	641	1,339	47.9%	43	1,153	3.7%
2012	295	13,383	2.2%	1,388	1,990	69.7%	162	1,976	8.2%
2013	267	11,933	2.2%	1,263	1,839	68.7%	182	1,576	11.5%
2014	185	10,989	1.7%	985	1,525	64.6%	18	871	2.1%
CoArm	X2 180.91	df 1	p 0.000	X2 373.16	df 1	p 0.000	X2 5.47	df 1	p 0.019



Overall rates of Vancomycin Resistant Enterococcus showed a significant increase over the years.

3.10-*Neisseria meningitidis*

Neisseria meningitidis is a colonizer of a few percent of the population and also an important cause of septicemia and pyogenic meningitis. Reduced susceptibility to rifampin is of concern since this antibiotic is often used for prophylaxis of close contacts. The number of Neisseria meningitidis tested for antibiotic sensitivity is very small (less than 20 per year). Sensitivity to cephalosporins and rifampin remain at 100%. Currently, a third-generation cephalosporin (ceftriaxone orcefotaxime) is the drug of choice for the treatment of meningococcal meningitis and septicemia. Penicillin G, ampicillin, chloramphenicol, fluoroquinolone, and aztreonam are alternatives therapies (IDSA guidelines).Jun 15, 2016

3.11-*Haemophilus influenzae*

Haemophilus are Gram-negative bacilli specific to humans, normally colonizing the pharynx. They cause otitis media, sinusitis, conjunctivitis, bronchopneumonia, cellulitis and invasive disease such as meningitis and septic arthritis. Some strains of *H influenzae* possess a polysaccharide capsule, and these strains are serotyped into 6 different types (a-f) based on their biochemically different capsules. The most virulent strain is *H influenzae* type b (Hib). Some *H influenzae* strains have no capsule and are termed nonencapsulated *H influenza* or nontypeable *H influenzae* (NTHi) (Medscape website 2016).

Parenteral antibiotics (eg, ceftriaxone, ceftazidime, cefotaxime, ampicillin-sulbactam, fluoroquinolones,) to patients with uncomplicated meningitis for 7-14 days. Resistance to macrolides is high. Cefotaxime and ceftriaxone are the initial drugs of choice for suspected Hib meningitis.

	Haemophilus influenzae								
	Ceftriaxone			**Macrolides**			**Fluoroquinolones**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	0	129	0.0%				0	121	0.0%
2001	0	14	0.0%				0	95	0.0%
2002	0	115	0.0%				0	18	0.0%
2003	1	187	0.4%				0	34	0.0%
2004	3	85	3.8%				0	84	0.0%
2005	0	43	0.0%	1	13	8.0%	0	43	0.0%
2006	0	38	0.0%	4	28	14.0%	1	38	3.0%
2007	6	293	2.1%	16	65	25.0%	1	126	0.9%
2008	0	138	0.0%	19	46	41.0%	0	102	0.0%
2009	0	154	0.0%	24	75	32.0%	0	60	0.0%
2010	0	108	0.0%	28	88	32.0%	0	56	0.0%
2011	0	205	0.0%	12	62	19.4%	0	30	0.0%
2012	0	279	0.0%	27	92	29.3%	0	39	0.0%
2013	1	115	0.9%	30	81	37.0%	0	24	0.0%
2014	0	50	0.0%	12	58	20.7%	1	10	10.0%
Co Arm				X2 0.61	df 1	p 0.436			

2014 *Haemophilus influenzae*

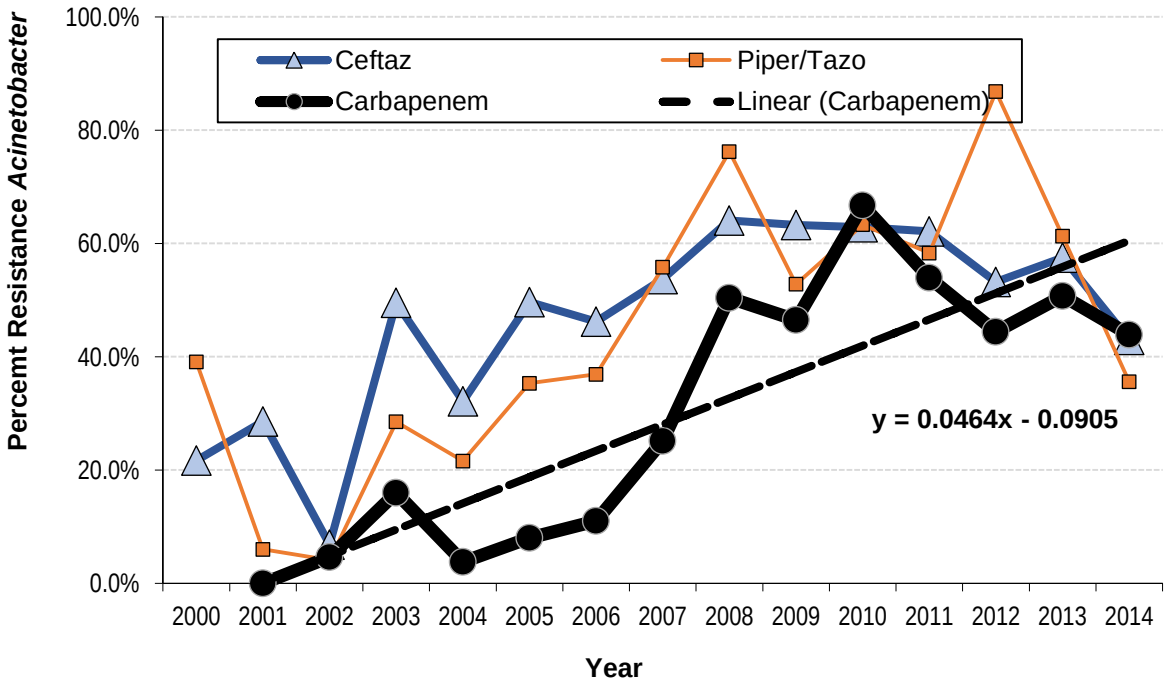
Group	Antibiotic	Isolates	Average	Lo	Hi
Penicillin Amino	Ampicillin	180	44.5	83.0	44.5
Betalactamase	BetaLactamase	228	0.0	0.0	0.0
Penicillin & β-lactam Inhib	Clavulanic-Amoxicillin	58	1.0	1.7	1.7
Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	10	0.0	0.0	0.0
Cephalosporin 3	Cefixime	58	0.0	0.0	0.0
Cephalosporin 3	Cefotaxime	98	0.0	0.0	0.0
Cephalosporin 3	Ceftriaxone	50	0.0	0.0	0.0
Macrolide	Clarithromycin	58	20.7	12.0	20.7
Quinolone	Levofloxacin	10	10.0	1.0	10.0
Cycline	Tetracycline	10	0.0	0.0	0.0
Carbapenem	Meropenem	58	0.0	0.0	0.0

3.12-*Acinetobacter*

Acinetobacter are small non-motile Gram-negative bacilli from the *Neisseriaceae* family. They have been designated *Mima*, *Herellea* and *Micrococcus* in the past. They are free-living organisms extremely common in food, water and on environmental surfaces. In humans, they are common in sputum, urine, feces and vaginal secretions. About 25% of adults are colonized. They are becoming a more common cause of nosocomial infections, usually ventilator-associated pneumonia, line sepsis or burn wound sepsis.

A baumannii is intrinsically multidrug resistant. Relatively few antibiotics are active against this organism.

	Acinetobacter								
	Ceftazidime			Pieracillin/Tazobactam			Carbapenem (class)		
	Res	Total	% Res	Res	Total	% Res	Res	Total	% Res
2000	19	88	21.6%	84	215	39.1%			
2001	21	75	28.0%	3	50	6.0%	0	11	0.0%
2002	4	59	6.8%	2	49	4.1%	2	44	4.6%
2003	343	692	49.6%	158	554	28.5%	67	419	16.0%
2004	42	131	32.1%	42	194	21.6%	7	173	3.8%
2005	93	187	49.7%	66	187	35.3%	2	30	8.0%
2006	152	329	46.2%	101	274	36.9%	8	75	11.0%
2007	347	646	53.7%	130	233	55.8%	148	589	25.1%
2008	701	1,095	64.0%	412	541	76.2%	655	1300	50.4%
2009	389	614	63.4%	245	464	52.8%	421	906	46.5%
2010	455	724	62.8%	188	297	63.3%	738	1107	66.7%
2011	595	958	62.1%	95	163	58.3%	556	1031	53.9%
2012	589	1,107	53.2%	203	234	86.8%	648	1459	44.4%
2013	412	716	57.5%	49	80	61.3%	514	1013	50.7%
2014	222	516	43.0%	21	59	35.6%	298	679	43.9%
CoArm	X2 39.19	df 1	p 0.000	X2 326.88	df 1	p 0.000	X2 238.27	df 1	p 0.000



2014 *Acinetobacter*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Ureido	Piperacillin	41	53%	52%	55%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	139	46%	17%	64%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	59	35%	34%	37%
Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	449	43%	10%	57%
Cephalosporin 3	Cefotaxime	90	60%	33%	73%
Cephalosporin 3	Ceftazidime	516	43%	0%	70%
Cephalosporin 3	Ceftriaxone	365	67%	53%	81%
Cephalosporin 4	Cefepime	500	50%	27%	71%
Carbapenem	Imipenem	279	42%	25%	62%
Carbapenem	Meropenem	400	46%	20%	68%
Cyclines	Tetracycline	244	45%	24%	64%
Glycylcycline	Tigecycline	37	51%	51%	51%
Quinolone	Ciprofloxacin	616	50%	7%	73%
Quinolone	Levofloxacin	394	47%	29%	65%
Aminoglycosides	Amikacin	360	29%	7%	43%
Aminoglycosides	Gentamicin	691	33%	0%	47%
Aminoglycosides	Tobramycin	506	32%	13%	47%
Sulfonamide	Trimethoprim-sulfa	661	39%	0%	60%

There is a huge increase in resistance to imipenem which went from 0% in 2001 to 67% in 2010.

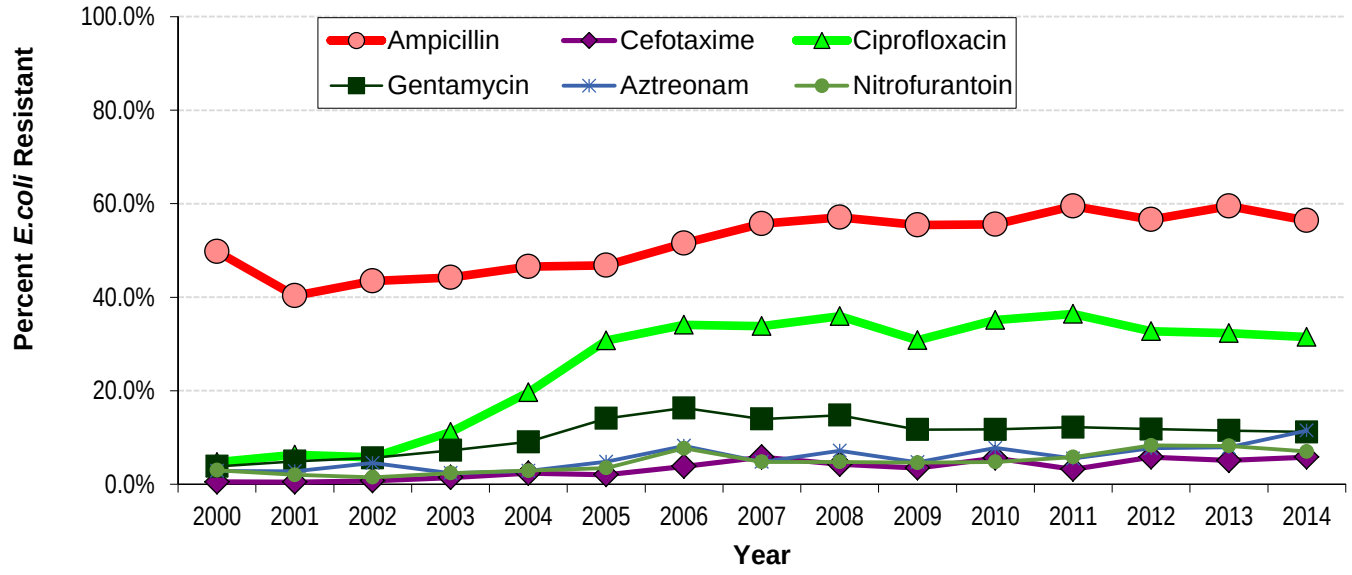
3.13-*Enterobacteriaceae*

Enterobacteriaceae is a large group of Gram-negative organisms which are widely distributed in the soil and are normal colonizers of the intestinal tract of humans and animals. They are an important cause of infection when found outside the gastrointestinal tract. They account for 30% of all nosocomial infectious agents isolated (30% of septicemia isolates, 20% of surgical site infections, 55% of urinary tract isolates and 20% of pulmonary infections isolates). Among the enterobacteriaceae, *Escherichia coli*, *Klebsiella, Proteus, Salmonella, Shigella* and *Enterobacter* are the most important pathogens.

3.13.1-*E.coli*

E.coli is a normal inhabitant of the human gastrointestinal tract. It produces disease when it is in other habitats such as the urinary tract, biliary tract, blood or meninges. A few isolates are not part of the human flora and when introduced in humans cause gastroenteritis (entero-toxigenic, entero-invasive and entero-hemorrhagic *E. coli*).

	E. Coli								
	Gentamycin			**Aztreonam**			**Nitrofurantoin**		
	Res	**Exam**	**%Res**	**Res**	**Exam**	**%Res**	**Res**	**Exam**	**%Res**
2000	268	6,996	3.8%	117	4,059	2.9%	187	6,243	3.0%
2001	136	2,770	4.9%	54	1,935	2.8%	24	1,207	2.0%
2002	522	9,235	5.6%	173	3,782	4.6%	118	7,766	1.5%
2003	2,367	32,685	7.2%	293	12,297	2.4%	507	21,499	2.4%
2004	1,507	16,644	9.1%	191	6,658	2.9%	333	11,340	2.9%
2005	2,240	15,894	14.1%	382	7,902	4.8%	345	9,744	3.5%
2006	4,395	26,941	16.3%	1,110	13,550	8.2%	1,296	16,856	7.7%
2007	3,550	25,406	14.0%	850	17,794	4.8%	947	19,784	4.8%
2008	5,020	33,981	14.8%	2,023	28,236	7.2%	1,537	31,894	4.8%
2009	4,407	37,724	11.7%	1,309	27,687	4.7%	1,008	21,774	4.6%
2010	2,834	24,163	11.7%	1,091	14,056	7.8%	971	20,182	4.8%
2011	4,331	35,428	12.2%	1,221	22,317	5.5%	1,787	30,579	5.8%
2012	6,678	56,784	11.8%	2,663	34,680	7.7%	3,048	36,919	8.3%
2013	6,098	53,174	11.5%	2,776	35,184	7.9%	2,979	36,246	8.2%
2014	5,935	52,980	11.2%	3,948	34,362	11.5%	2,411	34,360	7.0%
CoArm	X2 244.40	df 1	p 0.00	X2 1479.69	df 1	p 0.00	X2 1567.42	df 1	p 0.00



2014 *E.coli*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Amino	Ampicillin	46577	56%	37%	83%
Penicillin Ureido	Piperacillin	4202	54%	44	67%
Penicillin & β-lactam Inhib	Clavulanic-Amoxicillin	31243	22%	13%	44%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	17980	13%	13%	18%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	48800	4%	0%	27%
Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	41323	54%	32%	86%
Carbapenem	Carbapenem	817	0%	0%	0%
Carbapenem	Ertapenem	30201	1%	0%	4%
Carbapenem	Imipenem	26088	1%	0%	4%
Carbapenem	Meropenem	33942	1%	0%	4%
Monobactam	Aztreonam	34362	11%	0%	40%
Cephalosporin 1	Cephalothin	5186	59%	53%	71%
Cephalosporin 1	Cefazolin	48602	13%	2%	62%
Cephalosporin 2	Cefotetan	1905	1%	0%	1%
Cephalosporin 2	Cefoxitin	9048	12%	2%	22%
Cephalosporin 3	Cefotaxime	7123	6%	1%	14%
Cephalosporin 3	Ceftazidime	41987	5%	0%	18%
Cephalosporin 3	Ceftriaxone	52355	6%	0%	29%
Cephalosporin 4	Cefepime	48003	4%	0%	29%
Cyclines	Tetracycline	26700	27%	7%	42%
Cyclines	Doxycycline	512	19%	19%	19%
Glycylcycline	Tigecycline	4153	0%	0%	0%
Aminoglycosides	Amikacin	45577	1%	0%	4%
Aminoglycosides	Gentamicin	52980	11%	0%	42%
Aminoglycosides	Tobramycin	51677	12%	0%	50%
Quinolone	Nitrofurantoin	34360	7%	1%	27%
Quinolone	Ciprofloxacin	50612	32%	10%	64%
Quinolone	Levofloxacin	34329	34%	10%	64%
Quinolone	Moxifloxacin	15868	28%	0%	61%
Sulfonamide	Trimethoprim-sulfa	53596	33%	17%	71%

- Ampicillin resistance is found in many *E.coli* strains due to their production of extended spectrum beta lactamase (ESBL). Sensitivity to ampicillin has steadily increased to 55% overall in Louisiana. Resistance to cephalosporins is also increasing:
  - *E.coli* has become very resistant to ciprofloxacin in the early 2000s
  - Resistance to aminoglycosides has also been increasing around 2004
  - Although not as sharply, resistance to aztreonam is also increasing.

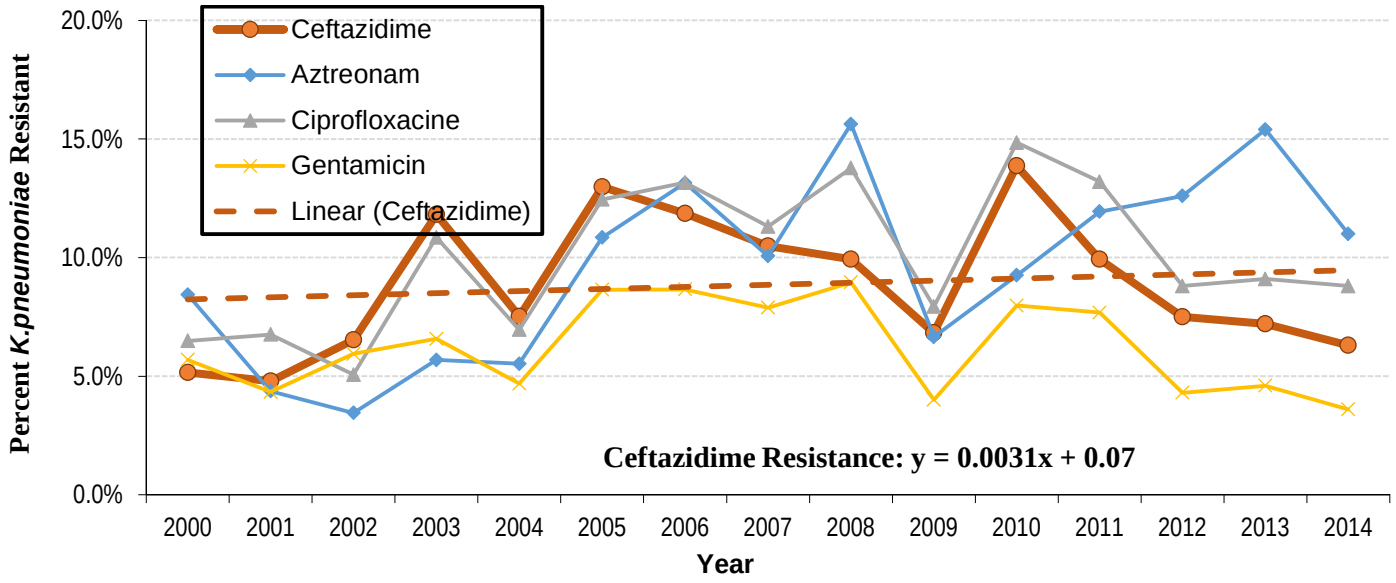
Antibiotics of choice include third generation cephalosporins, fluoroquinolones, trimethoprim/sulfamethoxazole, nitrofurantoin, piperacillin/tazobactam, imipenem/cilastin, and meropenem.

3.13.2-*Klebsiella Pneumoniae*

Klebsiella pneumoniae may cause community acquired lobar pneumonia in patients with severe underlying medical conditions. More importantly, these organisms have a predisposition to cause nosocomial infections such as ventilator associated pneumonia, meningitis, cellulitis and UTIs. It is the most common pathogen in ICUs.

Klebsiella pneumoniae									
	Ampicillin			**Ceftazidime**			**Aztreonam**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	1,531	1,721	89.0%	56	1,088	5.2%	93	1,097	8.4%
2001	541	578	93.7%	41	860	4.8%	32	737	4.4%
2002	2,209	2,245	98.4%	135	2,071	6.5%	34	984	3.5%
2003	6,496	6,652	97.7%	720	6,093	11.8%	186	3,281	5.7%
2004	3,438	3,557	96.7%	191	2,536	7.5%	122	2,212	5.5%
2005	2,259	2,316	97.6%	305	2,349	13.0%	279	2,571	10.8%
2006	4,269	4,473	95.4%	521	4,393	11.9%	433	3,290	13.1%
2007	4,764	4,824	98.7%	733	6,989	10.5%	606	6,016	10.1%
2008	4,327	4,631	93.4%	848	8,540	9.9%	1,188	7,598	15.6%
2009	378	385	98.1%	474	6,948	6.8%	1,001	15,036	6.7%
2010	389	479	81.2%	712	5,134	13.9%	187	2,019	9.3%
2011	323	341	94.7%	678	6,818	9.9%	724	6,062	11.9%
2012	0	0	0.0%	713	8,491	8.4%	1,011	8,466	11.9%
2013	0	0	0.0%	542	7,546	7.2%	1,167	7,556	15.4%
2014	0	0	0.0%	562	8,986	6.3%	850	7,701	11.0%
CoArm				X2 63.19	df 1	p 0.000	X2 204.61	df 1	p 0.00

	Cipro			**Gentamicin**			**Carbapenem (class)**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	75	1,151	6.5%	112	1,969	5.7%	6	1,848	0.3%
2001	58	854	6.8%	47	1,087	4.3%	8	909	0.8%
2002	68	1,340	5.1%	148	2,500	5.9%	6	2,336	0.3%
2003	769	7,091	10.9%	615	9,353	6.6%	20	6,021	0.3%
2004	228	3,272	7.0%	200	4,273	4.7%	34	3,199	1.1%
2005	322	2,586	12.5%	349	4,039	8.6%	0	3,064	0.0%
2006	487	3,704	13.2%	560	6,467	8.7%	186	5,026	3.7%
2007	641	5,671	11.3%	627	7,952	7.9%	37	9,616	0.4%
2008	877	6,365	13.8%	881	9,840	9.0%	95	13,759	0.7%
2009	499	6,294	7.9%	344	8,591	4.0%	91	12,945	0.7%
2010	635	4,276	14.8%	493	6,175	8.0%	42	6,191	0.7%
2011	1,127	8,543	13.2%	691	8,995	7.7%	151	16,270	0.9%
2012	1,073	11,447	9.4%	573	12,255	4.7%	230	21,328	1.1%
2013	967	10,584	9.1%	513	11,132	4.6%	235	20,311	1.2%
2014	927	10,476	8.8%	401	11,257	3.6%	398	20,885	1.9%
CoArm	X2 1.16	df 1	p 0.282	X2 124.99	df 1	p 0.000	X2 96.10	df 1	p 0.000



2014 *Klebsiella pneumonia*

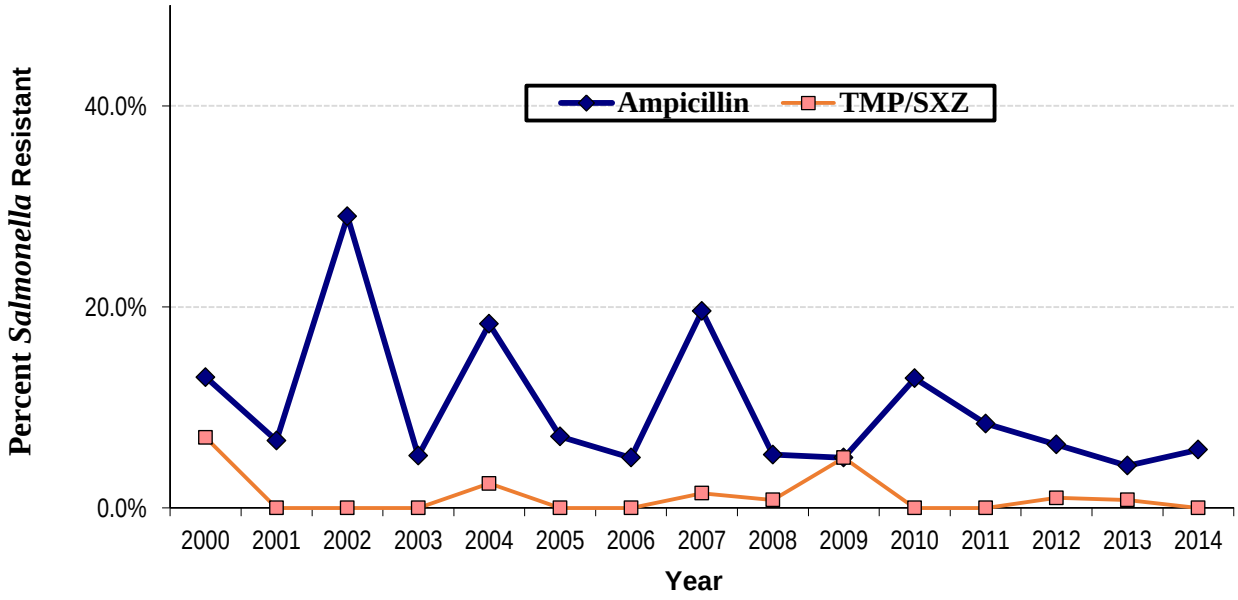
Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Ureido	Piperacillin	258	44%	37%	62%
Penicillin & β-lactam Inhib	Clavulanic-Amoxicillin	6021	9%	0%	30%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	3300	7%	0%	23%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	10372	6%	0%	19%
Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	8847	23%	4%	53%
Cephalosporin 1	Cephalothin	652	20%	10%	31%
Cephalosporin 1	Cefazolin	10070	10%	0%	72%
Cephalosporin 2	Cefoxitin	2155	8%	0%	23%
Cephalosporin 3	Ceftazidime	8986	6%	0%	26%
Cephalosporin 3	Ceftriaxone	10948	8%	0%	72%
Cephalosporin 4	Cefepime	10026	7%	0%	72%
Carbapenem	Carbapenem	185	0%	0%	0%
Carbapenem	Ertapenem	6123	1%	0%	4%
Carbapenem	Imipenem	5792	1%	0%	4%
Carbapenem	Meropenem	7426	4%	0%	91%
Cyclines	Doxycycline	39	21%	21%	21%
Glycylcycline	Tigecycline	1134	3%	0%	11%
Quinolone	Nitrofurantoin	6719	67%	29%	89%
Quinolone	Levofloxacin	7436	8%	0%	56%
Quinolone	Moxifloxacin	3091	11%	0%	38%
Aminoglycosides	Amikacin	9988	2%	0%	90%
Aminoglycosides	Gentamicin	11257	4%	0%	50%
Aminoglycosides	Tobramycin	10386	7%	0%	50%
Sulfonamide	Trimethoprim-sulfa	11180	12%	0%	40%

Antibiotics of choice include third-generaltion cephalosporins, carbapenems, aminoglycosides, and quinolones. These antibiotics may be used as monotherapy or combination therapy. Other antibiotics that may be used are ampicillin/sulbactam, piperacillin/tazobactam, ticarcillin/clavulanate, and cefepime.

3.13.3-*Salmonella*

Salmonella is a group of organisms containing numerous serotypes, many of which are pathogenic for both animals and humans. The human pathogens are within the species *S. enterica*. Ingestion of contaminated food is the main mode of transmission with a few cases originating from contaminated water or from person-to-person transmission via the fecal-oral route. Gastroenteritis and enteric fever are the main clinical syndromes observed. *Salmonella* is periodically the source of foodborne outbreaks, usually arising from undercooked egg products, raw dairy, or contaminated meat.

	***Salmonella* spp**											
	Ampicillin			**TMP-SXZ**			**Cefotaxime**			**Ciprofloxacin**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	2	16	13.0%	1	16	7.0%	0	16	0.0%			
2001	1	15	6.7%	0	12	0.0%	0	15	0.0%			
2002	2	7	29.0%	0	7	0.0%	0	12	0.0%	0	7	0.0%
2003	1	19	5.2%	0	19	0.0%	0	7	0.0%	0	18	0.0%
2004	7	38	18.3%	1	41	2.4%	0	7	0.0%	0	40	0.0%
2005	2	27	7.1%	0	27	0.0%	0	6	0.0%	0	27	0.0%
2006	6	113	5.0%	0	118	0.0%	0	118	0.0%	1	118	0.8%
2007	29	146	19.6%	2	142	1.5%	0	4	0.0%	0	142	0.0%
2008	7	127	5.3%	1	127	0.8%	0	22	0.0%	0	112	0.0%
2009	2	41	5.0%	2	41	5.0%	0	41	0.0%	0	41	0.0%
2010	18	136	12.9%	0	146	0.0%	0	61	0.0%	0	136	0.0%
2011	13	154	8.4%	0	154	0.0%	0	75	0.0%	0	154	0.0%
2012	12	191	6.3%	2	191	1.0%	0	83	0.0%	1	171	0.6%
2013	5	120	4.2%	1	132	0.8%	0	43	0.0%	1	132	0.8%
2014	8	138	5.8%	0	228	0.0%	0	72	0.0%	0	138	0.0%
CoArm	X2 7.99	df 1	p 0.005									



In most cases of simple enterocolitis due to *Salmonella*, no treatment is necessary. They do not appear to shorten the duration of symptoms and may prolong the carrier state. For severe enterocolitis and invasive disease (typhoid fever, paratyphoid fever) treatment is recommended. Antibiotics recommended include quinolone, macrolide, and third-generation cephalosporin pending sensitivities.

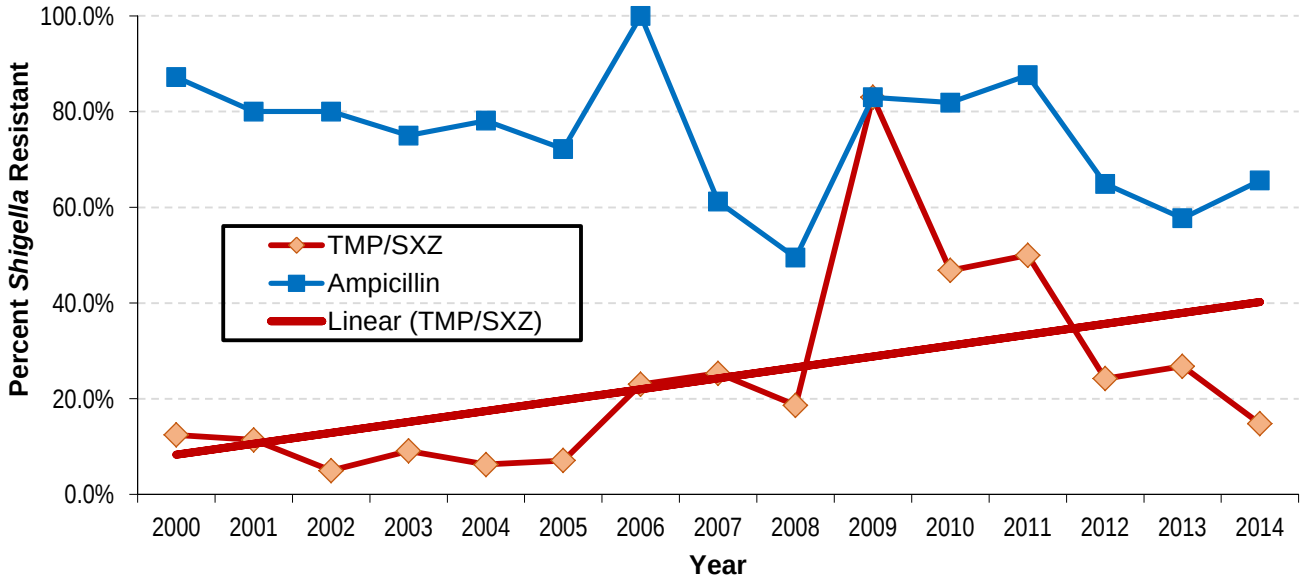
2014 *Salmonella*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Amino	Ampicillin	138	6%	0%	7%
Cephalosporin 3	Cefotaxime	72	0%	0%	0%
Quinolone	Ciprofloxacin	138	0%	0%	0%
Sulfonamide	Trimethoprim-sulfa	228	0%	0%	0%

3.13.4-*Shigella*

Shigella are responsible for acute gastroenteritis and bacillary dysentery transmitted by the fecal-oral route. It is a frequent cause of community outbreaks, particularly among day-care centers, homosexual men, and in overcrowded or unsanitary conditions.

	Shigella spp											
	Ampicillin			**TMP-SXZ**			**Cephalo 3**			**Ciprofloxacin**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	41	47	87.2%	6	47	12.4%	0	12	0.0%			
2001	4	5	80.0%	4	35	11.4%	0	10	0.0%	0	5	
2002	8	10	80.0%	2	41	5.0%	0	9	0.0%	0	1	0.0%
2003	9	12	75.0%	3	33	9.1%	0	7	0.0%	0	1	0.0%
2004	25	32	78.1%	2	32	6.3%	0	25	0.0%	0	31	0.0%
2005	26	36	72.2%	2	31	7.1%	0	1	0.0%	0	1	0.0%
2006	110	110	100.0%	25	110	23.0%	0	110	0.0%	1	110	0.9%
2007	97	158	61.2%	40	158	25.3%	0	52	0.0%	0	158	0.0%
2008	50	101	49.5%	19	102	18.6%	0	19	0.0%	0	104	0.0%
2009	5	6	83.0%	5	6	83.0%	0	15	0.0%	0	6	0.0%
2010	77	94	81.9%	44	94	46.8%	0	0	0.0%	0	94	0.0%
2011	113	129	87.6%	69	138	50.0%	0	75	0.0%	0	129	0.0%
2012	87	134	64.9%	32	132	24.2%	0	134	0.0%	0	134	0.0%
2013	41	71	57.7%	19	71	26.8%	0	71	0.0%	0	71	0.0%
2014	40	61	65.6%	9	61	14.8%	0	61	0.0%	0	61	0.0%
CoArm	X2 10.07	df 1	p 0.002	X2 31.63	df 1	p 0.00						



2014 *Shigella*

Group	**Antibiotic**	**Nbr Isol**	**Avg Res**	**Low Res**	**High Res**
Penicillin Amino	Ampicillin	61	66%	66%	66%
Cephalosporin 3	Ceftriaxone	61	0%	0%	0%
Quinolone	Ciprofloxacin	61	0%	0%	0%
Sulfonamide	Trimethoprim-sulfa	61	15%	15%	15%

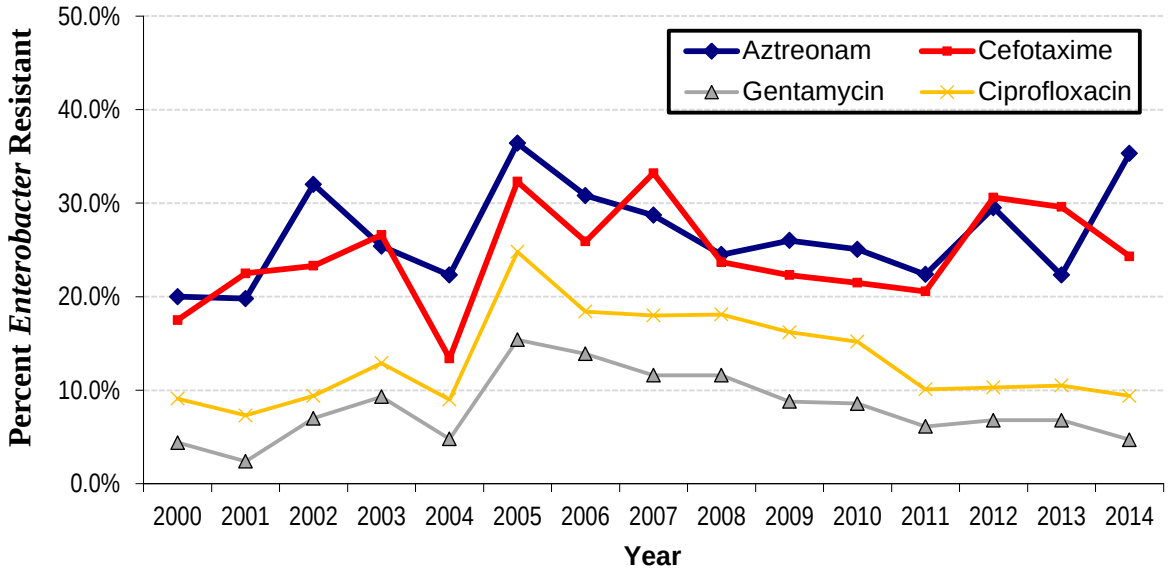
Antibiotics may not be required in individuals who are otherwise healthy. If antibiotic therapy is needed, the antibiotic susceptibility testing is essential before giving treatment. There is widespread resistance to ciprofloxacin, trimethoprim/sulfamethoxazole, and azithromycin. A third-generation cephalosporin or quinolone are the antibiotics of choice.

3.13.5-*Enterobacter cloacae*

Enterobacter species, particularly *Enterobacter cloacae* and *Enterobacter aerogenes*, are important nosocomial pathogens responsible for various infections, including bacteremia, lower respiratory tract infections, skin and soft-tissue infection, urinary tract infections (UTI), endocarditis, intra-abdominal infections septic arthritis, osteomyelitis, and ophthalmic infections. *Enterobacter* species can also cause various community-acquired infections, including UTIs, skin and soft-tissue infections, and wound infections, among others.

	Enterobacter cloacae								
	Aztreonam			**Cefotaxime**			**Gentamicin**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	74	372	20.0%	66	378	17.5%	28	628	4.4%
2001	23	115	19.8%	31	140	22.5%	5	203	2.4%
2002	75	235	32.0%	117	504	23.3%	42	595	7.0%
2003	236	930	25.4%	223	840	26.6%	203	2,173	9.3%
2004	116	522	22.3%	35	261	13.4%	39	822	4.8%
2005	219	603	36.4%	33	101	32.3%	110	716	15.4%
2006	256	832	30.8%	72	278	25.9%	176	1,265	13.9%
2007	431	1,505	28.7%	300	901	33.2%	255	2,199	11.6%
2008	428	1,744	24.5%	130	551	23.7%	269	2,312	11.6%
2009	352	1,354	26.0%	153	685	22.3%	171	1,939	8.8%
2010	107	427	25.1%	44	205	21.5%	103	1,202	8.6%
2011	136	607	22.4%	111	540	20.6%	86	1,397	6.1%
2012	471	1,597	29.5%	111	363	30.6%	167	2,467	6.8%
2013	266	1,194	22.3%	107	361	29.6%	150	2,210	6.8%
2014	414	1,174	35.3%	84	346	24.3%	84	1,806	4.7%
CoArm	X2 5.47	df 1	p 0.019	X2 4.89	df 1	p 0.027	X2 28.51	df 1	p 0.000

	Ciprofloxacin			TMP/SXZ			Carbapenems		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	37	348	10.6%	56	607	9.1%	2	598	0.3%
2001	20	169	11.6%	15	203	7.3%	2	180	1.1%
2002	26	402	6.4%	62	655	9.4%	3	593	0.5%
2003	243	1,748	13.9%	172	1,331	12.9%	8	1,453	0.6%
2004	41	574	7.2%	62	686	9.0%	2	770	0.3%
2005	88	411	21.5%	146	587	24.8%	8	700	1.1%
2006	123	723	17.0%	192	1,042	18.4%	28	1,211	2.3%
2007	250	1,518	16.5%	369	2,053	18.0%	61	2,441	2.5%
2008	221	1,630	13.6%	394	2,178	18.1%	94	3,098	3.0%
2009	193	1,493	12.9%	299	1,848	16.2%	64	2,636	2.4%
2010	125	823	15.2%	225	1,202	18.7%	46	1,658	2.8%
2011	134	1,329	10.1%	182	1,397	13.1%	34	2,447	1.4%
2012	240	2,323	10.3%	331	2,372	14.0%	84	4,032	2.1%
2013	221	2,099	10.5%	281	2,033	13.8%	74	3,751	2.0%
2014	156	1,667	9.4%	216	1,727	12.5%	92	2,985	3.1%
CoArm	X2 20.90	df 1	p 0.000	X2 0.56	df 1	p 0.455	X2 26.59	df 1	p 0.000



2014 *Enterobacter cloacae*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	507	70%	45%	80%
Penicillin & β-lactam Inhib	Piperacillin/ Tazobactam	1586	16%	0%	39%
Carbapenem	Ertapenem	789	5%	02%	13%
Carbapenem	Imipenem	900	4%	0%	15%
Carbapenem	Meropenem	1121	2%	0%	12%
Cephalosporin 3	Cefotaxime	346	24%	8%	32%
Cephalosporin 3	Ceftriaxone	1157	21%	0%	46%
Cephalosporin 4	Cefepime	1484	6%	0%	16%
Cyclines	Tetracycline	696	14%	8%	25%
Glycylcycline	Tigecycline	169	5%	0%	11%
Aminoglycosides	Amikacin	1550	1%	0%	4%
Aminoglycosides	Gentamicin	1806	5%	0%	13%
Aminoglycosides	Tobramycin	1697	6%	0%	14%
Quinolone	Ciprofloxacin	1667	9%	3%	27%
Sulfonamide	Trimethoprim-sulfa	1727	12%	0%	31%

These "ICU bugs" cause significant morbidity and mortality; infection management is complicated by resistance to multiple antibiotics. *Enterobacter* species possess inducible β-lactamases, which are undetectable in vitro but are responsible for resistance during treatment.

For severe *Enterobacter* infections, carbapenems are the most reliable drug of choice and fourth-generation cephalosporins are a distant second choice. Other antibiotics of choice include aminoglycosides, fluoroquinolones, and trimethoprim-sulfamethoxazole.

3.13.6-*Proteus mirabilis*

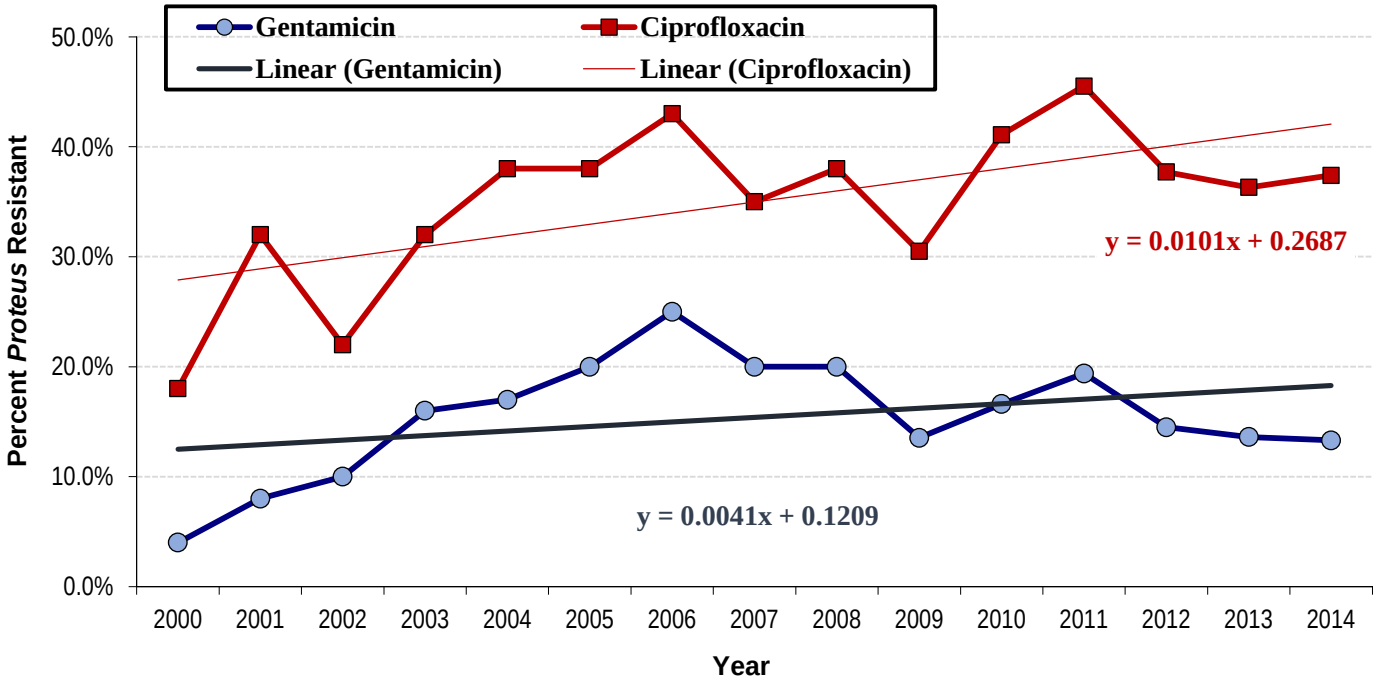
Proteus organisms are most commonly found in the human intestinal tract as part of normal human intestinal flora, along with *Escherichia coli* and *Klebsiella* species, of which *E coli* is the predominant resident. They are implicated as serious causes of infections in humans. *Proteu*s are prone to colonize and infect the urinary tract. Iatrogenic hematologic dissemination can occur after urologic procedures. Patients with recurrent infections, those with structural abnormalities of the urinary tract, those who have had urethral instrumentation, and those whose infections were acquired in the hospital have an increased frequency of infection caused by *Proteus* and other organisms (eg, *Klebsiella*, *Enterobacter*, *Pseudomonas*, enterococci, staphylococci). *Proteus* are found in multiple environmental habitats, including long-term care facilities and hospitals.

Proteus mirabilis causes 90% of *Proteus* infections and can be considered a community-acquired infection. *Proteus vulgaris* and *Proteus penneri* are easily isolated from individuals in long-term care facilities and hospitals, and from patients with underlying diseases or compromised immune systems.

Proteus vulgaris is indole-positive and has more antibiotic resistance. *Proteus mirabilis*, which is indole-negative, is the most common species encountered in humans (90%).

	Proteus mirabilis								
	Ampicillin			**Clav-Ticarcillin**			**ceftriaxone (3rd gen Ceph)**		
	Res	**Exam**	**%Res**	**Res**	**Exam**	**%Res**	**Res**	**Exam**	**%Res**
2000	102	1,341	7.6%	7	1,261	0.5%	14	973	1.5%
2001	93	566	16.5%	7	606	1.1%	9	459	1.9%
2002	585	2,511	23.3%	26	1,063	2.4%	3	1,362	0.2%
2003	2,323	7,798	29.8%	26	2,135	1.2%	50	4,496	1.1%
2004	1,582	4,711	33.6%	10	1,380	0.7%	49	2,493	2.0%
2005	902	2,741	32.9%	2	682	0.3%	14	1,967	0.7%
2006	1,780	4,982	35.7%	123	1,489	8.3%	161	3,827	4.2%
2007	1,737	6,183	28.1%	165	2,653	6.2%	121	6,057	2.0%
2008	2,547	7,891	32.3%	16	2,217	0.7%	464	7,716	6.0%
2009	1,311	4,792	27.4%	21	2,584	0.8%	198	4,326	4.6%
2010	600	2,564	23.4%	2	875	0.2%	247	3,896	6.4%
2011	2,070	6,369	32.5%	4	1,265	0.3%	777	6,661	11.7%
2012	2,033	6,605	30.8%	19	2,076	0.9%	917	8,348	11.0%
2013	1,714	5,417	31.6%	17	1,812	0.9%	762	7,562	10.1%
2014	1,360	4,749	28.6%	15	1,938	0.8%	447	6,934	6.4%
CoArm	X2 40.80	df 1	p 0.00	X2 23.05	df 1	p 0.000	X2 1036.01	df 1	p 0.000

	Gentamicin			Ciprofloxacin			TMP/SX		
	Res	**Exam**	**%Res**	**Res**	**Exam**	**%Res**	**Res**	**Exam**	**%Res**
2000	65	1,540	4.2%	167	925	18.1%	72	1,491	4.8%
2001	56	702	7.9%	164	516	31.7%	71	702	10.1%
2002	254	2,511	10.1%	323	1,487	21.7%	524	2,737	19.1%
2003	1,194	7,637	15.6%	2,020	6,307	32.0%	1,683	5,776	29.1%
2004	784	4,711	16.6%	1,341	3,554	37.7%	1,292	3,893	33.2%
2005	557	2,774	20.1%	589	1,567	37.6%	807	2,326	34.7%
2006	1,360	5,392	25.2%	1,112	2,589	42.9%	1,907	4,675	40.8%
2007	1,341	6,857	19.6%	1,742	4,959	35.1%	2,154	6,444	33.4%
2008	1,687	8,860	19.0%	2,209	5,693	38.8%	3,166	8,162	38.8%
2009	815	6,025	13.5%	1,314	4,309	30.5%	1,815	6,012	30.2%
2010	688	4,144	16.6%	1,293	3,146	41.1%	1,545	4,243	36.4%
2011	1,326	6,827	19.4%	3,007	6,650	45.2%	2,464	6,400	38.5%
2012	1,289	8,875	14.5%	3,105	8,240	37.7%	2,889	8,764	33.0%
2013	1,073	7,871	13.6%	2,638	7,273	36.3%	2,439	7,755	31.5%
2014	942	7,072	13.3%	2,525	6,746	37.4%	2,082	7,224	28.8%
CoArm	X2 5.73	df 1	p 0.017	X2 163.18	df 1	p 0.000	X2 144.51	df 1	p 0.000



P mirabilis remains susceptible to nearly many antimicrobials except cyclines. Resistance does not appear to be a significant clinical factor, but 10% to 30% of strains have acquired resistance to ampicillin and some cephalosporins. Acquisition of resistance to extended-spectrum alpha-lactamases remains uncommon in Proteus.

P vulgaris and *P penneri* show higher resistance to ampicillin and first-generation cephalosporins. Activation of an inducible chromosomal beta-lactamase (not found in *P mirabilis*) occurs in up to 30% of these strains. Imipenem, fourth-generation cephalosporins, aminoglycosides, TMP/SMZ, and quinolones have excellent activity (90%-100%).

2014 *Proteus* spp: mirabilis mostly

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Amino	Ampicillin	5426	30%	7%	79%
Penicillin & β-lactam Inhib	Clavulanic-Amoxicillin	4390	7%	0%	41%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	1938	1%	0%	1%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	6682	1%	0%	6%
Penicillin & β-lactam Inhib	Sulbactam-Ampicillin	5619	18%	3%	50%
Cephalosporin 1	Cefazolin	6397	14%	0%	69%
Cephalosporin 2	Cefoxitin	1458	8%	0%	18%
Cephalosporin 2	Cefuroxime	2771	6%	0%	24%
Cephalosporin 3	Cefotaxime	1018	3%	0%	7%
Cephalosporin 3	Ceftazidime	5600	5%	0%	35%
Cephalosporin 3	Ceftriaxone	7611	6%	0%	38%
Cephalosporin 4	Cefepime	7074	6%	0%	38%
Monobactam	Aztreonam	4546	10%	0%	33%
Carbapenem	Carbapenem	150	0%	0%	0%
Carbapenem	Ertapenem	4240	1%	0%	6%
Carbapenem	Imipenem	2742	14%	0%	74%
Carbapenem	Meropenem	4478	1%	0%	13%
Carbapenem	Imipenem/Cilastatin	178	2%	2%	2%
Aminoglycosides	Amikacin	6317	1%	0%	6%
Aminoglycosides	Gentamicin	7798	15%	0%	46%
Aminoglycosides	Tobramycin	7574	13%	0%	44%
Quinolone	Gatafloxin	62	73%	73%	73%
Quinolone	Ciprofloxacin	7472	39%	3%	82%
Quinolone	Levofloxacin	5638	44%	3%	79%
Quinolone	Moxifloxacin	1719	25%	0%	59%
Sulfonamide	Trimethoprim-sulfa	7879	30%	5%	77%

3.13.7-*Serratia marcescens*

Members of this genus produce characteristic red pigment, prodigiosin. *S. marcescens*, was formerly known as *Bacillus prodigiosus* because of its causing a bright red color on communion

bread. It was also thought to be non-pathogenic and was used to study the dispersal of bacteria throughout the atmosphere (California coastal area 1950). In fact, *Serratia marcescens* is the only pathogen in this genus and usually causes nosocomial infections.

In the hospital, *Serratia* species tend to colonize the respiratory and urinary tracts, rather than the gastrointestinal tract, in adults. *Serratia* infection is responsible for about 2% of nosocomial infections of the bloodstream, lower respiratory tract, urinary tract, surgical wounds, and skin and soft tissues in adult patients. Outbreaks of *S. marcescens* meningitis, wound infections, and arthritis have occurred in pediatric wards.

S. marcescans is naturally resistant to ampicillin, macrolides, and first generation cephalosporins. Antibiotics of choice in treatment of *Serratia* infections include aminoglycoside plus an antipseudomonal beta-lactam, amikacin, and quinolones. There are reports that indicate increasing resistance to gentamicin and tobramycin. Cefepime may be a treatment option for strains that produce AmpC β-lactamase.

2014 *Serratia marcescens*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Ureido	Piperacillin	35	3%	0%	6%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	125	8%	6%	9%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	367	24%	0%	63%
Cephalosporin 2	Cefoxitin	143	76%	60%	86%
Cephalosporin 3	Ceftriaxone	648	11%	0%	70%
Cephalosporin 3	Ceftazidime	435	19%	0%	56%
Cephalosporin 4	Cefepime	627	2%	0%	8%
Monobactam	Aztreonam	326	19%	0%	33%
Carbapenem	Ertapenem	308	2%	0%	8%
Carbapenem	Imipenem	194	4%	0%	8%
Carbapenem	Meropenem	483	0%	0%	2%
Cyclines	Tetracycline	198	78%	66%	85%
Glycylcycline	Tigecycline	94	3%	0%	8%
Quinolone	Ciprofloxacin	592	11%	0%	33%
Quinolone	Levofloxacin	444	10%	0%	25%
Quinolone	Moxifloxacin	133	10%	0%	17%
Aminoglycosides	Amikacin	574	2%	0%	9%
Aminoglycosides	Gentamicin	702	2%	0%	13%
Aminoglycosides	Tobramycin	493	17%	0%	30%
Sulfonamide	Trimethoprim-sulfa	634	5%	0%	17%

3.13.8-*Citrobacter freundii*

Citrobacter can be found almost everywhere in soil, water, wastewater, etc. It can also be found in the human intestine. They are rarely the source of illnesses, except for infections of the urinary tract and infant meningitis and sepsis.

C. freundii strains have inducible ampC genes encoding resistance to ampicillin and first-generation cephalosporins. In addition, isolates of *Citrobacter* may be resistant to multiple other antibiotics as a result of plasmid-encoded resistance genes.

Citrobacter infections follow the principles for treatment of other *Enterobacteriaceae* infections because there are no comparative studies of antibiotic therapy. The preferred treatment for *C. freundii* infections are based on an in vitro study done and include aminoglycosides, fluoquinolones, carbapenems, and fourth-generation cephalosporins. The first line drugs of treatment for *C. koseri* include third-generation cephalosporins, aztreonam, and piperacillin. Alternative treatment choices include those also used in treatment for *C. freundii*.

2014 *Citrobacter species*

Antibiotic	Group	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Amino	Ampicillin	61	77%	64%	85%
Penicillin Ureido	Piperacillin	31	32%	29%	36%
Penicillin & β-lactam Inhib	Clavulanic/Amoxicillin	621	39%	0%	86%
Penicillin & β-lactam Inhib	Clavulanic/Ticarcillin	591	13%	4%	36%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	1105	6%	0%	31%
Penicillin & β-lactam Inhib	Sulbactam/Ampicillin	636	22%	0%	58%
Cephalosporin 1	Cefazolin	593	10%	0%	86%
Cephalosporin 2	Cefuroxime	175	28%	0%	58%
Cephalosporin 3	Ceftriaxone	1277	9%	0%	36%
Cephalosporin 3	Cefotaxime	77	18%	0%	29%
Cephalosporin 3	Ceftazidime	1050	11%	0%	36%
Cephalosporin 4	Cefepime	1242	0%	0%	3%
Monobactam	Aztreonam	768	10%	0%	29%
Carbapenem	Imipenem	568	1%	0%	4%
Carbapenem	Imipenem/Cilastatin	17	0%	0%	0%
Carbapenem	Meropenem	953	0%	0%	3%
Carbapenem	Ertapenem	784	1%	0%	9%
Cyclines	Tetracycline	689	13%	0%	27%
Cyclines	Doxycycline	11	0%	0%	0%
Glycylcycline	Tigecycline	73	3%	0%	7%
Quinolone	Nitrofurantoin	661	23%	0%	67%
Quinolone	Ciprofloxacin	1232	10%	0%	50%
Quinolone	Levofloxacin	696	11%	0%	50%
Quinolone	Moxifloxacin	528	11%	6%	19%
Aminoglycosides	Amikacin	1208	0%	0%	0%
Aminoglycosides	Gentamicin	1326	4%	0%	20%
Aminoglycosides	Tobramycin	1086	3%	0%	15%
Sulfonamide	Trimethoprim-sulfa	1263	13%	0%	31%

3.13.9-*Morganella morganii*

Morganella morganii is a commensal Gram-negative bacillus of the intestinal tract of humans and other mammals and reptiles. Few reports exist in the literature regarding infections caused by this organism. It is an uncommon cause of community-acquired infections and nosocomial infections.

Antibiotic treatment should be initiated with an extended-spectrum antipseudomonal cephalosporin or penicillin combined with an aminoglycoside. Some preferred beta-lactam antibiotics include cefepime, ceftazidime, aztreonam, piperacillin, and piperacillin-tazobactam. Carbapenems and intravenous fluoroquinolones are reserved for resistant cases. With the widespread use of third-generation cephalosporins there has been an emergence of highly resistant *M. morganii.*

2014 *Morganella morganii*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Ureido	Piperacillin	35	58%	32%	88%
Penicillin & β-lactam Inhib	Clavulanic-Amoxicillin	38	89%	89%	89%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	54	37%	31%	39%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	508	6%	0%	15%
Cephalosporin 1	Cefazolin	38	89%	89%	89%
Cephalosporin 2	Cefoxitin	190	49%	62%	15%
Cephalosporin 3	Ceftriaxone	555	14%	0%	26%
Cephalosporin 3	Ceftazidime	397	35%	25%	69%
Cephalosporin 4	Cefepime	517	4%	0%	11%
Monobactam	Aztreonam	234	18%	7%	26%
Carbapenem	Ertapenem	192	4%	0%	18%
Carbapenem	Imipenem	221	14%	0%	62%
Carbapenem	Meropenem	304	1%	0%	3%
Cyclines	Tetracycline	102	52%	25%	62%
Glycylcycline	Tigecycline	12	67%	67%	67%
Quinolone	Ciprofloxacin	506	45%	18%	81%
Quinolone	Levofloxacin	538	44%	11%	81%
Aminoglycosides	Amikacin	506	1%	0%	4%
Aminoglycosides	Gentamicin	566	20%	2%	42%
Aminoglycosides	Tobramycin	409	10%	0%	32%
Sulfonamide	Trimethoprim-sulfa	566	41%	11%	81%

3.13.10-*Providencia stuartii*

Providencia stuartii is an opportunistic pathogen seen in patients with severe burns or long-term indwelling urinary catheters. In animals *P. stuartii* infections can cause neonatal diarrhea due to *P stuartii* infection in dairy cows. In humans, *P. stuartii* can be isolated from urine (most common), stool and blood, as well as from sputum, skin and wound cultures. *P. stuartii* septicemia is primarily of urinary origin. It is the most common cause of purple urine bag syndrome.

Good first-line antibiotics for non-life threatening infections include amikacin and beta-lactam/beta-lactamase inhibitors such as piperacillin/tazobactam. Carbapenems are the best choice for empirical therapy in life-threatening infections or nosocomial outbreaks. Once the suscepetibility pattern is known, target therapy with the most narrow-spectrum agent to which the organism is susceptible.

2014 *Providencia stuartii*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	92	0%	0%	0%
Cephalosporin 2	Cefoxitin	36	8%	8%	9%
Cephalosporin 3	Ceftazidime	43	26%	26%	26%
Cephalosporin 3	Ceftriaxone	92	2%	0%	4%
Cephalosporin 4	Cefepime	92	%	0%	0%
Monobactam	Aztreonam	24	0%	0%	0%
Carbapenem	Ertapenem	67	0%	0%	0%
Carbapenem	Imipenem	11	0%	0%	0%
Carbapenem	Meropenem	49	0%	0%	0%
Quinolone	Ciprofloxacin	56	85%	77%	88%
Quinolone	Levofloxacin	79	76%	45%	88%
Quinolone	Moxifloxacin	11	82%	82%	82%
Aminoglycosides	Amikacin	92	0%	0%	0%
Aminoglycosides	Gentamicin	11	64%	64%	64%
Aminoglycosides	Tobramycin	11	82%	82%	82%
Sulfonamide	Trimethoprim-sulfa	92	37%	0%	52%

3.14-*Pseudomonas aeruginosa*

Pseudomonas aeruginosa is a common bacterium which can cause infections in animals and humans. It is found in soil, water, and most man-made environments throughout the world. It thrives not only in normal atmospheres, but also with little oxygen, and has thus colonized many natural and artificial environments. It uses a wide range of organic material for food; in animals, the versatility enables the organism to infect damaged tissues or people with reduced immunity.

It causes pneumonias (community-acquired but predominantly health care-associated), septicaemia, urinary tract infection, gastrointestinal infection (especially in premature infants and neutropenic cancer patients), and skin and soft tissue infections. It is often associated to diffuse bronchopneumonia, skin lesions of ecthyma gangerenosum, urinary tract catheterisation, necrotising enterocolitis (NEC), haemorrhage and necrosis.

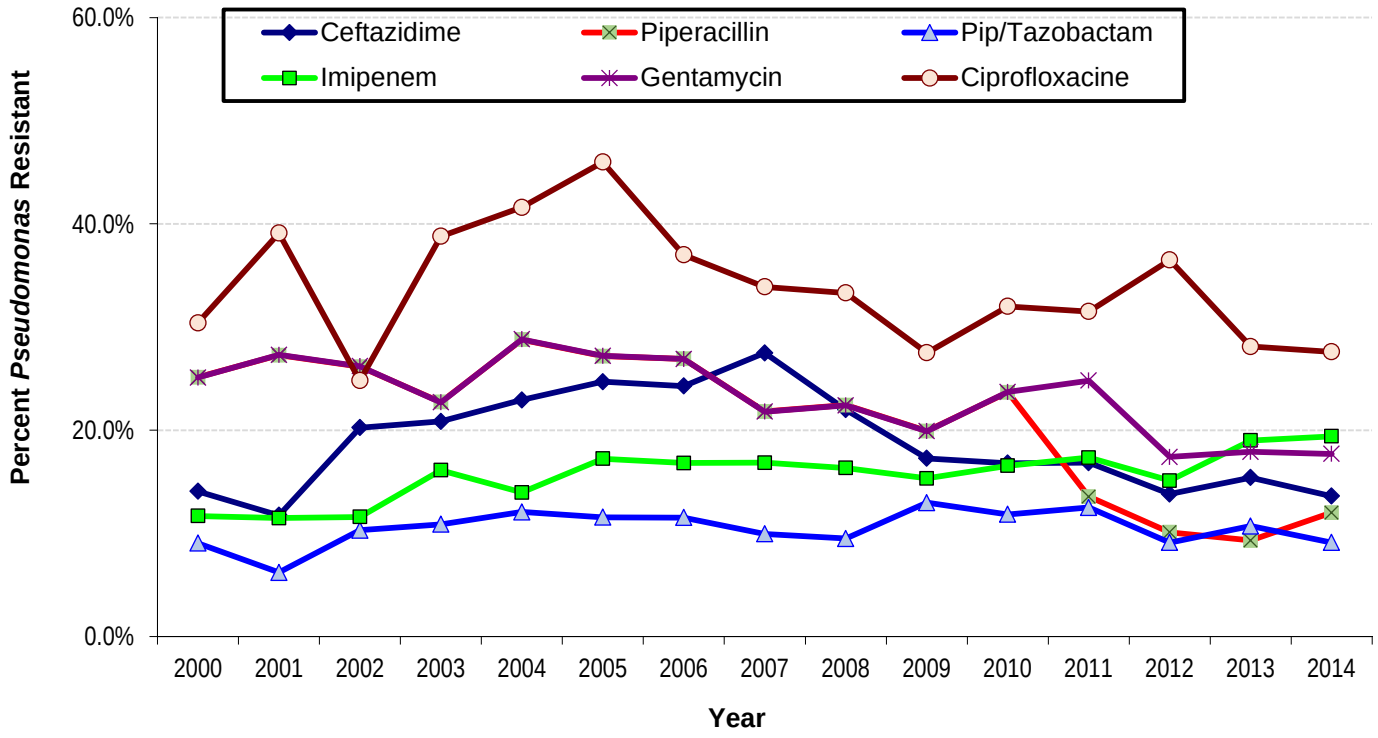
Those at greatest risk of infection are cystic fibrosis patients, neutropenic patients, burn victims and patients with wound infections.

One of the most worrisome characteristics of *P. aeruginosa* is its low antibiotic susceptibility. This low susceptibility is attributable to a concerted action of multidrug efflux pumps with chromosomally-encoded antibiotic resistance genes (e.g. *mexAB*, *mexXY*) and the low permeability of the bacterial cellular envelopes. In addition to this intrinsic resistance, *P. aeruginosa* easily develops acquired resistance either by mutation in chromosomally-encoded genes or by the horizontal gene transfer of antibiotic resistance determinants. Development of multidrug resistance by *P. aeruginosa* isolates requires several different genetic events including acquisition of different mutations and/or horizontal transfer of antibiotic resistance genes. Hypermutation favors the selection of mutation-driven antibiotic resistance in *P. aeruginosa* strains producing chronic infections, whereas the clustering of several different antibiotic resistance genes in integrons favors the concerted acquisition of antibiotic resistance determinants. Some recent studies have shown that phenotypic resistance associated to biofilm formation or to the emergence of small-colony variants may be important in the response of *P. aeruginosa* populations to antibiotic treatment.

	Pseudomonas aeruginosa								
	Ceftazidime			**Piperacillin**			**Pipe/Tazobactam**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	260	1,852	14.1%	61	638	25.1%	135	1,491	9.0%
2001	158	1,350	11.7%	71	990	27.3%	64	1,025	6.2%
2002	535	2,643	20.2%	293	1,692	26.2%	291	2,823	10.3%
2003	1,700	8,152	20.8%	432	2,980	22.7%	685	6,302	10.9%
2004	780	3,402	22.9%	163	1,191	28.8%	400	3,314	12.1%
2005	679	2,748	24.7%	14	137	27.2%	430	3,717	11.6%
2006	1,262	5,201	24.3%	100	596	26.9%	692	6,001	11.5%
2007	2,088	7,597	27.5%	196	1,298	21.8%	711	7,151	9.9%
2008	2,105	9,580	22.0%	226	2,063	22.4%	1,011	10,658	9.5%
2009	1,188	6,882	17.3%	77	888	19.9%	950	7,322	13.0%
2010	840	4,999	16.8%	70	713	23.7%	623	5,267	11.8%
2011	1,248	7,423	16.8%	199	1,466	13.6%	775	6,203	12.5%
2012	1,194	8,647	13.8%	155	1,529	10.1%	650	7,126	9.1%
2013	1,013	6,584	15.4%	63	681	9.3%	837	7,825	10.7%
2014	821	6,029	13.6%	73	608	12.0%	589	6,504	9.1%
CoArm	X2 304.13	df 1	p 0.00	X2 14.52	df 1	p 0.000	X2 0.65	df 1	p 0.421

	Imipenem			**Gentamicin**			**Ciprofloxacin**		
	Res	**Exam**	**Res %**	**Res**	**Exam**	**Res %**	**Res**	**Exam**	**Res %**
2000	224	1,917	11.7%	500	1,990	25.1%	527	1,749	30.1%
2001	155	1,350	11.5%	405	1,486	27.3%	525	1,344	39.1%
2002	318	2,748	11.6%	795	3,041	26.2%	729	2,096	34.8%
2003	1,131	7,015	16.1%	2,506	11,030	22.7%	3,460	8,912	38.8%
2004	528	3,781	14.0%	1,491	5,183	28.8%	1,657	3,988	41.6%
2005	660	3,826	17.2%	1,175	4,322	27.2%	968	2,104	46.0%
2006	911	5,419	16.8%	1,795	6,669	26.9%	1,111	3,000	37.0%
2007	1,361	8,075	16.9%	1,772	8,125	21.8%	1,959	5,780	33.9%
2008	1,620	9,916	16.3%	2,179	9,714	22.4%	2,161	6,488	33.3%
2009	1,013	6,613	15.3%	1,526	7,664	19.9%	1,572	5,725	27.5%
2010	808	4,882	16.5%	1,281	5,411	23.7%	1,315	4,106	32.0%
2011	1,344	7,758	17.3%	2,018	8,141	24.8%	2,481	7,878	31.5%
2012	1,012	6,712	15.1%	1,760	10,086	17.4%	2,515	6,883	36.5%
2013	1,040	5,486	19.0%	1,464	8,168	17.9%	2,214	7,889	28.1%
2014	839	4,322	19.4%	1,303	7,379	17.7%	1,854	6,712	27.6%
CoArm	X2 85.63	df 1	p 0.000	X2 366.38	df 1	p 0.000	X2 337.34	df 1	p 0.000

Double drug therapy is recommended for serious infection, consisting of an anti-pseudomonal penicillin (piperacillin/tazobactam, ticarcillin/clavulanate), meropenem or cefipime plus a fluoroquinolone or an aminoglycoside. Alternative antibiotics of choice include ceftazidime, other carbapenems, mezlocillin, and ciprofloxacin.



2014 *Pseudomonas aeruginosa*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin Carboxy	Ticarcillin	376	29%	10%	58%
Penicillin Ureido	Piperacillin	608	12%	2%	29%
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	1575	20%	10%	72%
Penicillin & β-lactam Inhib	Piperacillin/Tazobactam	6504	9%	0%	29%
Cephalosporin 3	Cefotaxime	632	83%	73%	90%
Cephalosporin 3	Ceftriaxone	1115	75%	56%	88%
Cephalosporin 3	Ceftazidime	6029	14%	3%	32%
Cephalosporin 4	Cefepime	6785	16%	1%	35%
Monobactam	Aztreonam	3278	31%	20%	55%
Carbapenem	Doripenem	475	0%	0%	0%
Carbapenem	Imipenem	4322	19%	4%	59%
Carbapenem	Meropenem	4767	12%	0%	37%
Carbapenem	Imipenem/Cilastatin	556	20%	17%	23%
Quinolone	Ciprofloxacin	6712	28%	5%	66%
Quinolone	Levofloxacin	5441	34%	13%	71%
Quinolone	Moxifloxacin	48	37%	37%	37%
Quinolone	Norfloxacin	49	27%	27%	27%
Aminoglycosides	Amikacin	3570	5%	0%	28%
Aminoglycosides	Gentamicin	7379	18%	5%	43%
Aminoglycosides	Tobramycin	7038	8%	0%	39%
Oxazolidinone	Linezolid	103	20%	20%	20%

3.15-*Stenotrophomonas maltophilia*

Stenotrophomonas maltophilia is a Gram-negative rod which causes uncommon, but difficult to treat infections in humans. Initially classified as *Pseudomonas maltophilia*, *S. maltophilia* was also grouped in the genus *Xanthomonas* before eventually becoming the type species of the genus *Stenotrophomonas* in 1993.

S. maltophilia is ubiquitous in aqueous environments, soil and plants, including water, urine, or respiratory secretions. In immunocompromised patients, *S. maltophilia* can lead to nosocomial infections. *S. maltophilia* frequently colonizes breathing tubes such as endotracheal or tracheostomy tubes, the respiratory tract and indwelling urinary catheters. Infection is usually facilitated by the presence of prosthetic material (plastic or metal), and the most effective treatment is removal of the prosthetic material (usually a central venous catheter or similar device). The growth of *S. maltophilia* in microbiological cultures of respiratory or urinary specimens is therefore sometimes difficult to interpret and not a proof of infection. If, however, it is grown from sites which would be normally sterile (e.g., blood), then it usually represents true infection.

In immunocompetent individuals, *S. maltophilia* is a relatively unusual cause of pneumonia, urinary tract infection, or blood stream infection; in immunocompromised patients; however, *S. maltophilia* is a growing source of latent pulmonary infections. *S. maltophilia* colonization rates in individuals with cystic fibrosis have been increasing.

S. maltophilia is usually resistant to aminoglycosides, antipseudomonal penicillins, and antipseudomonal third-generation cephalosporins. It is consistently susceptible to trimethoprim-sulfamethoxazole (TMP-SMZ). If TMP-SMZ cannot be used, the organism is usually sensitive to minocycline, respiratory quinolones, or colistin/polymixin B.

2014 *Stenotrophomonas maltophilia*

Group	Antibiotic	Nbr Isol	Avg Res	Low Res	High Res
Penicillin & β-lactam Inhib	Clavulanic-Ticarcillin	105	39%	30%	41%
Cephalosporin 2	Cefuroxime	18	67%	67%	67%
Cephalosporin 3	Ceftazidime	252	55%	29%	77%
Quinolone	Levofloxacin	361	18%	0%	33%
Sulfonamide	Trimethoprim-sulfa	407	6%	0%	35%