Antibiotics Currently in Clinical Development

As of February 2014, there are at least 45 new antibiotics[1] with the potential to treat serious bacterial infections in clinical development for the U.S. market. The success rate for drug development is low; at best, only 1 in 5 candidates that enter human testing will be approved for patients.* This snapshot of the antibiotic pipeline will be updated periodically as products advance or are known to drop out of development. Please contact Rachel Zetts at rzetts@pewtrusts.org or 202-540-6557 with additions or updates.

Drug Name	Development Phase[2]	Company	Drug Class	Cited for Potential Activity Against Gram-Negative Pathogens?[3]	Known QIDP[4] Designation?	Potential Indication(s)[5]
Oritavancin	New Drug Application (NDA) submitted	The Medicines Company	Glycopeptide		Yes	**Acute bacterial skin and skin structure infections**
Dalbavancin	New Drug Application (NDA) submitted	Durata Therapeutics	Lipoglycopeptide		Yes	**Acute bacterial skin and skin structure infections**
Tedizolid	NDA submitted (for acute bacterial skin and skin structure infection indication)	Cubist Pharmaceuticals	Oxazolidinone		Yes	**Acute bacterial skin and skin structure infections, hospital acquired bacterial pneumonia/ventilator acquired bacterial pneumonia**
ACHN-975	Phase 1	Achaogen	LpxC inhibitor	Yes		Bacterial infections
AFN-1720	Phase 1	Affinium Pharmaceuticals	FabI inhibitor (AFN-1252 pro-drug)			Acute bacterial skin and skin structure infections[6], methicillin-resistant Staphylococcus aureus (MRSA) pulmonary infections in cystic fibrosis patients[6], osteomyelitis[6], bone and joint infections[6]
AZD0914	Phase 1	AstraZeneca	DNA gyrase inhibitor	Yes		Gonococcal infections
Aztreonam+Avibactam[7] (ATM-AVI)	Phase 1	AstraZeneca/Forest Laboratories	Monobactam + novel beta-lactamase inhibitor	Yes		Bacterial infections
BAL30072	Phase 1	Basilea Pharmaceutica	Monosulfactam	Yes		Multidrug-resistant Gram-negative bacterial infections[6]
Carbavance	Phase 1	Rempex Pharmaceuticals/the Medicines Co.	Carbapenem (biapenem) + novel boronic beta-lactamase inhibitor	Yes	Yes	**Complicated urinary tract infections, complicated intra-abdominal infections, hospital-acquired bacterial pneumonia/ ventilator-associated bacterial pneumonia, febrile neutropenia.**

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CRS-3123	Phase 1	Crestone, Inc.	Methionyl tRNA synthetase (MetRS) inhibitor			C. *difficile* infection[6]
EDP-788	Phase 1	Enanta Pharmaceuticals	Bicyclolide			Bacterial infections
GSK-2696266	Phase 1	GlaxoSmithKline (partnered product)	Cephalosporin			Bacterial infections[6]
LCB01-0371	Phase 1	LegoChem Biosciences (S. Korea)	Oxazolidinone			Bacterial infections
MRX-I	Phase 1	MicuRx Pharmaceuticals	Oxazolidinone			Bacterial infections including community-acquired MRSA and vancomycin-resistant enterococci infections[6]
POL7080	Phase 1	Polyphor (Roche licensee)	Macrocycle (peptide epitope mimetic) LptD inhibitor	Yes (Pseudomonas)		Bacterial infections caused by Pseudomonas[6]
TD-1607	Phase 1	Theravance, Inc.	Glycopeptide-cephalosporin heterodimer			Serious Gram-positive bacterial infections (acute bacterial skin and skin structure infections, hospital-acquired pneumonia/ventilator-associated pneumonia, bacteremia)[6]
WCK 2349	Phase 1	Wockhardt	Fluoroquinolone (WCK 771 pro-drug)			Bacterial infections
WCK 771	Phase 1	Wockhardt	Fluoroquinolone			Bacterial infections
AFN-1252	Phase 2	Affinium Pharmaceuticals	FabI inhibitor		Yes	**Acute bacterial skin and skin structure infections**
Avarofloxacin	Phase 2	Furiex Pharmaceuticals	Fluoroquinolone	Yes	Yes	**Community-acquired bacterial pneumonia, acute bacterial skin and skin structure infections**
Brilacidin	Phase 2	Cellceutix Corp.	Defensin-mimetic			Acute bacterial skin and skin structure infections[6]
Ceftaroline+Avibactam[8]	Phase 2	AstraZeneca/Forest Laboratories	Cephalosporin + novel beta-lactamase inhibitor	Yes		Complicated urinary tract infections
CG-400549	Phase 2	CrystalGenomics, Inc.	FabI inhibitor			Acute bacterial skin and skin structure infections; osteomyelitis[6]
Finafloxacin	Phase 2	MerLion Pharmaceuticals	Fluoroquinolone	Yes	Yes	**Complicated urinary tract infections, acute pyelonephritis (kidney infection), acute intra-abdominal infections, acute bacterial skin and skin structure infections**
GSK-1322322	Phase 2	GlaxoSmithKline	Peptide deformylase inhibitor			Acute bacterial skin and skin structure infections

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GSK-2140944	Phase 2	GlaxoSmithKline	Type 2 topoisomerase inhibitor			Respiratory tract infections, acute bacterial skin and skin structure infections
Lefamulin (BC-3781)	Phase 2	Nabriva Therapeutics	Pleuromutilin			Acute bacterial skin and skin structure infections
LFF571	Phase 2	Novartis	Elongation factor inhibitor			*Clostridium difficile*-associated diarrhea
MK-7655+ (imipenem/cilastatin)[8]	Phase 2	Merck & Co.	Carbapenem + novel beta-lactamase inhibitor	Yes		Complicated urinary tract infections, acute pyelonephritis, complicated intra-abdominal infections
Nemonoxacin[9]	Phase 2	TaiGen Biotechnology	Quinolone	Yes	Yes	**Community-acquired bacterial pneumonia,** diabetic foot infection, **acute bacterial skin and skin structure infections**
Omadacycline	Phase 2	Paratek Pharmaceuticals	Tetracycline	Yes	Yes	**Community-acquired bacterial pneumonia, acute bacterial skin and skin structure infections, complicated urinary tract infections**
Radezolid	Phase 2	Melinta Pharmaceuticals	Oxazolidinone	Yes	Yes	**Acute bacterial skin and skin structure infections, community-acquired bacterial pneumonia**
Ramoplanin	Phase 2	Nanotherapeutics	Lipoglycopeptide			*Clostridium difficile*-associated diarrhea[6]
Taksta (Fusidic acid)[10]	Phase 2	Cempra Pharmaceuticals	Fusidane			Prosthetic joint infections
TD-1792	Phase 2	Theravance, Inc.	Glycopeptide-cephalosporin heterodimer			Acute bacterial skin and skin structure infections, other serious infections caused by Gram-positive bacteria including hospital-acquired pneumonia/ventilator-associated pneumonia and bacteremia[6]
Zabofloxacin	Phase 2	Dong Wha Pharmaceutical	Fluoroquinolone			Community-acquired bacterial pneumonia
Cadazolid	Phase 3	Actelion Pharmaceuticals	Quinolonyl-oxazolidinone		Yes	***Clostridium difficile*-associated diarrhea**
Ceftazidime+Avibactam (CAZ-AVI)[8]	Phase 3	AstraZeneca/Forest Laboratories	Cephalosporin + novel beta-lactamase inhibitor	Yes	Yes	**Complicated urinary tract infections, complicated intra-abdominal infections,** acute pyelonephritis (kidney infection), **hospital-acquired bacterial pneumonia/ ventilator-associated bacterial pneumonia**
Ceftolozane+Tazobactam[8]	Phase 3	Cubist Pharmaceuticals	Novel cephalosporin+beta-lactamase inhibitor	Yes	Yes	**Complicated urinary tract infections, complicated intra-abdominal infections,** acute pyelonephritis (kidney infection), **hospital-acquired bacterial pneumonia/ ventilator-associated pneumonia**

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Delafloxacin	Phase 3	Melinta Pharmaceuticals	Fluoroquinolone	Yes	Yes	**Acute bacterial skin and skin structure infections, community-acquired bacterial pneumonia,** uncomplicated gonorrhea
Eravacycline[8]	Phase 3	Tetraphase Pharmaceuticals	Tetracycline	Yes	Yes	**Complicated intra-abdominal infections, complicated urinary tract infections,** hospital-acquired bacterial pneumonia[6]
Plazomicin[8]	Phase 3	Achaogen	Aminoglycoside	Yes		Bloodstream infections and nosocomial pneumonia caused by carbapenem-resistant Enterobacteriaeceae
Solithromycin	Phase 3	Cempra Pharmaceuticals	Macrolide (ketolide)	Yes	Yes	**Community-acquired bacterial pneumonia, uncomplicated urogenital gonorrhea**
Surotomycin	Phase 3	Cubist Pharmaceuticals	Lipopeptide		Yes	***Clostridium difficile*-associated diarrhea**
Ceftobiprole	Phase 3[11]	Basilea Pharmaceutica	Cephalosporin	Yes		Hospital-acquired bacterial pneumonia, community-acquired bacterial pneumonia

* M. Hay et al. "Clinical Development Success Rates for Investigational Drugs," Nature Biotechnology 32, no. 1 (2014): 40-51. - See more at: http://www.pewhealth.org/other-resource/antibiotics-currently-in-clinical-development-85899541594#sthash.XLzMLQta.dpuf

References

1. Antibiotics include products containing at least one component not approved in the United States previously. All analyses were strictly limited to systemic antibiotics (drugs that work throughout the body) and drugs to treat Clostridium difficile-associated disease. The Centers for Disease Control and Prevention cited Clostridium difficile as an urgent public health threat in a 2013 report (*Antibiotic Resistance Threats in the United States*, 2013, Sept. 16, 2013, http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf). We excluded biological products, vaccines, and locally acting drugs such as topical, ophthalmic, and inhaled products. Also excluded were drugs used to treat mycobacterial infections such as tuberculosis and *Mycobacterium avium* complex, *H. Pylori*, and biothreat pathogens. Avibactam, a novel beta-lactamase inhibitor, is being studied in combination with three approved antibiotics and all three were counted for this report as each combination targets a distinct set of pathogens.
2. Based on the most advanced development phase for any indication according to trials registered in clinicaltrials.gov. If no trials were included in clinicaltrials.gov, then the phase listed on the company website or provided directly by the company is noted.
3. Based on information provided on the company website or press releases or based on inclusion in citations 4 or 5 below. 'Yes' in this category means that the antibiotic has potential activity against at least one gram-negative organism. Examples include: the pathogen that causes gonorrhea, *Neisseria gonorrhoeae*, which the CDC classified as an urgent public health threat; Gram-negative bacilli such as members of the Enterobacteriaceae family such as *Klebsiella pneumoniae* and *Escherichia coli*; Acinetobacter species and Pseudomonas species; and so-called fastidious Gram-negative bacteria that commonly cause community-acquired respiratory infections.
4. Certain antibiotics intended to treat serious or life-threatening infections can be designated by the Food and Drug Administration as qualified infectious disease products, or QIDPs. QIDPs are eligible to receive benefits under the Generating Antibiotic Incentives Now Act (signed into law as part of the Food and Drug Administration Safety and Innovation Act), including expedited FDA review and extended exclusivity for approved products.
5. Based on clinical trials currently registered in clinicaltrials.gov and/or reported QIDP designations unless otherwise noted. Bolded indications are reported QIDP designations.
6. Not currently registered in clinicaltrials.gov. Information obtained from the company via a corporate website, press release, and/or direct communication.
7. Avibactam is a new beta-lactamase inhibitor being tested in conjunction with three individual antibiotics. We list all three combinations here.
8. Identified as antibiotics in advanced development (phase 2 or 3) with the potential to treat infections caused by gram-negative bacilli (*Enterobacteriaceae, Pseudomonas, Acinetobacter*) resistant to currently available treatments. According to the Infectious Disease Society of America, multidrug-resistant strains of these organisms represent today's most pressing medical needs.
9. Marketing applications were submitted for nemonoxacin in China and Taiwan.
10. Taksta was granted an orphan drug designation for the indication of prosthetic joint infections.
11. Ceftobiprole was recently approved in Europe for hospital- and community-acquired bacterial pneumonia.

Citations

i. Citeline's Pharmaprojects Pipeline, Informa, 2012.

ii. "Antibiotics NCE pipeline," BioCentury, accessed October 28, 2013, http://www.biocentury.com/antibioticsncepipeline.htm.

iii. ClinicalTrials.Gov, U.S. National Institutes of Health, http://www.clinicaltrials.gov/.

iv. H.W. Boucher et al., "10 x '20 Progress-Development of New Drugs Against Gram-Negative Bacilli: An Update From the Infectious Diseases Society of America," Clinical Infectious Disease 56 (2013): 1685-94.

v. M.J. Pucci, K. Bush. "Investigational Antimicrobial Agents of 2013," *Clinical Microbiology Reviews* 26 (2013): 792-821.

vi. Centers for Disease Control and Prevention. *Antibiotic Resistance Threats in the United States*, 2013, September 16, 2013, http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf