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Susceptibility of *Propionibacterium acnes* Clinical Isolates to 22 Antimicrobial Agents

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Susceptibilities of 104 *Propionibacterium acnes* isolates to each of 22 antimicrobial agents was evaluated by broth microdilution. These isolates were susceptible to all of the test agents except metronidazole. *N*-Formimidoyl thienamycin, a penem coded Sch 29482, and penicillin ranked first, second, and third, respectively, in activity and were significantly more active than other penicillins, cephalosporins, tetracyclines, clindamycin, or chloramphenicol.

We evaluated the activity of 22 antimicrobial agents against 104 isolates of *Propionibacterium acnes*. Our purpose was to study antimicrobial agents currently used in therapy against *P. acnes* and to test a number of the newer cephalosporins and penicillins not previously reported in scientific literature. The accumulated data should serve as a guide in the management of serious anaerobic infections in which *P. acnes* is incriminated (1, 3–5, 8, 10, 13).

A total of 104 *P. acnes* isolates were obtained from the stock culture collection of the Anaerobe Section, Bacteriology Division, Center for Infectious Diseases, Centers for Disease Control (CDC), Atlanta, Ga., through the courtesy of V. R. Dowell, Jr. and G. L. Lombard. The majority of these organisms were recovered from clinical specimens in diverse geographical areas and sent between 1973 and 1982 to the CDC as single isolates for identification. Other cultures acquired from the CDC were obtained from G. Pulverer, Institute of Hygiene, University of Cologne, Cologne, Germany, from the American Type Culture Collection (ATCC 6919 and ATCC 11828), and from the Microbiology Laboratory, Emory University Hospital, Atlanta, Ga. The sources of the isolates included: blood, bone marrow, respiratory tract, central nervous system, tissue, abscesses, hair, skin, wounds and exudates, intestinal tract, and other body fluids; one isolate was of unknown origin.

All of the organisms were identified by the methods recommended by Dowell and Hawkins (2). Anaerobic control strains included *Bacteroides fragilis* ATCC 25285, *Bacteroides thetaiotaomicron* ATCC 29741, and *Clostridium perfringens* ATCC 13124. Also tested were *Streptococcus faecalis* ATCC 29212, *Staphylococcus aureus* ATCC 29213, *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Pseudomonas aeruginosa* ATCC 27853.

The following reference standard powders were supplied through the courtesy of the manufacturers indicated: cefoperazone, doxycycline, tetracycline, and carbenicillin from Pfizer Inc., New York, N.Y.; cefamandole, moxalactam, and erythromycin from Eli Lilly & Co., Indianapolis, Ind.; cefoxitin and *N*-formimidoyl thienamycin from Merck Sharp & Dohme, West Point, Pa.; azlocillin and mezlocillin from Miles Pharmaceutical, West Haven, Conn.; minocycline and piperacillin from Lederle Laboratories, Pearl River, N.Y.; clindamycin and pirlimycin from The Upjohn Company, Kalamazoo, Mich.; penicillin from Bristol Laboratories, Syracuse, N.Y.; ceftazidime from Glaxo, Ltd., Research Triangle Park, N.C.; cefotaxime from Hoechst-Roussel Pharmaceuticals, Inc., Sommerville, N.J.; chloramphenicol from Parke, Davis & Co., Detroit, Mich.; Sch 29482 (11) from Schering Corp., Bloomfield, N.J.; metronidazole from Searle & Co., Chicago, Ill.; and cefotetan from Stuart Pharmaceuticals, Wilmington, Del. Antimicrobial agents were dissolved according to the instructions of the manufacturers to make a stock concentration of 1,280 μg of active agent per ml. All stock solutions were stored at −70°C for 48 h, except *N*-formimidoyl thienamycin, which was prepared just before it was diluted.

Minimum inhibitory concentrations (MICs) were determined by the microdilution broth method (9). Serial twofold dilutions of each

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antimicrobial agent were prepared in Wilkins-Chalgren broth and dispensed into microdilution trays with a Quick Spense dispenser (originally purchased from Sandy Spring Instruments, Ijamsville, Md., now sold through Bellco, Inc., Vineland, N.J.). Dilutions extended from 0.004 to 8 μg/ml, except for metronidazole, which extended from 0.25 to 128 μg/ml. The microdilution trays were stored in sealed plastic bags at −70°C and used within 3 weeks. Organisms to be tested were grown on anaerobic blood agar plates (Nolan Biological Labs, Inc., Atlanta, Ga.) at 35°C for 48 to 72 h in an anaerobic chamber (Forma Scientific, Marietta, Ohio). The inoculum was prepared by suspending growth from the blood agar plates in 40 ml of prereduced sterile distilled water to obtain a turbidity equivalent to 0.5 of a no. 1 McFarland standard. The microdilution trays were removed from the freezer, thawed, and reduced in the anaerobic chamber for 4 h just before they were used. They were inoculated with an MIC 2000 inoculator (Dynatech Laboratories, Inc., Alexandria, Va.). The final inoculum concentration was approximately 10^6 bacteria per ml. The trays were incubated at 35°C in the anaerobic chamber. After 48 h of incubation, the MICs were read as the lowest concentration of antimicrobial agent at which there was no growth or a barely visible haze.

Aerobic and facultatively anaerobic control strains were tested with the following modifications. Growth from a 24-h sheep blood agar plate was suspended in sterile distilled water and diluted to give a final concentration of 10^5 organisms per ml. These microdilution trays were incubated in air at 35°C overnight.

The results of this study are summarized in Table 1. Control strains gave reproducible results, with MICs within one dilution of the mean.

The MIC results indicate that isolates of *P. acnes* from various body sites are susceptible to all the antimicrobial agents tested except metronidazole. These findings agree with those of other published studies (6, 7, 12). For those agents tested in common, there was also good agreement between our results with broth dilution and those of other investigators who used agar dilution (6, 7, 12).

N-formimidoyl thienamycin was the most active drug tested, whereas the penem Sch 29482, an oral drug, and penicillin G were the next most active, in that order. These three agents were significantly more active against *P. acnes* than the other penicillins, cephalosporins, tetracyclines, chloramphenicol, erythromycin, or clindamycin. Among the newer penicillins, azlocillin, mezlocillin, and piperacillin appear to be more active than carbenicillin. Cefotaxime was the most active among the newer cephalosporins. Minocycline was slightly more active than doxycycline and tetracycline.

TABLE 1. Summary of *P. acnes* susceptibility to 22 antimicrobial agents

Antimicrobial agent	MIC (μg/ml)[a]		
	Range	50%	90%
Azlocillin	0.03 to 2	0.25	1
Mezlocillin	0.12 to 2	0.5	1
Piperacillin	0.12 to 2	0.5	1
Carbenicillin	0.25 to 8	1	2
Penicillin	0.015 to 0.12	0.06	0.12
Cefamandole	0.03 to 1	0.12	0.5
Cefoxitin[b]	0.03 to 1	0.12	0.5
Cefotetan[b]	0.06 to 2	0.5	1
Cefotaxime	0.015 to 0.25	0.06	0.25
Cefoperazone	0.12 to 2	0.5	1
Ceftazidime	0.25 to 4	2	4
Moxalactam	0.06 to 4	0.5	2
Thienamycin	0.004 to 0.03	0.008	0.015
Sch 29482	0.004 to 0.12	0.015	0.03
Metronidazole	>128	>128	>128
Doxycylcine	0.12 to 1	0.25	0.5
Minocylcine	0.06 to 0.5	0.12	0.25
Tetracycline	0.12 to 1	0.5	1
Chloramphenicol	0.25 to 8	1	2
Erythromycin	0.03 to 0.5	0.06	0.12
Clindamycin	0.03 to 0.5	0.12	0.25
Pirlimycin[c]	0.03 to 0.5	0.12	0.25

[a] 50% and 90%, MIC at which 50 and 90% of strains, respectively, were inhibited.

[b] Cephamycin antibiotics.

[c] R. D. Birkenmeyer, Program Abstr. Intersci. Conf. Antimicrob. Agents Chemother. 20th, New Orleans, La., abstr. no. 65, 1980.

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