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Bacteriology of Human and Animal Bite Wounds

ELLIE J. C. GOLDSTEIN,†* DIANE M. CITRON,[1] BRENDA WIELD,[3] UZY BLACHMAN,‡ VERA L. SUTTER,[3] TIMOTHY A. MILLER,[2,5] AND SYDNEY M. FINEGOLD[1,4]

Medical,[1] Surgical[2] and Research Services,[3] Wadsworth Hospital Center, Veterans Administration, Los Angeles, California 90073, and the Departments of Medicine[4] and Surgery,[5] University of California at Los Angeles, School of Medicine, Los Angeles, California 90024

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Seventy-three patients with bite wounds (16 patients with clenched-fist injuries, 18 with human bite wounds, and 39 with animal bites) were cultured aerobically and anaerobically. A total of 33 of 34 patients with human bites and clenched-fist injuries and 33 of 39 patients with animal bites had aerobic or facultative bacteria isolated from their wounds. A total of 224 strains of aerobic or facultative bacteria were isolated, the most frequent isolate being alpha-hemolytic streptococci (50 strains). *Staphylococcus aureus* was isolated from 18 wounds. Penicillin-resistant gram-negative rods were infrequently isolated (12 strains). Anaerobic bacteria were isolated in 18 of 34 human bite wounds and clenched-fist injuries and 16 of 39 animal bite wounds. A total of 88 anaerobic strains was isolated, the most common being various *Bacteroides* species (36 strains).

Human bites and other orally contaminated wounds are relatively common. Although they may look innocuous initially, they frequently lead to serious complications (4, 12, 26, 35). Prior reports have described *Staphylococcus aureus* as the major pathogen in human bite and clenched-fist injury (CFI) infections (9, 12, 26, 31). Anaerobic bacteria, although prevalent as normal oral flora, have seldom been cultured from human bite or CFI. The bacteriology of animal bite wounds has not been well-defined (1, 29). Animal bites are optionally reported to the Center for Disease Control, yet 13 states listed a total of 134,819 animal bites for 1976 (33).

As an initial stage, in attempting to establish what, if any, constitutes proper antimicrobial therapy, the bacteriology of bite wounds needs to be defined. Consequently, we undertook a prospective study of the bacteriology of human and animal wounds.

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MATERIALS AND METHODS

Patient selection. From March 1977 to May 1978, all patients entering the emergency room or out-patient department of the Wadsworth Hospital Center, Veterans Administration, and the University of California at Los Angeles Center for the Health Sciences with human or animal bite wounds were considered for study. All wounds with oral self-contamination or in direct communication with a mucous membrane were excluded. The patients were grouped as: (i) Human bite—actual bite (HB) and CFI (a wound, usually a traumatic laceration over the third or fourth metacarpophalangeal joint, occurring when a person strikes another in the mouth with a clenched fist); and (ii) animal bite—dog (DB) and other (OB).

Cultural methods. Aerobic and anaerobic cultures were obtained from the wound area by aspiration of pus, when feasible, or by swab. Aspirated specimens were transported in a syringe and needle capped with a rubber stopper. Swabs were maintained in an anaerobic atmosphere before use. Upon obtaining the specimen, the swab was placed in a second glass tube that contained a deep column of prereduced semisolid Cary and Blair transport medium with resazurin as indicator and stoppered with a butyl rubber stopper (32).

Specimens were plated within 45 min of collection on the following media: MacConkey agar, brucella blood agar supplemented with vitamin K_1 (10 μg/ml), hemin (5 μg/ml) and 5% sheep blood (BAP), and phenylethyl alcohol blood agar (PEA) incubated aerobically; chocolate agar incubated in 10% CO_2; BAP, kanamycin-vancomycin laked blood agar supplemented with vitamin K_1 and hemin, and PEA, all reduced for at least 48 h in an anaerobic chamber before use, and incubated anaerobically in GasPak jars after inoculation. All incubation was at 35°C. Thioglycolate broth supplemented with vitamin K_1, hemin, and $NaHCO_3$ (1 mg/ml) was used as a backup culture.

Specimens were processed, and anaerobic isolates were identified by the procedures outlined in the *Wadsworth Anaerobic Bacteriology Laboratory Manual* (32) and the *Anaerobic Laboratory Manual* of the Virginia Polytechnic Institute (18). Aerobic and

† Address reprint requests to: Infectious Disease Division, Box 56, State University of New York, Downstate Medical Center, 450 Clarkson Ave., Brooklyn, NY 11203.

‡ Present address: Oliveview Medical Center, Sylmar, CA 91342.

facultative bacteria were identified by standard criteria (24). Fastidious aerobic gram-negative bacteria were identified by the methods described by Blachman and Pickett (3).

Control cultures for *S. aureus* were obtained from the corresponding skin surface of the unaffected extremity or corresponding body area and from the anterior nares.

Infection. Infection was considered to be present if the affected area was swollen, erythematous, and painful and/or if there was a purulent discharge. The presence of fever, abscess, or lymphangitis was noted.

RESULTS

Seventy-three patients were seen with human or animal bite wounds. The age of the patients ranged from 21 to 84 years. Sixty-five patients were male and eight were female. This reflects the nature of the veteran population comprising our study group.

Types of bites. Thirty-four patients sustained human bites, of which 18 were actual bite wounds and 16 were CFI. Thirty-nine patients sustained animal bites, of which 26 were dog bites, 4 cat bites, 4 squirrel bites, 3 rodent bites and 2 rattlesnake bites.

Time postinjury. Patients were seen from 30 min to over 30 days postinjury. Forty-four patients were seen in less than 1 day postinjury, within a range of between 30 min and 23 h. Nineteen of those patients were seen within 2 h. Twenty-nine patients were seen later than 1 day postinjury, within a range of between 25 h and more than 30 days. Only three of the patients seen were in the over-30-day group. When grouped according to type of bite wound, 30 of the 39 AB patients were seen within 24 h of injury, usually within 4 h, whereas only 10 of 18 HB patients and 3 of 16 CFI patients sought medical attention within 24 h of injury.

Location. Fifty of the 73 wounds were of the hands. Nine of the HB, 12 of the DB, and the 13 OB were to the hands.

Prior therapy. Fifty-seven of 68 patients questioned on this point had some prior form of treatment; 35 patients had used multiple prior therapies. Eleven patients had taken antimicrobial agents, 26 had washed the wound with water and soap, and 11 had washed the wound with hydrogen peroxide. Twenty-four patients had used topical agents such as vitamin A and D ointment, Camphophenique, Merthiolate, Mercurochrome, Betadine, and Phisohex.

Control cultures. Sixty-eight of the patients had control cultures of the contralateral skin surface area. Five of the control cultures grew *S. aureus;* in three of those patients the wound cultures were also positive, and in two the wound cultures were negative for *S. aureus.* Twelve patients had negative control cultures but positive wound cultures for *S. aureus.* Of the five patients without control cultures, two grew *S. aureus* from their wounds.

Fourteen of the patients had nasal control cultures done. Three of the nasal control cultures grew *S. aureus;* in two of these patients, the wound cultures were also positive for *S. aureus.* Two patients had negative nasal control cultures but positive wound cultures for *S. aureus.*

Bacteriology. Six patients (three with DB, one with a squirrel bite, one with a rattlesnake bite, and one with an HB) had neither aerobic nor anaerobic bacteria isolated from their wounds. The HB was in an oral surgeon whose clinical picture was that of herpetic infection, although the virus was not recovered on viral culture. Thirty-four patients (13 with DB, 7 with CFI, 8 with HB, and six with OB) (Table 1) had only aerobic or facultative bacteria isolated from their wounds. Six of these patients had attempted self-debridement multiple times, and another five had previously been on antibiotics active against most anaerobes. Sixty-six patients (Table 1) had aerobic or facultative bacteria isolated from their wounds. When anaerobes were isolated, they were present in mixed culture in 33 of 34 wounds (in the one patient with only anaerobes present, there was only light growth of *Propionibacterium acnes*).

A total of 224 strains of aerobic or facultative bacteria (72 likely contaminants, i.e., *S. epidermidis, Corynebacterium* species, and *Bacillus* species) were isolated (Tables 2 and 3). The most frequent isolate was alpha-hemolytic streptococci (50 strains). Thirty-nine strains of coagulase-negative staphylococci were isolated in 38 wounds. Nineteen strains of *S. aureus* were iso-

TABLE 1. *Type of microorganisms cultured from human and animal bite wounds*

Type of bite	Total no. of patients	No. of patients with aerobic isolates present	No. of patients with anaerobic isolates present	No growth
Human				
CFI	16	16 (7)[a]	9 (0)[b]	0
HB	18	17 (8)	9 (0)	1
Animal				
DB	26	23 (13)	10 (0)	3
OB[c]	13	10 (6)	5 (1)	2

[a] Numbers in parentheses indicate the number of wounds (patients) with only aerobic isolates present.

[b] Numbers in parentheses indicate the number of wounds (patients) with only anaerobic isolates present.

[c] Includes cat, squirrel, snake, and rodent bites.

lated in 18 wounds; six of these patients had attempted self-debridement. Six patients with *S. aureus* were seen within 24 h of injury; the remainder was seen between 2 days to greater than 1 month postinjury. Neither nasal or skin control cultures for *S. aureus* correlated with presence or absence of *S. aureus* in the wound.

Only 12 strains with penicillin-resistant gram-negative rods were isolated. Five were *Haemophilus parainfluenzae* (sensitive to ampicillin), and one was *Proteus mirabilis* (sensitive to ampicillin). Two biotypes of *Enterobacter cloacae* were isolated from the same patient, who also had *S. aureus* isolated, had attempted debridement, and was seen 13 days postinjury. There were 38 strains with penicillin-sensitive aerobic gram-negative rods isolated.

A total of 88 strains of anaerobic bacteria were isolated (Tables 4 and 5). *Bacteroides* species were the most frequent isolates (36 strains), none of which were *B. fragilis*. There were 11 strains of *Fusobacterium*, 15 of anaerobic streptococci, and only 1 of *Clostridium* isolated.

Two isolates failed to grow on aerobic subculture and could not be identified. One aerobic, nonfermenting gram-negative rod remains unidentified.

Infection. Forty of the patients had clinical signs of infection. All CFI patients, 8 HB patients, 13 DB patients, and 3 OB patients were infected when seen initially.

All infected patients had cellulitis, erythema, and tenderness. Only two patients (one CFI and one OB) had abscess formation. Eight patients (seven with CFI) had low-grade fever (≤100.5°F [ca. 38.1°C]). Adenopathy and lymphangitis were uncommon.

TABLE 2. *Aerobic and facultative bacteria isolated in infected and noninfected HB and CFI wounds*[a]

Bacterium	CFI[b]	HB	
		Infected	Non-infected
Streptococci			
Alpha-hemolytic	14	8	11
Beta-hemolytic group A	6	3	
Beta-hemolytic not group A	3		1
Gamma-hemolytic	1		
S. aureus	6	4	
S. epidermidis	7	4	7
Neisseria species	1	1	3
Moraxella species	1		
Nocardia species			1
Corynebacterium species	5	4	5
H. parainfluenzae	2	1	2
Eikenella corrodens	4		1
Enterobacter cloacae	1		
Klebsiella pneumoniae	1		
Enterobacter species	1		
Micrococcus species		1	

[a] Total number of infected CFI patients were 16; total number of infected and noninfected HB patients were 10 and 8, respectively. Patients with CFI wounds were seen between 2 h and 90 days after injury; patients with infected and noninfected HB wounds were seen between 10 h and 5 days, and between 0.5 and 8 h, respectively.

[b] All CFI seen were infected.

TABLE 3. *Aerobic and facultative bacteria isolated in infected and noninfected animal bite wounds*[a]

Bacterium	DB		OB[b]	
	Infected	Non-infected	Infected	Non-infected
Streptococci				
Alpha-hemolytic	1	11	4	1
Beta-hemolytic Non-group A	1	2		
Gamma hemolytic	1	1	1	
S. aureus	4	4		1
S. epidermidis	4	8	6	3
Micrococcus luteus		1		
Neisseria species			4	
Moraxella species		4		
Corynebacterium species	1	11	3	2
P. multocida	2	6	2	
Pasteurella "gas"		1	2	
P. mirabilis	1			
E. cloacae	3			
Pseudomonas fluorescens group	1	2		
Actinobacillus actinomycetemcomitans		3		
Haemophilus aphrophilus	1	1		
Chromobacterium species		1		
Bacillus species		3	1	
Unidentified gram-negative rods	1			
Nonviable gram-negative rods		2		
M-5		3		
EF-4		2		

[a] Total number of patients with infected and noninfected DB wounds were 8 and 18, respectively; total number of patients with infected and noninfected OB wounds were 7 and 16, respectively. Patients with infected and noninfected DB wounds were seen between 12 h and 13 days, and between 0.5 h and 3 days, respectively; patients with infected and noninfected OB wounds were seen between 16 h and 30 days, and between 0.5 and 5 h, respectively.

[b] Includes cat, hamster, squirrel, and snake bites.

DISCUSSION

Since 1910, human bite infections have re-

ceived attention in the medical literature (19). Several studies were done during the 1930's and 1940's to determine the bacteriology, clinical course, and most efficacious therapy of human bite infections (2, 4, 25, 27, 35). These early studies noted alpha-hemolytic streptococci to be the most common organism isolated. *S. aureus* was also found to be a common isolate. The presence of spirochetes and fusiform bacilli (2, 4, 35), terms indicating the anaerobic bacteria, were noted to correlate with a less favorable prognosis, but, according to Welch, "fortunately they usually are not abundant and often are absent" (35). Since then, methods for isolation and identification of anaerobes have improved vastly.

Since the mid-1960's human bite infections have again received attention, mostly in the surgical literature (9, 11, 12, 15, 26, 30, 31, 34) and primarily aimed at appropriate antibiotic selection. Although recent attempts have been made to define the bacteriology of human bite infections, the methodology used in these studies was less than optimal for isolation of the capnophilic and anaerobic bacteria. Consequently, the isolation of these organisms has been infrequent, and several studies reported sterile cultures from these infections (15, 31). The current literature usually does not report specific bacteriology, usually referring to pure gram-positive, pure gram-negative, and mixed infections (9, 15, 30). Most articles have reported *S. aureus* to be the most frequent organism isolated, recovered from 62 to 80% of wounds (9, 11, 30, 31), and the one most often correlated with severity of and complications from human bite infections (9, 12, 15, 31). Penicillin-resistant gram-negative rods alone or in mixed culture have been reported in 24 to 43% of bite wounds cultured (9, 11, 15, 26, 30).

The study of animal bite wounds and infections has been even less complete. The bacteriology of animal bite wounds has focused on the isolation of *Pasteurella multocida* (6, 14, 16, 23).

TABLE 4. *Anaerobic bacteria isolated from infected and noninfected HB and CFI wounds*

Bacterium	CFI[a]	HB	
		Infected	Non-infected
Bacteroides melaninogenicus subsp. *melaninogenicus*	2	1	2
B. melaninogenicus subsp. *intermedius*	5	1	3
B. melaninogenicus species	1	1	
B. asaccharolyticus			
B. ruminicola subsp. *brevis*	3	1	1
B. oralis	2		
B. corrodens	1		
B. disiens		1	
Bacteroides species	2		2
Fusobacterium nucleatum	3	1	
P. micros	3	1	
P. intermedius	1		
P. prevotti	1		
P. anaerobius	1		
P. morbillorum	1		
Peptostreptococcus species		1	
Peptococcus magnus	1		
Veillonella parvula	2	1	
V. alcalescens	2		4
Clostridium species	1		
Arachnia propionica			1
Propionibacterium acnes			1
Eubacterium species	1		

[a] All CFI were infected.

TABLE 5. *Anaerobic bacteria isolated from infected and noninfected animal bite wounds*

Bacterium	DB		OB[a]	
	Infected	Non-infected	Infected	Non-infected
Bacteroides melaninogenicus subsp. *intermedius*		2		
B. melaninogenicus species				
B. asaccharolyticus		2		
B. pneumosintes			1	
B. bivius			1	
Bacteroides species		1		
Fusobacterium nucleatum		2	1	
F. russii		1	1	
Fusobacterium species	1	1		
Peptococcus prevotii	1			
Peptococcus magnus	1	1		
Peptostreptococcus species		1		
Veillonella parvula	1			1
Propionibacterium acnes		2		1
P. granulosum		1	1	1
Propionibacterium species	1			2
Eubacterium species	1	1		
Leptotrichia buccalis		1		

[a] Includes cat, squirrel, snake, and rat bites.

Some recent reports have concentrated on cases that were associated with unidentified gram-negative rod bacteremia (8) or other serious complications (13). The DB wounds in these cases were rarely cultured, and correlation was solely by history of exposure. Recently the gingival canine flora has been studied in an effort to correlate it with bite wound bacteriology (1, 29).

The results of this study show the normal oral flora, rather than the skin flora, to be the source of most bacteria isolated from bite wound cultures. There was no striking difference between the infected and the noninfected groups when comparable. However, in human bites, group A streptococci, *S. aureus*, and *Eikenella corrodens* were usually associated with infection.

Aerobic or facultative bacteria were isolated from all CFI, 17 of 18 HB, and 33 of 39 AB wound cultures. The alpha-hemolytic streptococci were the organisms most frequently isolated from all types of bite wounds. This is consistent with earlier reports (4, 35) and in contrast to more recent reports (9, 30). Fifty strains with aerobic gram-negative rods were isolated, 38 of which were penicillin sensitive. Our findings are in conflict with other reported series (9, 15, 30) which advocate broad spectrum empiric antibiotic coverage (i.e., cephalosporins and/or aminoglycosides) due to the frequent isolation of penicillin-resistant gram-negative organisms.

Our findings do not support the recent studies that have noted a high incidence of IIj, EF-4, and other Center for Disease Control alphanumeric designated bacteria isolated from the oral and nasal cavity of canines and speculated that these bacteria might be frequent isolates from DB wounds (1, 29). Only three M-5, two EF-4, and no IIj bacteria were isolated from our 26 DB patients. *P. multocida* was isolated from 9 of 39 animal bite wounds.

The source of the 19 isolates (one patient had two biotypes isolated) of *S. aureus* from wounds in our series is uncertain. *S. aureus* is not usually part of the normal oral flora, and our contralateral control skin cultures or nasal control cultures failed to demonstrate any correlation with the presence or absence of *S. aureus* in the wound cultures. The time elapsed postinjury did not correlate with presence or absence of *S. aureus* in the wound cultures.

Since anaerobes are predominant in the normal oral flora, they should also have an important role in wounds with oral contamination. There was a significant incidence of anaerobic bacteria in all types of bite wound cultures. Nine of 16 CFI, 9 of 18 HB, and 10 of 26 DB wounds had significant numbers of anaerobic bacteria isolated. The various *Bacteroides* species were the most commonly isolated anaerobic bacteria. Anaerobes, when isolated, were almost always in mixed culture, and several species of anaerobes were present in the same wound.

E. corrodens, a capnophilic gram-negative rod that is part of the normal oral flora (25, 27, 33), was isolated from 4 of 16 of the CFI wounds. There are over 60 reported cases with *E. corrodens* isolated from human bite infections (27–33). This is of note because of the unusual antibiotic sensitivity pattern of *E. corrodens*. It is susceptible to penicillin and ampicillin, but resistant to oxacillin, methicillin, nafcillin, and clindamycin (27, 33, 34). Although many strains tested against cephalothin are reported to be susceptible (27, 28, 31), there are also isolates reported to be resistant (27), as well as clinical failures in cases with susceptible organisms while on cephalothin therapy (27). Therefore, when isolated, *E. corrodens* should have susceptibility testing if cephalosporin therapy is to be considered.

We suggest that clinicians take note of the wide variety of aerobic and anaerobic bacteria isolated from both human and animal bite wounds when considering the choice of antimicrobial therapy.

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