

Prevalence of *Corynebacteria* in Diabetic Foot Infections

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OBJECTIVE — Microbiological flora of diabetic foot infections are usually polymicrobial and frequently include bacteria of the *Corynebacterium* sp. (diphtheroids). The purpose of this study was to determine the prevalence of these bacteria in both deep and superficial cultures in diabetic patients with foot infections.

RESEARCH DESIGN AND METHODS — The charts of 50 patients of successive admissions to the Orthopedic-Diabetes Service at our hospital were reviewed to obtain the following data: age, sex, ethnic origin, method of treatment of diabetes, blood glucose level, prior antibiotics, and reports of cultures taken from bedside and intraoperative sites. Data were analyzed to compare the prevalence of diphtheroids in reliable versus unreliable cultures and the influence of other parameters on the presence of these organisms.

RESULTS — Fourteen of 19 (74%) of the intraoperative specimens grew diphtheroids compared with 25 of 65 (39%) of the bedside cultures, a highly significant difference. In addition, there was a somewhat greater occurrence of diphtheroids in women compared with men. The likelihood that contamination is the cause for the presence of diphtheroids is highly unlikely, because one arm of the study included cultures derived from deep tissue at the time of the surgical procedure (i.e., the intraoperative cultures). Cultures always grew at least one other organism in addition to the diphtheroid.

CONCLUSIONS — *Corynebacteria*, commonly known as diphtheroids, are present as a part of the polymicrobial flora in a large percentage of diabetic patients with foot infections. Because the diphtheroids were identified in culture material taken in the operating room or at the time of incision and drainage in a higher percentage of patients than in specimens from superficial cultures, it is highly unlikely that they are contaminants.

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The microbiological flora in diabetic foot infections are frequently polymicrobial. The flora usually have been described as harboring predominantly gram-positive cocci and gram-negative *Enterobacteriaceae*. The presence of diphtheroids as a part of this flora has been mentioned, but the identification and inclusion of these organisms in various reports have been erratic. *Corynebacterium* sp., other than *Corynebacterium diphtheriae*, have long been recognized as being associated with and causative of various clinical syndromes in animals and humans (1–3). Unspecified *Corynebacteria* have been suspected to contribute to the microbial flora of various infections. The purpose of this study is to determine the prevalence of *Corynebacteria* in diabetic foot infections.

RESEARCH DESIGN AND METHODS

The charts of 50 patients of successive admissions to the Orthopedic-Diabetes Service at Rancho Los Amigos Medical Center were reviewed. Patients were included in this chart review study if they had a soft tissue infection (hand or foot) that had been cultured on at least one occasion. Other patient information that was gathered from the charts included age, sex, ethnic origin, method of treatment of diabetes mellitus, blood glucose level the same day as the culture specimen, and whether or not the patient had received antibiotics before the taking of material for culture. Of the 50 patients, 27 had more than one culture taken. A total of 84 cultures were evaluated. Cultures were taken either in the operating room from deep tissue through a noncontaminated area or at bedside from freely expressed pus and/or deep within the wound. All specimens were placed on both aerobic and anaerobic transport media. Specimens were cultured for aerobes and anaerobes in the usual fashion, and bacteria were identified according to conventional methods.

Table 1—Factors affecting the presence of diphtheroids in diabetic foot infections

	Yes	No	SIGNIFICANCE
AGE (YR)	52.8 ± 12.8	48.6 ± 12.4	P = 0.10
YEARS DURATION	14.5 ± 9.0	13.3 ± 8.2	P = 0.51
BLOOD GLUCOSE (MG/DL)	189 ± 68	180 ± 67	P = 0.41
SEX			
FEMALE	20 (51%)	13 (29%)	
MALE	19 (49%)	32 (71%)	P = 0.036*
ETHNIC GROUP			
CAUCASIAN	12	8	
HISPANIC	22	29	
BLACK	5	7	
OTHER	0	1	P = 0.44
ANTIBIOTICS			
YES	30	38	
NO	9	7	P = 0.38
TREATMENT			
INSULIN	22	34	
ORAL AGENT	12	10	
DIET	3	0	
ORAL AND INSULIN	2	1	P = 0.13
CULTURE TAKEN			
OPERATING ROOM	14	5	
BEDSIDE	25	40	P = 0.007†

Age and years duration are means ± SD for 50 patients—21 diphtheroid positive, 29 diphtheroid-negative. Blood glucose levels are means for all occurrences—39 diphtheroid-positive and 45 diphtheroid-negative. Contingency tables include all cultures taken—a total of 84. Probabilities shown in contingency tables are Pearson's χ^2 values.

*Significant.

†Highly significant.

RESULTS— Table 1 compares the data regarding sex, age, ethnic origin, prior antibiotics, duration of diabetes, method of treatment of diabetes, blood glucose level, and site of culture in those patients with and without diphtheroids in their wound cultures. Analysis of these data reveals no significant differences between these parameters in patients whose lesions contain diphtheroids compared with those who do not, except for sex distribution and site of origin of culture. Female patients harbored diphtheroids in significantly greater numbers than did male subjects. When two cultures, taken on different dates, were obtained from the same patient, 8 grew diphtheroids in both cultures and 5 grew diphtheroids in only one of the two specimens. Of this latter group, the operating room speci-

mens from 3 patients grew diphtheroids, but the preoperative specimens did not. In these cultures, in this group of patients, diphtheroids were never isolated as the sole organism, but were always accompanied by one or more other bacteria. A greater percentage of operating room specimens contained diphtheroids (14 of 19, 74%) than did the bedside specimens (25 of 65, 39%). This difference was highly significant (Table 1).

CONCLUSIONS— In 1982, Lipsky et al. (4) reviewed infections caused by nondiphtheria *Corynebacteria* and discussed the pathogenic potential of this wide-ranging group of bacteria. The authors mentioned that, because these organisms commonly occur on the skin, that they have typically been dismissed

as contaminants. Since that time, many studies have been conducted on the microbiology of diabetic foot infections. Many of these publications mention *Corynebacteria* in their list of organisms found on the lesions.

Wheat et al. (5) divided their culture results into reliable (deep cultures) versus unreliable (surface cultures); *Corynebacteria* were isolated in 20% of reliable cultures and 28% of unreliable cultures. Other investigators found varying prevalence: 8 of 51 patients (6); 4 of 104 patients (7); 1 of 26 patients (8); 6 of 52 patients (9) (5 of these 6 grew only in anaerobic cultures); and 4 of 32 patients (10). In the study by Louie et al. (11), *Corynebacteria* were not mentioned. In the study by Meislin et al. (12) of cutaneous abscesses in various parts of the body, diphtheroids were identified from 0% (trunk, inguinal, vulvo-vaginal, and hand) to 13% (extremity) to 25% (buttocks). Another study did not mention *Corynebacteria* as part of the flora (13). Gibbons and Eliopoulos (14) divided the ulcers of their patients into three categories: superficial, moderate, and severe. In these patients, they found a prevalence of *Corynebacteria* in 14, 18, and 17%, respectively. In none of these reports were diphtheroids reported as the sole isolate. In these various studies, the presence and/or significance of *Corynebacteria* are alluded to as contaminants; frequently, there is no discussion at all. In a recent review of soft tissue and bone infection in the diabetic foot, *Corynebacterium* sp., along with coagulase-negative staphylococci, are mentioned as potentially clinically significant isolates (15). Recently, *Corynebacterium* was isolated as the only organism from a sample of osteomyelitic bone removed at surgery in two of our patients (A.N.B., H.C., unpublished observations) and in another patient in a different report (16). In the latter report, diphtheroids were repeatedly isolated as the sole organism both by wound curettage and from surgical specimens. This patient's antibiotic treatment failed and an amputation was required. As has been

demonstrated from our results, the percentage of *Corynebacteria* in reliable cultures is as high as in unreliable cultures. Similarly, in a study in which five sites (ranging from ulcer swab to deep tissue) were cultured in the same patients, 1 of 13 patients harbored *Corynebacteria*, and the bacteria were identified in all sites (17). In our opinion, therefore, the organism is unlikely to be a contaminant.

Corynebacteria sp. contain many varying genera, with widely varying antibiotic sensitivities. In most clinical laboratories, *Corynebacterium* sp. isolated from clinical infections are not being speciated or tested for antibiotic susceptibility. Because *Corynebacteria* are isolated with such frequency from deep (i.e., reliable tissue) foot infections and have been identified as the sole pathogen in the bone in three cases of osteomyelitis (vide supra), we feel that these bacteria may play an active, even primary, role in diabetic foot infections. Most *Corynebacteria* are sensitive to many antibiotics, including cephalosporins, penicillins, erythromycin, and vancomycin. The J-K group, however, demonstrates resistance to most antibiotics and is usually sensitive only to vancomycin (18). If antibiotic sensitivities and speciation are not available, and the *Corynebacterium* is a persistent isolate in a nonhealing wound, the authors recommend empiric vancomycin therapy. The desirability of having speciation and antibiotic sensitivities can be seen in reference to the widely varying antibiotic sensitivities of this group of bacteria.

In conclusion, we found a high prevalence of *Corynebacteria* in the polymicrobial flora of diabetic foot infections. The clinical significance and need for di-

rected antibiotic therapy are as yet unknown. More information is needed regarding the antibiotic sensitivities and subgrouping of these ubiquitous organisms.

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