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Antibiotic-Resistant Group JK Bacteria in Hospitals

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The organisms designated as Center for Disease Control group JK are gram-positive rods that have previously been described as causing serious infection in compromised hosts. Four years of hospital experience with this group of organisms in Clinical Center patients was reviewed. Studies were also undertaken on specific wards to determine frequency of occurrence and distribution patterns. Inguinal cultures taken on two wards showed that 30 to 35% of patients were colonized with group JK and that newly admitted patients may already be colonized at the time of admission. Colonization was shown to persist for weeks and sometimes months. Isolates obtained throughout the hospital were predominantly from cancer patients, particularly in wounds, abscesses, and drainage sites. Most blood isolates were from granulocytopenic patients with hematological malignancies.

A *Corynebacterium* species resistant to multiple antibiotics was described in 1976 by Hande et al. (2). Their report presented four cases of sepsis with this organism, three of which occurred in patients with leukemia. In 1977 Pearson et al. (4) described an additional 12 cases of sepsis with this organism in oncology patients. Similar organisms have also been reported to occur in patients with endocarditis following cardiac surgery (1) and also in patients with prosthetic valves (7).

This organism has been well characterized by Riley et al. (5) and has been designated as group JK. Although the organism has been called a corynebacterium, the true genus affiliation has not yet been defined. We will therefore refer to this organism hereafter as group JK.

The occurrence of several episodes of sepsis with group JK in National Institutes of Health Clinical Center patients during 1974 and 1975 enabled our laboratory to become aware of the organism's distinctive colony and Gram stain characteristics. This led to the recognition of group JK in specimens from sites other than blood, particularly skin lesions, wounds, and abscesses. Previously, group JK from such specimens would have been identified as a *Corynebacterium* species, warranting no further evaluation or antibiotic susceptibility testing. During 1977 an increase in the number of group JK isolates was noted, and by the end of 1977, seven cases of bacteremia with group JK had occurred. Studies were then undertaken to obtain more information about the occurrence, distribution, and significance of this organism.

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MATERIALS AND METHODS

Organism identification. Biochemical characterization of the isolates included in these studies was performed as described by Hande et al. (2). Characteristics for the identification of group JK include acid production either from dextrose alone or from both dextrose and maltose broths, but no acid production from broths containing sucrose, lactose, mannitol, or xylose. The organism produced catalase, but had negative reactions when tested for urease production, motility, nitrate reduction, and esculin hydrolysis. Bile-esculin slants with horse serum (8) were used to determine esculin hydrolysis. On this medium the organism grew luxuriantly within 48 h, but showed no hydrolysis of esculin.

Antibiotic susceptibility testing. Testing was performed on all isolates, using a microdilution technique described by MacLowry et al. (3) until December 1977 and that of Witebsky et al. (9) from January 1978 through 1979. The broth medium used consisted of Columbia broth enriched with a final concentration of 10% horse serum, 2.5 μg of nicotinamide adenine dinucleotide per ml, and 2.5 μg of hemin per ml. Microdilution trays were incubated aerobically with 5% CO_2 for 48 h before being read. Tests for penicillinase production were performed by using a rapid acidometric test (6).

Selective isolation of group JK. For the surveys to be described, the following general isolation techniques were used. Specimens were inoculated on blood agar plates and also on special blood agar plates containing a selective antibiotic, either cephalothin at 20 μg/ml or gentamicin at 10 μg/ml. Plates were incubated for 48 h; all different colony types were isolated and Gram stained. All gram-positive rods resembling corynebacteria were further screened by bile-esculin

and urea reactions. Only isolates which were urease negative and grew well on bile-esculin slants, but did not hydrolyze esculin, were further characterized as described above. The selective antibiotic agar plates often helped to speed the isolation of group JK and sometimes revealed its presence when its growth might otherwise have been obscured by other organisms. Antibiotic susceptibility testing was done on all isolates which biochemically resembled group JK.

Screening surveys. The following studies were done between April 1977 and March 1978.

(i) Body distribution. Ten patients from whom group JK had been isolated from a routinely submitted specimen were subsequently cultured from other body sites, including nose, hands, ears, throat, urine, and inguinal, rectal, axillary, and umbilical areas. Except for urines, specimens were transported to the laboratory in Amies transport media; all were processed as described for the selective isolation procedure above.

(ii) Normal volunteer inguinal and axillary cultures. Seventeen normal volunteers (non-patients) were cultured from inguinal and axillary sites, using saline-moistened swabs which were transported to the laboratory in Amies transport media, inoculated, and processed as described above. Five of the volunteers were hospital personnel, although only one was involved with patient care.

(iii) Selected hospital ward surveys. Inguinal swab cultures were taken by one nurse epidemiologist from two selected wards. Swabs were inoculated onto media directly at the bedside and then processed in the laboratory according to the selective isolation procedure described above.

Ward A was selected for study because no serious infections with group JK had occurred in their patient population. In contrast, the second ward chosen, ward B, had the highest occurrence of group JK bacteremia encountered in the Clinical Center. Two studies were done on ward B. During the first study, cultures were taken on all patients on the ward at twice weekly intervals. During the second study, only newly admitted patients were entered into the study and subsequently recultured either at weekly intervals or upon readmission, if they were discharged and returned during the following 10-week follow-up period.

Isolates obtained from the routine bacteriology laboratory. In addition to the specific studies described above, group JK organisms were also obtained from patient materials processed by routine laboratory procedures. If an isolate morphologically resembled group JK, antibiotic susceptibility testing was performed and the organism was also identified biochemically as described above. No specific measures had been instituted to select for group JK. This collection of isolates includes organisms encountered between 1975 and 1979.

RESULTS

Culture of body sites. Ten patients from whom group JK had been isolated from a routinely submitted specimen were subsequently cultured from other body sites within a few days of the original positive culture. All sites were not cultured from all 10 patients. Table 1 summarizes the results of these cultures. Inguinal, rectal, and axillary areas were the most commonly colonized sites.

Culture of normal volunteers. Seventeen normal volunteers, 14 males and 3 females, were cultured from inguinal and axillary sites to see if the organism could be found as part of the normal flora of healthy individuals. Two (12%) of these individuals had positive cultures, both from inguinal, not axillary, areas. One individual was a hospital employee, not involved in patient care; the other was not a hospital worker.

Culture of patients on ward A. Patients on ward A had not experienced group JK bacteremia or other known serious infections with this organism. There had been instances, however, of occasional group JK colonization and possible infection of skin or wound sites, as part of mixed flora. For the screening surveys, all patients on this ward, on a given day, had inguinal swab cultures taken. All specimens were taken by one nurse epidemiologist, and all bacteriology was performed by one technologist. The spectrum of diseases, age and sex of patients, and results of

TABLE 1. *Culture of body sites from patients known to harbor group JK*

Body site	No. of patients cultured	Cultures positive	
		No.	%
Inguinal	9	8	89
Rectal	8	7	87
Axillary	10	7	70
Urine	6	3	50
Umbilical	7	3	43
Nose	5	2	40
Hands	6	2	33
Ears	8	2	25
Throat	8	1	12

TABLE 2. *Inguinal cultures, ward A*[a]

Patient diagnosis	No. of patients cultured	No. of patients positive
Wegener's granulomatosis	5	2
Mucocutaneous candidiasis	4	1
Chediak-Higashi	2	1
Chronic urticaria	2	0
Tuberculosis	1	1
Hypereosinophilic syndrome	1	1
Midline granuloma	1	1
Chronic granulomatous disease	1	0
Hereditary angioedema	1	0
Polyarteritis nodosa	1	0
Oral candidiasis	1	0

[a] Of the 20 patients cultured, 9 were male and 11 were female, with 6 (67%) and 1 (9%) positive cultures, respectively.

TABLE 3. *Biweekly inguinal cultures, ward B*

Patient no.	Sex	Successive culture periods										Subsequent positive cultures at:
		1	2	3	4	5	6	7	8	9	10	
1	M	+[a]	0[b]	0	0	0	+	+	+	+	+	
2	M	+	+	+	+	+	0	0	0	0	0	6 mo
3	M	0	0	+	−[c]	0	−	−	0	0	0	
4	M	−	−	−	+	+	+	0	0	0	+	1 mo
5	M	0	0	0	0	+	0	0	0	0	0	5 mo
6	M	0	0	0	0	0	+	+	+	+	0	6 mo
7	M	0	0	0	0	0	+	0	−	+	0	
8	M	0	0	0	0	0	0	+	0	0	0	5 mo
9	F	0	0	0	0	0	−	−	−	+	−	2 mo

[a] +, Culture positive.
[b] 0, Culture not obtained (patient not in hospital).
[c] −, Culture negative.

TABLE 4. *Ward B inguinal cultures, new patients*

Patient no.	Sex	Successive culture periods[a]									
		1	2	3	4	5	6	7	8	9	10
1	M	−[b]	−	−	0[c]	0	0	0	0	0	0
2	M	−	−	0	−	0	0	0	−	0	0
3	M	+[d]	0	+	0	0	0	+	0	0	+
4[e]	M	−	0	0	0	0	0	0	0	0	0
5	M	+	0	0	0	+	0	0	+	0	0
6	M	−	0	0	0	0	0	0	0	0	0
7	M	+	0	0	+	0	0	+	0	0	0
8	M	−	+	0	0	0	0	0	0	0	+
9	M	+	0	0	0	0	+	0	0	+	0
10	F	−	0	0	−	0	0	0	0	−	0
11	F	+	0	0	0	0	0	0	0	0	0
12	F	−	−	0	0	0	−	0	0	−	0
13	F	−	0	0	0	−	0	0	0	0	0
14	F	−	0	0	0	0	0	0	0	0	0
15	F	+	0	0	+	0	+	0	+	0	0

[a] Cultures taken at approximately weekly intervals until patient's discharge, and also upon patient's return if readmitted during period of study.
[b] −, Culture negative.
[c] 0, Culture not obtained (patient not in hospital).
[d] +, Culture positive.
[e] A subsequent positive culture was obtained from this patient 2 years later from a wound site.

culture are summarized in Table 2. Seven of 20, or 35%, of the cultures yielded organisms characteristic of group JK. Although this is a higher percentage than that found for the normal volunteers, the difference is not statistically significant. Of note is the substantially higher isolation rate from male patients. Although no specific follow-up culture was done after this one survey culture, the organism was isolated again from one of the seven patients during subsequent hospital admissions. In this instance, the isolate was obtained 1 year later from a groin abscess and was found in mixture with four other organisms.

Culture of patients on ward B. Ward B, a pediatric oncology service, had several prior cases of bacteremia with group JK as well as frequent isolation of the organism from cultures of skin lesions, wounds, and other sites. For a period of 5 weeks, biweekly inguinal swabs were cultured from all patients on this service. The cultures were all obtained by one nurse epidemiologist, and bacteriology was performed by one technologist. Seven to 11 patients were cultured on each occasion, resulting in a range of one to four positive cultures at each time. A total of 36 individual patients were cultured (some repetitively), 9 of whom were positive for group JK on at least one occasion. The culture results for these nine patients are shown in Table 3. Seven of these nine patients were found to have positive cultures at the time of entry to this study. The other two became positive during the study period. Five patients carried group JK for 1 to 3 weeks (Table 3). Although no attempts were made to specifically obtain follow-up cultures at a later date, six of these nine positive patients had routine cultures positive for group JK during subsequent hospital admissions. Carriage of the organism can thus persist for weeks to months.

Since seven of the nine positive patients were positive at the time of first culture, and since carriage can persist for weeks to months, these seven patients may have acquired the organism during previous Clinical Center hospitalizations. We therefore cultured 15 patients within 24 h of their first admission to this pediatric oncology service. The results are shown in Table 4. Six of the 15 patients had inguinal cultures positive for group JK at the time of this first admission. One was negative on day 1 but heavily positive after 1 week. Persistence of positive cultures can again be seen in five of these patients. It is notable that 14 of the 15 patients had been recently hospitalized elsewhere before their admission to the Clinical Center.

A summary of culture results for all patients

cultured during both studies is shown in Table 5. There was again a higher incidence in males. Of the 16 patients positive during these studies, one became septic with group JK 1 month after the study. This patient was simultaneously septic with *Bacteroides fragilis* and expired. Of the 35 patients with negative study cultures, none became bacteremic with group JK during the ensuing 2-year period.

Cultures submitted for routine bacteriological examination. Since 1975, 111 isolates of group JK were obtained from patient specimens submitted for routine culture. All have been confirmed by biochemical evaluation and have had antibiotic susceptibility tests performed. Sources of the isolates are summarized in Table 6. These 111 isolates were obtained for 74 patients. Sixty-nine of the 111, or 62%, were from skin lesions, wounds, abscesses, and drainage sites, with perineal and inguinal locations being the most common. Most of the isolates were found in mixed culture with other bacteria. Blood cultures were the next most frequent source; the majority of these were in pure culture, although polymicrobic sepsis also occurred.

Table 7 shows the diagnoses of 57 patients for whom this information was available. Seventy-one percent were male and 29% were female. Overall patient admissions during this time period were approximately 53% male; cancer patient admissions were approximately 57% male.

Antibiotic susceptibilities. Table 8 summarizes the antibiotic susceptibilities of the isolates obtained from routine specimens. The majority of isolates were resistant to amikacin, carbenicillin, cephalothin, chloramphenicol, clindamycin, erythromycin, gentamicin, kanamycin, lincomycin, oxacillin, penicillin, streptomycin, tetracycline, and tobramycin. Five isolates that were penicillin resistant were checked for penicillinase production; all were negative. All of the isolates tested were susceptible to vancomycin.

The number of isolates from the individual ward studies were too few to establish firm differences among the study populations and are not shown in Table 8. Their antibiotic susceptibility patterns did suggest, however, that newly admitted patients had isolates which were frequently susceptible to erythromycin, tetracycline, kanamycin, and gentamicin.

DISCUSSION

Cultures of various body sites from patients known to harbor group JK showed that inguinal, rectal, and axillary areas are commonly colonized. The organism was found in cultures of inguinal swabs in 2 of 17 healthy volunteers.

Inguinal cultures from wards A and B showed that 30 to 35% of these hospitalized patients harbored the organism. On ward B, carriage of group JK persisted from weeks to months. Both wards had a preponderance of isolates from males, although this was more striking on ward A. Culture of new patients on ward B revealed that 6 of 15, or 40%, of new admissions to this ward were already positive within 24 h of their first admission to the Clinical Center. However, most of these patients had been seen at other hospitals before their admission here, so hospital acquisition was not ruled out. Also of interest on ward B was the distribution of isolates; 50% of sarcoma patients were colonized compared to 15 to 22% of the leukemia and lymphoma patients.

Compilation of the diagnoses for 57 patients from whom group JK was isolated from routinely submitted specimens revealed that 23 of 57 had hematological malignancies, 25 of 57 had solid tumors, and 9 were non-cancer patients. Of the isolates obtained from these routine specimens, skin, wound, abscess, and drainage sites were the most common sources, usually as part of mixed flora. Of the 15 blood isolates, 13 were from patients with hematological malignancies, mainly lymphomas and leukemias. Only 1 of these 15 patients was a sarcoma patient despite the high colonization rate of sarcoma patients. Only two episodes of bacteremia occurred outside of the leukemia and lymphoma patients; these were in one sarcoma patient and one neuroblastoma patient. Thirteen of these 15 patients

TABLE 5. *Summary of inguinal cultures, ward B*

Diagnosis	No. of patients positive/no. cultured (%)		
	Male	Female	Total
Sarcoma[a]	9/19	2/3	11/22 (50)
Lymphoma	2/6	0/3	2/9 (22)
Acute leukemia	2/9	0/5	2/14 (15)
Miscellaneous: aplastic anemia, lymphoproliferative disorder, ovarian carcinoma, benign follicular hyperplasia, not known	0/2	1/4	1/6 (17)
Total	13/36 (36)	3/15 (20)	16/51 (31)

[a] Osteogenic, Ewing's, and rhabdomyosarcoma.

TABLE 6. *Source of isolates from routinely submitted specimens (74 patients)*

Source	No.
Skin, wound, abscess, drainage sites (n = 69) from:	
Head, extremities	8
Ear	6
Axilla	8
Abdomen	7
Perineal, perirectal, inguinal	20
Back	3
Location not specified	17
Blood	15
Peritoneal fluid	3
Respiratory (nose, throat, sputum)	8
Urine	7
Rectal	5
Miscellaneous sources: cerebrospinal fluid, pleural fluid, catheter tip, dialysis tip	4

TABLE 7. *Summary of diagnoses on patients with routine cultures positive for group JK*

Diagnosis	No.
Hematological malignancies (n = 23)	
Lymphoma	12
Acute or chronic myelogenous leukemia	7
Acute or chronic lymphocytic leukemia	3
Leukemic reticuloendotheliosis	1
Non-hematological malignancies (n = 25)	
Sarcoma	8
Melanoma	3
Miscellaneous carcinomas: basal cell, breast, lung, gastrointestinal, testicular, thyroid, adrenal	14
Non-cancer (n = 9)	
Wiskott-Aldrich	2
Rheumatoid arthritis	2
Immune defect: mucocutaneous candidiasis, intestinal atrophy, chemotactic defect	3
Neurological disorders	2

TABLE 8. *Group JK antimicrobial susceptibilities*[a]

Antimicrobial agent	No. tested	MIC (μg/ml)	%
Amikacin	29	≤4	7
		≥32	93
Carbenicillin	73	≤60	1
		≥200	97
Cephalothin	73	≤10	3
		≥50	97
Chloramphenicol	37	≤6	8
		≥20	92
Clindamycin	31	>5	100
Erythromycin	73	≤2	20
		≥4	78
Gentamicin	73	≤3	17
		≥6	83
Kanamycin	73	≤6	10
		≥24	90
Lincomycin	42	≤3	5
		≥6	95
Oxacillin	73	>6	100
Penicillin	73	≤1.6	1
		≥6	99
Streptomycin	30	≤25	3
		≥100	97
Tetracycline	73	≤4	28
		≥8	64
Tobramycin	30	≤3	7
		≥12	93
Trimethoprim-sulfamethoxazole	7	R[b]	100
Vancomycin	67	<5	100

[a] Isolates from routinely submitted specimens only. MIC, Minimum inhibitory concentration.
[b] R, Resistant by disk susceptibility tests.

are known to have been granulocytopenic (<500 leukocytes/mm^3) at the time of bacteremia (information was not available on the other two patients). Fourteen of the 15 expired, 12 of whom expired within a 2-week period of their episode of group JK bacteremia. These findings are similar to those of Pearson et al. (4), who noted that all of their cases of sepsis occurred in patients with hematological malignancies or aplastic anemia. They had no isolates from solid-tumor patients.

The majority of our isolates were resistant to multiple antibiotics, although some variability occurred, particularly with erythromycin and tetracycline. The only antibiotic tested to which all isolates were susceptible was vancomycin. Our results for most antibiotics showed a greater percentage of resistance than those reported by Riley et al. (5), but this may reflect the fact that the majority of our isolates were from a patient population that is frequently immunosuppressed and therefore frequently exposed to a variety of antibiotics.

In summary, this distinct group of *Corynebacterium*-like organisms may exist as part of the normal skin flora, particularly on areas of the body such as inguinal or axillary sites. Our studies suggest that males may harbor the organisms more frequently or perhaps in greater quantities than females. Survey cultures of two Clinical Center wards demonstrated that 30 to 35% of

patients carried the organism. Colonization persisted for weeks and months. Although colonization occurred in both cancer and non-cancer patients, sepsis occurred only in cancer patients, usually during periods of granulocytopenia, usually in patients with hematological as opposed to solid neoplasms, and usually as part of terminal events. Vancomycin appears to be the most reliably effective antibiotic as judged by in vitro susceptibility testing.

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