Microbiology of Adult Cellulitis

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Needle aspiration of cellulitis sites is commonly advocated to assist in the identification of causative organisms. Twenty-five nondiabetic, adult patients with a clinical diagnosis of cellulitis had site aspirations and blood cultures obtained before antibiotic therapy was initiated. Site cultures were positive in 6 of 25 patients. Blood cultures were positive in 4 of 25 patients. All organisms except one (Enterobacter agglomerans) were staphylococci or streptococci. The gram-negative bacilli were not believed to be a pathogen based on the patient's prompt response to nafcillin. In adult patients who do not have complications, the use of needle aspiration was not supported. Empiric treatment of cellulitis aimed at gram-positive cocci appears to be sufficient.

Cellulitis can be defined as an acute inflammatory reaction of the skin, particularly the deeper subcutaneous tissue, generally characterized by pain or tenderness, erythema, swelling, and warmth. It is most commonly observed in the pediatric population and among parenteral drug abusers.[1,2] The rational selection of initial antibiotic therapy must be based on preexisting knowledge of the most likely pathogens. While the microbiology of cellulitis in the pediatric population is well known, with Staphylococcus aureus, Streptococcus pyogenes, and Hemophilus influenzae type B being the predominant organisms involved,[2–7] the causative bacteria in adults are less well described. A standard infectious disease textbook implicates Streptococcus pyogenes and Staphylococcus aureus as the most common causative organisms[8]; however, cases involving Hemophilus influenzae type B,[9–12] Streptococcus pneumoniae,[13,14] Neisseria meningitidis,[15] Pseudomonas aeruginosa,[16] other gram-negative rods,[17,18] and non-group A streptococci[18,19] have been reported. A study was undertaken to identify the causative organisms of adult cellulitis.

METHODS

Patients presenting to the emergency unit of the University of Cincinnati Medical Center with a clinical diagnosis of cellulitis were considered for inclusion. Cellulitis was defined as an acute, cutaneous inflammation characterized by the presence of swelling, heat, and erythema. Patients were excluded for the following reasons: age less than 18 years, diabetes mellitus, antibiotic therapy within the preceding seven days, severe thrombocytopenia (platelet count $< 40^9$/L; 40×10^3/mm^3), or a history of deficiency of clotting factors II, V, VIII, IX, or X. The protocol was approved by the University of Cincinnati Medical Center Committee for Human Research, and written informed consent was obtained from each patient prior to entry into the study.

Blood Cultures

Two sets of blood cultures were obtained from peripheral veins following preparation of the area with povidine-iodine and 70 percent isopropyl alcohol. The samples were inoculated at the bedside into a biphasic bottle containing triptic soy broth with sodium polyanetholesulfonate, carbon dioxide, and chocolate agar and into a companion bottle containing anaerobic Columbia broth (Gibco Life Technologies, Lawrence, Mass). The culture processing and organism identification were carried out according to standard laboratory protocols.

Site Culture

The leading edge of the cellulitis was identified and aspiration was performed using an 18- to 22-gauge needle attached to a 3-mL syringe. The needle was inserted at approximately a 15-degree angle and 1 to 1.5 mL of non-

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TABLE 1. ORGANISMS FROM CULTURE-POSITIVE PATIENTS

Patient No.	Site Culture	Blood Culture
1	—	Staphylococcus aureus
2	Staphylococcus epidermidis (three colony types)	—
3	Staphylococcus aureus Staphylococcus epidermidis Streptococcus pyogenes	Staphylococcus epidermidis
9	Enterobacter agglomerans	—
14	Streptococcus pyogenes	—
22	—	Streptococcus (viridans group)
23	Staphylococcus aureus	—
24	Staphylococcus epidermidis	—
25	—	Staphylococcus epidermidis

bacteriostatic 0.9 percent sodium chloride was injected. Without removal of the needle from the injection site, the fluid was immediately reaspirated into the syringe, the needle withdrawn, and the syringe sealed. The syringe was sent to the microbiology laboratory and the contents were Gram stained and cultured. The specimens were plated for aerobic growth on sheep blood agar, MacConkey agar, and colistin nalidixic acid agar, plus Columbia sheep blood agar, kanamycin-vancomycin agar, neomycin agar, and bacteroides bile esculin agar were inoculated for the recovery of strictly anaerobic organisms. In addition, all specimens were introduced to thioglycolate broth. Plates were incubated aerobically at 35 °C for 24 hours in 5 percent carbon dioxide; plates were incubated anaerobically at 35 °C for 48 hours in a gas pack jar.

RESULTS

The study period was approximately one year. Twenty-five patients (14 male and 11 female) were enrolled in the study. No patients were excluded from analysis after enrollment; however, four patients were not enrolled due to administration of antibiotics prior to obtaining cultures. The median age of the subjects was 38 years (range 19 to 85 years). Eight patients had oral temperatures exceeding 100 °F (37.8 °C) at admission. Leukocytosis (white blood cell count > 10.5×10^9/L; $10.5 \times 10^3/\mu$L) was present in 12 cases and 10 subjects had greater than 0.10 band cells in the leukocyte differential. The organisms recovered from the culture-positive patients are shown in Table 1. Site cultures were positive in six of 25 patients (24 percent).

TABLE 2. PREVIOUS STUDIES OF ADULT CELLULITIS

Study	Number of Patients	Site Culture Positive No. (%)	Blood Culture Positive No. (%)
Ginsberg[1]	16	2 (13)	0 (0)
Hook et al[21]	50	5 (10) 10 (20)*	2 (4)
Liles and Dall[22]	24	8 (33)	1 (4)
Goldgeier[23]	13	1 (8)	2 (18)**
Lentino et al[24]	39	27 (69)	1 (3)
Musher et al[25]	35	14 (40)	0 (0)
Gremillion et al[26]	12	5 (42)	NR
Orangio et al[27]	34	29 (85)	8 (24)
Lee et al[28]	21	12 (57)	NR

NR—Not reported
** Punch biopsy specimens*
*** Only 11 patients had blood cultures performed*

Blood cultures were positive in four of 25 (16 percent). The subject's admission temperature, white blood cell count, and differential were not useful in predicting the occurrence of positive cultures. In only one case (patient 3) was the same organism recovered from both the site and the blood. Underlying disease states present in the culture-positive patients included one case each of alcoholism, anemia, hypertension, intravenous drug abuse, a leg fracture, and a history of mental disease. Two subjects had no underlying diseases, and one developed cellulitis at the site of a needlestick from donating plasma. All organisms except one (Enterobacter agglomerans) were gram-positive cocci. Staphylococcus epidermidis was recovered from four patients; however, the clinical significance of the presence of this organism is not known. The Enterobacter agglomerans isolated from a site culture was not believed to be the primary pathogen, as the patient responded promptly to intravenous nafcillin before the availability of culture results. Three isolates each of Staphylococcus aureus and Staphylococcus epidermidis were resistant to penicillin. All of the gram-positive cocci isolated were susceptible to methicillin and cephalothin.

DISCUSSION

The use of needle aspiration in the bacteriologic diagnosis of soft-tissue infections was described as early as 1941 by De Waal.[20] More recently, Uman and Kunin[16] reported on its usefulness in seven cases and strongly urged the adoption of this procedure. Various methods (in addition to blood cultures) have been employed in an attempt to recover organisms from cellulitis patients. In addition to aspiration techniques similar to the one described here,

TABLE 3. CLASSIFICATION OF ORGANISMS ISOLATED FROM SITE CULTURES

Study	Staphylococci	Streptococci	Gram-negative Rods	Anaerobes	Other
Ginsberg[1]	1*	1	0	0	0
Hook et al[21]	4	2	0	0	0
Liles and Dall[22]	3	3	2	1	1
Goldgeier[23]	0	0	1	0	0
Lentino et al[24]	26	10	20	ND	0
Gremillion et al[26]	6	1	1	0	0
Orangio et al[27]	20	27	15	4	1
Lee et al[28]	7	3	1	4	0
Total	67	47	40**	9	2

ND—Not done
** Reported as gram-positive cocci in clusters (presumably Staphylococcus)*
*** Includes Pasteurella multocida (4) and Eikenella corrodens (1) probably susceptible to penicillin*

fine-needle aspiration biopsy and punch biopsy have been utilized. Hook et al[21] compared needle aspiration with punch biopsy and found that punch biopsy had a higher yield, albeit still low. The incidence of positive culture results in previous studies in adult patients is summarized in Table 2. The recovery rate of organisms in the current study falls within the reported ranges for both site and blood cultures. The infrequent correlation of site and blood cultures found here is consistent with the results of previous studies.[21–23] The bacteriologic findings in this literature are summarized in Table 3. In most previous studies, gram-positive cocci (streptococci and Staphylococcus aureus) predominated from site cultures.[1,21,22,25–26,28] In two studies most organisms were gram-positive; however, many gram-negative bacilli (various Enterobacteriaceae, Hemophilus, and Pseudomonas) were also recovered.[24,27] Patients in one of these studies consisted solely of intravenous drug abusers. The other study involved general medical and surgical patients admitted to a Veterans Administration hospital, and while many gram-negative bacilli species were isolated from specimens, their role in pathogenesis is unclear. No difference was found in the cure rate between the groups receiving cephalothin and cefotiam. Cefotiam, an investigational agent, is reported to have greater in vitro activity against gram-negative organisms than do first-generation cephalosporins, cefoxitin, or cefuroxime.[29,30]

Site aspiration was not found to be a useful procedure. Only anticipated pathogenic organisms were recovered. Although the procedure is relatively safe, the additional cost and low yield of significant culture results argue against the routine use of site aspiration. Specific subgroups of patients who may benefit from site culture include intravenous drug abusers, the immunocompromised host, patients with cellulitis of the neck, those with cellulitis following an upper respiratory tract infection, and patients not responding promptly to conventional therapy. It appears that patients with cellulitis rarely become bacteremic from the cellulitis site. As site and blood cultures correlate poorly, the criteria for drawing blood cultures is not changed by the performance of the site culture. In most adult patients, empiric therapy with a penicillinase-resistant penicillin or first-generation cephalosporin would be adequate coverage for infections caused by Staphylococcus and Streptococcus. In two groups, cellulitis of the neck and that following an upper respiratory tract infection, Hemophilus influenzae type B is of concern, and empiric therapy with an agent effective against this organism may be warranted. With intravenous drug abusers and the immunocompromised host, a higher incidence of gram-negative organisms might be anticipated, so broader spectrum coverage would be desired.

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