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Occurrence of *Staphylococcus lugdunensis* in Consecutive Clinical Cultures and Relationship of Isolation to Infection

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Consecutive record review over a 63-month period revealed 229 *Staphylococcus lugdunensis* isolates, or 10.1% of the staphylococcal species that were not *Staphylococcus aureus* or *Staphylococcus epidermidis*. A total of 155 *S. lugdunensis* specimens were isolated from sites over the entire bodies of the 143 patients studied. The most common clinical diagnoses were skin and skin structure infections (55.4%) and blood and vascular catheter infections (17.4%). For 40% of the reviewed specimens, *S. lugdunensis* was the sole agent isolated, and for 60% of specimens, *S. lugdunensis* was isolated as part of mixed flora. In only 15.4% of clinically reviewed specimens was *S. lugdunensis* clearly a culture contaminant or colonizing organism. The pattern of human infection identified in this study emphasizes the predominance of skin and soft tissue *S. lugdunensis* infections over deep serious infections such as endocarditis, peritonitis, infected hip prosthesis, and osteomyelitis and vascular-associated infections. *S. lugdunensis* should be included along with *S. epidermidis*, *Staphylococcus haemolyticus*, and *Staphylococcus saprophyticus* as a coagulase-negative species of *Staphylococcus* pathogenic for humans.

Staphylococcus lugdunensis is a recently described coagulase-negative species of the genus *Staphylococcus* named for Lyon (Latin adjective of Lugdunum), the French city where the organism was first isolated from a human with disease. Freney et al. (4) reported 11 strains from humans, 5 of which were from blood cultures, that they isolated in France; they were characterized by production of fibrinogen affinity factor, ornithine decarboxylase, and susceptibility to novobiocin. Tests for heat-stable nuclease, coagulase, and staphylokinase were negative, as were tests for enterotoxins A, B, and C, toxic shock syndrome toxin 1, and exfoliatin toxin (4). Laboratory identification has been further addressed by Hébert (5). Subsequently, the clinical syndromes for 13 patients were described (3). These syndromes included infective endocarditis, septicemia, deep tissue infection, vascular prosthesis infection, osteomyelitis, and skin infection (3). Four cases of *S. lugdunensis* endocarditis (1, 10) and three cases of *S. lugdunensis* peritonitis (8) have been reported separately. A primary pathogenic role for this species has been supported by the work of Lambe et al. (7), who compared the pathogenicities of 20 *S. lugdunensis* strains with those of three other coagulase-negative staphylococcal species in an animal model. *S. lugdunensis* caused abscess formation in 60% of patients; 100% of abscess cultures were positive. Screening for protease was positive, but other virulence factors such as DNase, esterase, lipase, and delta hemolysin were not found (7). A delta-like hemolysin has been described previously (2). In this study we examined the occurrence of *S. lugdunensis* in consecutive clinical specimens over a 63-month period. The detailed clinical characteristics of 50 culture-positive patients are presented. This report represents the first description of U.S. isolates, and expands the spectrum of clinical syndromes reported in previous studies (3, 4).

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MATERIALS AND METHODS

Patient population. All culture specimens were collected from patients evaluated at The Ohio State University multispecialty outpatient clinics or admitted to University Hospitals, a 1,000-bed tertiary-care teaching facility in Columbus, Ohio, between January 1985 and March 1990.

Clinical staphylococcal isolates. All culture specimens were submitted to the Bacteriology Section, Division of Clinical Microbiology, University Hospitals, for routine bacterial culture. When possible, specimens were examined directly by Gram-stained smear as well as by routine culture. Staphylococcal culture isolates associated with a purulent exudate, visualized in a Gram-stained smear as gram-positive cocci associated with purulence or necrotic debris, or found in culture of a specimen from a sterile site were identified. Identification was by growth and hemolytic characteristics on Trypticase soy agar with 5% (vol/vol) sheep blood agar at 35°C; catalase production, latex slide agglutination for clumping factor and protein A (Accu-Staph; Carr-Scarborough Microbiologicals, Inc., Decatur, Ga.); tube coagulase (pig plasma); modified oxidase reaction (Microdase Disk; Remel Laboratories, Lenexa, Kans.); and an in-house microtube panel of 24 biochemical tests including L-pyrrolidonyl-β-naphthylamide hydrolysis (1989 and 1990 only); nitrate reduction; acid production from glucose, arabinose, xylose, mannose, rhamnose, raffinose, fructose, sucrose, trehalose, maltose, lactose, mannitol, sorbitol, and salicin; ornithine and arginine decarboxylation; esculin hydrolysis; growth in bile; and urease production. Results were interpreted by using published references (4–6) and by comparison with the results for six strains of *S. lugdunensis* kindly provided by J. Freney. Numerical codes derived from results of the 24 biochemical tests described above along with patient administrative data and specimen type were regularly entered into an in-house computer program. *S. lugdunensis* isolates were retrospectively identified from computer lists following publication of the species description (4). Data for all staphylococcal species that were not *S. aureus* or *S. epidermidis*

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TABLE 1. Consecutive clinical specimens and specimen sources over a 63-month period, 1985 to 1990

Yr	No.		% *S. lugdunensis*	No. of patients with *S. lugdunensis*	No. of specimens	% Inpatients	Specimen source (no. of patients)							
	S. lugdunensis isolates	Non-*S. aureus*, non-*S. epidermidis* isolates					Cellulitis	Abscess	Wound	Respiratory	Blood	Catheters (vascular)	Urogenital	Other
1985	9	275	3.3	6	8	38	0	0	4	1	2	0	0	1
1986	24	294	8.2	19	22	55	1	0	6	1	3	3	4	2
1987	18	418	4.3	18	18	51	1	2	5	0	1	3	2	1
1988	44	432	10.2	29	30	33	3	8	14	3	2	2	1	7
1989	116	714	16.2	56	59	44	2	3	28	7	6	3	7	4
1990[a]	18	127	14.2	15	18	44	0	1	8	1	1	0	1	0
Total (%)	229	2,260	10.1	143	155	45	7 (4.5)	14 (9.0)	65 (41.9)	13 (8.4)	15 (9.7)	11 (7.7)	15 (9.7)	15 (9.7)

[a] Three months.

were retrieved from computer records for the study period. *S. lugdunensis* was then identified within this group.

Patient record review. The medical records of patients with positive cultures between June 1986 and February 1989 who could be identified were reviewed for clinical presentation, direct smear and culture results, and treatment.

RESULTS

A total of 2,260 *Staphylococcus* isolates were retrieved from computer records. The distribution of *S. lugdunensis* is reported in Table 1. *S. lugdunensis* accounted for 229 (10.1%) of the non-*S. aureus*, non-*S. epidermidis* strains from 155 specimens submitted from 143 patients. The number of patients identified with *S. lugdunensis* as well as the total number of patients with non-*S. aureus*, non-*S. epidermidis* isolates increased over the study period. Specimens were almost as likely to be from inpatients (45%) as from outpatients. The specimens were submitted from a variety of anatomical sites. In addition to the sites listed in Table 2, sites included cerebrospinal fluid, bone marrow, bone, cheek, hip prosthesis, respiratory tract, elbow, throat, pleural fluid, fetal membranes, fetal lung, aortic valve, spleen, kidney, urine, and gall bladder (bile).

The anatomic site of isolation and clinical diagnosis for patients whose medical records were reviewed are summarized in Table 2. Fifty patients were identified and accounted for 52 isolates (*S. lugdunensis* was isolated from separate sites in 2 patients 2 and 8 months apart). The ages of the patients ranged from 16 to 83 years (mean ± standard deviation, 51 ± 18.1 years); there were 27 males. Most patients had at least one predisposing illness; half of the patients had diabetes or had undergone surgery. Most patients had low-grade fevers, but systemic signs of infection were generally absent. For 39% of specimens from infected patients, *S. lugdunensis* was the sole agent isolated. For 60% of all specimens, *S. lugdunensis* was isolated as part of mixed flora. Other bacterial isolates from these patient's lesions included *S. epidermidis* (n = 12), *S. aureus* (n = 7), other staphylococci (n = 3), *Enterococcus faecalis* (n = 8), other streptococci (n = 8), diphtheroids (n = 8), *Escherichia coli* (n = 6), *Klebsiella pneumoniae* (n = 5), other enteric gram-negative bacilli (n = 10), *Pseudomonas aeruginosa* (n = 3), other nonfermenters (n = 1), anaerobes (n = 3), and fungi (n = 5). These bacteria reflected the location of the lesions and included some common skin commensal organisms such as *Micrococcus* sp., alpha streptococcus, and diphtheroids as well as fecal type bacteria commonly associated with mixed infections. For 9.6% of specimens, *S. lugdunensis* was involved in a vascular-associated infection. Isolates from the eye were not associated with infections but were identified as part of a surveillance protocol for eye surgery. *S. lugdunensis* was isolated as a culture contaminant or colonizing organism in 15.4% of specimens. Two-thirds of patients were treated with antibiotics for at least 1 week.

DISCUSSION

S. lugdunensis is an uncommon but not rare clinical isolate (10.1% of non-*S. aureus* and non-*S. epidermidis* species). The number of *S. lugdunensis* isolates identified increased over the study period, in part because of an increased effort to identify all significant staphylococcal isolates (particularly in 1989). The testing of multiple colony types increased duplicate tests, but provided an increase in the number of patients infected with *S. lugdunensis* as well as other coagulase-negative species. The isolation of 14.2% *S. lugdunen-*

TABLE 2. Site and clinical diagnosis for 52 consecutive *S. lugdunensis* isolates

Site	No. of patients			
	Infection		Colonization	
	Pure	Mixed	Pure	Mixed
Skin and skin structures	15	19	4	3
Scalp	0	1	0	0
Eyelid	0	0	1	2
Conjunctiva	0	0	3	0
Neck	1	1	0	0
Arm	0	0	0	1
Axilla	4	1	0	0
Finger	0	1	0	0
Back	1	0	0	0
Buttock	0	1	0	0
Perineum	1	0	0	0
Abdominal wall	0	1	0	0
Breast	1	0	0	0
Groin	2	1	0	0
Leg	0	2	0	0
Foot	4	3	0	0
Toe	1	3	0	0
Wound, site not specified	0	4	0	0
Vascular	0	5	0	0
Other[a]	2	3	0	1

[a] Sinus, peritoneal fluid, and placenta.

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sis from non-*S. aureus*, non-*S. epidermidis* staphylococcal species in 1990 represents the most experienced laboratory search for significant isolates. In a consecutive record review, *S. lugdunensis* is associated with skin and skin structure and vascular infections in adults. Review of individual patient records confirmed that up to 80% of isolates were obtained from skin surface-related sites and that blood and blood-related devices were the only other prominent (9.6%) source of isolates (Table 2). Previous reports based on referred isolates and serious instances of infection focused on the later type of infection (3).

S. lugdunensis appears to be found over the entire surface of human skin and has the ability to establish primary infection in contiguous or deep sites or to participate in mixed infections. The initiation of infection appears to be related to trauma or immunosuppression (50%) but also appears to occur with simple opportunity. The presence of *S. lugdunensis* in respiratory secretions (8.3%), urogenital specimens (9.6%), and other deep sites (12.9%) demonstrates the broad participation of *S. lugdunensis* in low-incident infections and contamination of specimens.

The pattern of human infection identified in this study is consistent with the observations reported in the literature, but this study of consecutive isolates emphasizes the prominence of *S. lugdunensis* in relatively minor wound infections. The behavior of *S. lugdunensis* in our patients closely reflected the expectations established from animal studies and the in vitro assessment of virulence factors (7).

The recognition of a pathogenic coagulase-negative staphylococcus such as *S. lugdunensis* in skin and wound infections is useful in understanding the origins of soft tissue cellulitis or abscesses previously thought to be only contaminated or colonized by nonpathogenic coagulase-negative staphylococci. The majority of laboratory isolations represent colonization, participation in mixed infections, or low-grade primary soft tissue infections; however, it is important to reemphasize the participation of *S. lugdunensis* in the serious infections described here and reported elsewhere (3), such as endocarditis (aortic valve), peritonitis, infected hip prostheses, osteomyelitis, and vascular line-bloodstream infections.

S. lugdunensis should be included along with *S. epidermidis*, *S. haemolyticus*, and *S. saprophyticus* (9) as a coagulase-negative species of *Staphylococcus* pathogenic for humans.

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