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Clinical and Laboratory Characteristics of *Achromobacter xylosoxidans* Infection

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Achromobacter xylosoxidans was isolated from six patients. The organism causes opportunistic infections in patients who are compromised. *A. xylosoxidans* is a catalase- and oxidase-positive, motile, gram-negative rod that oxidizes xylose and glucose. The organism exists in a water environment and may be confused with *Pseudomonas* species. Unlike pseudomonas, achromobacter has peritrichous flagella. The clinical and laboratory characteristics of *A. xylosoxidans* are presented.

Achromobacter xylosoxidans, an aerobic, nonfermentative, gram-negative rod, is rarely isolated from clinical material. The organism was initially characterized by Holmes et al. (3) and further studied and named by Yabuuchi and Ohyama (12). *A. xylosoxidans* can be confused with other nonfermentative, gram-negative rods, especially pseudomonas species, in clinical specimens so that its role as a significant pathogen may be underestimated.

The purpose of this report is to describe our experience with *A. xylosoxidans* isolated from different body sites of six patients on seven occasions during the last three years.

CASE REPORTS

Case 1. A 69-year-old black male was admitted in July 1976 for generalized exfoliative dermatitis and bilateral otitis externa. Past history revealed treatment of the exfoliative dermatitis for 12 years with prednisone and a history of asthma and diabetes mellitus. During the patient's hospital stay, cultures from a purulent discharge from both ears grew *A. xylosoxidans*, *Proteus mirabilis*, and *Staphylococcus aureus*. The patient was treated with eardrops containing neosporin and was discharged after 1 week without evidence of an external otitis.

Case 2. A 68-year-old black male was admitted in October 1976 with symptoms of a urinary tract infection that had lasted 5 months. Past history was significant for moderate alcohol intake and for hospitalization for an enlarged prostate, diverticulosis, and a urinary tract infection due to *Pseudomonas aeruginosa* (sensitive only to carbenicillin, gentamicin, and polymyxin B). During his hospitalization in October 1976, the patient had a transurethral prostatectomy. Histological examination revealed an infiltrating, well-differentiated adenocarcinoma of the prostate. Two of three urine specimens taken before surgery grew *A. xylosoxidans* on culture, and the other specimen grew the same organism and a microaerophilic, gram-positive coccus. The patient was treated with carbenicillin, did well, and was discharged 2 weeks after surgery with macrodantin and stilbestrol treatment.

Case 3. A 15-year-old pregnant female was seen as an outpatient complaining of a sore throat in February 1977. Physical examination revealed enlarged tonsils. A throat culture grew *A. xylosoxidans* and *S. aureus*. The patient received no antibiotic therapy and did well.

Case 4. A 57-year-old white male was admitted in May 1977 for treatment of a cavitary lesion in his right lung. The patient related a history of weight loss and a productive cough of foul-smelling sputum that had lasted 1 month. Past history was significant for smoking and alcohol use. A chest X ray revealed a large, thick-walled cavity in the right upper lobe, with a pneumonic process in the adjacent area. Sputum Gram stain revealed many polymorphonuclear leukocytes and mixed flora. Smears for acid-fast bacilli were negative. Two sputum specimens on 2 consecutive days grew many *A. xylosoxidans* and a moderate number of *Klebsiella pneumoniae*. Anaerobic cultures were not done. The patient was initially treated with clindamycin and gentamicin but did poorly and expired on hospital day 4. A postmortem examination was not performed.

Case 5. A 55-year-old white male was being treated at the Ears, Nose and Throat Clinic for chronic otitis media. Past history was significant for chronic alcohol use and for multiple surgical procedures on his ears in an attempt to relieve the chronic infection. In November 1978, *A.*

xylosoxidans and *Escherichia coli* were isolated from a discharge from his right ear while the patient was taking oral ampicillin. In January 1979, while the patient was taking oral erythromycin, *A. xylosoxidans* and *E. coli* were isolated again from a discharge from his right ear. Currently the patient is not receiving treatment, and repeat surgical intervention is being considered.

Case 6. A 53-year-old black male with a history of diabetes mellitus, diabetic retinopathy, and diabetic nephropathy with end-stage renal failure, who was on maintenance peritoneal dialysis, was admitted for cloudy dialysis fluid in December 1978. In September 1977, the patient had been switched to a home dialysis program and subsequently was hospitalized four times for cloudy peritoneal dialysis fluid, low-grade fever, and vomiting. A variety of microorganisms was isolated from the peritoneal fluid, and the patient was treated appropriately, with clearing of the peritoneal fluid. In December 1978, three cloudy peritoneal fluid (dialysate) specimens collected within 48 h of admission grew *A. xylosoxidans*. Two of the three dialysate cultures also grew *Staphylococcus epidermidis*. The patient was treated with parenteral carbenicillin, with rapid clearing of the fluid. He was discharged from the hospital and is currently doing well.

RESULTS

The clinical data of the six patients are summarized in Table 1. Most of the patients seen were greater than 50 years of age and had an underlying illness at the time that *A. xylosoxidans* was isolated. The organism was considered the primary pathogen in most patients requiring therapy.

Bacteriology. The characteristics of *A. xylosoxidans* are listed in Table 2. Our first four isolates were submitted to the New Jersey State Laboratory for identification (no further information is available on how the organism was characterized). The last three isolates were identified by one of us (C.C.) in our microbiology laboratory. The organism is a motile, gram-negative rod that produces glistening, smooth pinpoint colonies after overnight incubation at 35°C, with the biochemical characteristics listed in Table 2. The organism grew well on MacConkey agar and was citrate, oxidase, and catalase positive. Glucose was oxidized slowly, as was xylose, whereas other carbohydrates were not. Tests for urease, lysine decarboxylase, and arginine dihydrolase were negative. The flagellar morphology of the organism was studied with Leifson staining (5) and electron microscopy of two isolates. *A. xylosoxidans* was demonstrated

TABLE 1. *Characteristics of A. xylosoxidans infection*

Case	Age, sex	Site of isolation	Infectious disease	Antibiotic therapy before isolation	No. of cultures	Concomitant organisms	Underlying disease	Outcome
1	69, M	Ear discharge	External otitis	None	1	*P. mirabilis* and *S. aureus*	Recurrent exfoliative dermatitis and diabetes mellitus	Improved
2	68, M	Urine	Urinary tract infection	None	3	(1)[a] None (2) Microaerophilic, gram-positive coccus (3) None	Metastatic prostate carcinoma	Improved
3	15, F	Throat	Pharyngitis	None	1	*S. aureus*	Pregnancy	Improved
4	57, M	Sputum	Lung abscess	None	2	(1) Moderate no. of *K. pneumoniae* (2) Moderate no. of *K. pneumoniae*	Metastatic carcinoma in lung and in liver	Died
5	55, M	Ear discharge	Chronic otitis media	(1) Ampicillin (2) Erythromycin	2	(1) A few *E. coli* (2) A few *E. coli*	Multiple ear surgeries and chronic alcoholism	Improved
6	53, M	Peritoneal fluid	Peritonitis	None	3	(1) None (2) *S. epidermidis* (3) *S. epidermidis*	Chronic renal failure and chronic peritoneal dialysis; diabetes mellitus	Improved

[a] Numbers 1, 2, and 3 refer to the culture number.

TABLE 2. *Biochemical characteristics of A. xylosoxidans*[a]

Characteristic	No. of isolates positive	Total no. tested	% Positive
Gram-negative, asporogenous, straight rod	138	138	100
Peritrichous flagella	137	138	99
Motility	136	138	98.5
OF glucose medium open, acid	126	129	97.6
OF glucose sealed, acid	0	79	0
Growth on MacConkey agar	71	71	100
Growth on cetrimide agar	114	127	90
Oxidase	138	138	100
Catalase	125	125	100
Citrate, Simmons	134	138	97
Urease	0	127	0
Indole	0	127	0
Oxidative acid production from:			
Xylose	137	138	99
Lactose and maltose	0	138	0
Mannitol and sucrose	0	138	0
L-Lysine decarboxylase	0	88	0
L-Arginine dihydrolase	0	88	0
L-Ornithine decarboxylase	0	66	0
Voges-Proskauer	1	52	1.9
Acetamide	1	1	100
Nitrate reduction to nitrite	84	91	92
Nitrate reduction to gas	72	97	74

[a] Data are from this research and from references 3, 8, 10, 11, and 13.

to have peritrichous flagella, a characteristic that distinguishes this organism from *Pseudomonas* sp.

Table 3 summarizes the antibiotic susceptibilities of our six isolates as determined by the standard disk diffusion method. Most isolates were sensitive to carbenicillin and trimethoprim/sulfamethoxazole.

DISCUSSION

In 1971, Yabuuchi and Ohyama described a nonfermentative, gram-negative, peritrichous rod that they isolated from purulent ear discharges of seven patients with chronic otitis media and proposed the name *Achromobacter xylosoxidans* (12). They subsequently described the characteristics of 35 strains (including the original 7) of this organism and demonstrated the uniformity of the species (13). Furthermore, they were able to show that various gram-negative rods previously described as *Alcaligenes faecalis* by Moore and Pickett (6, 7), as biotypes IIIa and IIIb by King (cited in reference 14), and as *Alcaligenes denitrificans* and *Alcaligenes* sp. by De Ley et al. (1) were members of the same species. The minimal characteristics for the identification of *A. xylosoxidans* are as follows (19): motile, gram-negative, asporogenous, straight rods with peritrichous flagella; positive reactions for oxidase, catalase, and Simmons citrate; oxidation of xylose and glucose but not of maltose and other carbohydrates; and negative tests for urease, lysine decarboxylase, and arginine dehydrolase. The species has been divided into two biotypes by the type of nitrate reduction, as follows: group IIIa reduces nitrate to nitrite only, whereas group IIIb reduces nitrate to nitrogen gas (11).

A. xylosoxidans is rarely reported in the English literature (2–4, 8–13). The characteristics of the isolates described in these reports are listed in Table 2, along with those of the cases described here. The homogeneity of the species is clearly demonstrated. Furthermore, it is readily observed that *A. xylosoxidans* can be confused with *Pseudomonas* sp. if the type of flagella is not sought. *A. xylosoxidans* has peritrichous flagella. This may account for the few reportings of this organism. In contrast to other investigators (8), we feel that colonial morphology and the antibiotic sensitivity pattern are not specific enough to allow differentiation from other nonfermentative, gram-negative rods. The antibiotic sensitivity pattern, although indistinguishable from that of some pseudomonads, is considered fairly typical. Most of our strains (Table 3) were resistant to the currently used aminoglycosides but were sensitive to polymyxin B and trimethoprim/sulfamethoxazole. All of our strains were sensitive to carbenicillin but were resistant to other semisynthetic penicillins. Some strains were sensitive to chloramphenicol, tetracycline, and colistin. A similar pattern with some varia-

TABLE 3. *Antibiotic susceptibilities of A. xylosoxidans*

Antibiotic	Susceptibility in each case[a]							Total no. of strains sensitive
	1	2	3	4	5		6	
					Isolate no. 1	Isolate no. 2		
Ampicillin	R	R	R	R	R	R	S	1
Carbenicillin	S	S	S	S	S	S	S	7
Cephalothin	R	R	R	R	R	R	I	0
Colistin	R	S	—	R	S	R	S	3
Gentamicin	R	R	S	R	R	R	R	1
Kanamycin	R	R	S	R	I	R	R	1
Tobramycin	—	R	S	—	R	R	R	1
Amikacin	—	—	—	—	I	—	R	0
Tetracycline	R	R	S	R	S	S	R	3
Trimethoprim/sulfamethoxazole	S	R	S	S	S	S	S	6
Chloramphenicol	S	S	R	R	—	—	—	2
Polymyxin B	S	S	S	S	—	—	—	4
Nalidixic acid	R	R	—	—	—	—	—	0
Macrodantin	—	R	—	—	—	—	—	0
Neomycin	S	—	—	—	—	—	—	1

[a] R, Resistant; S, sensitive; I, intermediate; —, not done.

tion has been reported in the literature (3, 4, 8, 10, 12, 13).

Clinically, *A. xylosoxidans* has been isolated from many types of specimens, most frequently from the urine, blood, respiratory tract, spinal fluid, and ears (Table 4). Unfortunately, sufficient clinical information is missing from most descriptions. Thus, it is difficult to assess the clinical significance of its isolation. The fact that *A. xylosoxidans* is frequently isolated in combination with other organisms makes it even more difficult to determine its pathogenic role (8). However, there are a few well-described cases in which its pathogenic role is clearly demonstrated (10).

A. xylosoxidans can be considered an opportunistic pathogen. Dworzack et al. (2) described a patient with a community-acquired bacteremic pneumonia due to *A. xylosoxidans* who was found to have a deficiency of immunoglobulin M. Of the four opportunistic infections due to *A. xylosoxidans* described by Holmes et al. (3), one patient received extensive chemotherapy for breast carcinoma, another had metastatic adenocarcinoma in the liver, a third patient was on chronic steroid inhalation therapy, and a fourth patient had a chronic orbit infection after numerous surgical procedures. Shigeta et al. (10) described six patients with cerebral ventriculitis due to *A. xylosoxidans* that occurred after neurosurgical operations. Also, the use of prolonged or broad-spectrum antibiotic therapy has been suggested as a possible cause of infection with this organism (3, 10). The common denominator in all patients appears to be a breakdown in host defense mechanisms that allows this opportunistic pathogen to cause infection.

The source of *A. xylosoxidans* and its natural habitat are unknown. Holmes et al. have suggested that *A. xylosoxidans* is a water pathogen (3). Two of their strains were isolated from a swimming pool and from a chlorhexidine solution, respectively. Shigeta et al. also suggested that their outbreak of cerebral ventriculitis was due to contaminated chlorhexidine solution, *A. xylosoxidans* being isolated from 20 containers

TABLE 4. *Clinical sources of previously described isolates of A. xylosoxidans*

Source	No. of isolates in reference:							Total
	(13)	(3)	(10)	(8)	(4)	(2)	(11)	
Ears	16			5	8			29
Respiratory tract	6	1		1	12		12	32
Peritoneal dialysis fluid	5							5
Brain and spinal fluid	4		6				22	32
Skin, wounds, and burns	7	2		2	1		7	19
Blood (bacteremia)		2				1	32	35
Urine	1	1			19		23	44
Miscellaneous[a]	4	1	5	1				11
Nonhuman[b]		4						4
Unknown	12							12
Total no. of strains	55	11	11	9	40	1	96	223

[a] Pus, stool, eye, and vesicle.
[b] Swimming pool, antiseptic solutions, and banked blood.

and from the wash basins on their surgical wards (10). It is possible that the patient with peritonitis described above may have acquired his infection from contaminated peritoneal dialysate fluid containers.

In conclusion, *A. xylosoxidans* causes opportunistic infections in patients with underlying illnesses. The organism probably exists in a water environment and can be confused with *Pseudomonas* species. The organism is usually sensitive to carbenicillin, commonly sensitive to chloramphenicol, tetracycline, and trimethoprim/sulfamethoxazole, and resistant to other penicillins and currently used aminoglycosides.

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