JOURNAL OF CLINICAL MICROBIOLOGY, June 1986, p. 1056–1064
0095-1137/86/061056-09$02.00/0

Vol. 23, No. 6

Occurrence and Distribution of Serotypes of the Arizona Subgroup of *Salmonella* Strains in the United States from 1967 to 1976

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Received 9 September 1985/Accepted 19 February 1986

The *Salmonella* Arizona subgroup contains gram-negative enteric bacteria that are closely related to other salmonellae biochemically, serologically, and genetically. Although the Arizona subgroup may be isolated from a wide variety of nonhuman and human sources, the arizonae are uncommonly recognized as human pathogens, and surprisingly little is known about their epidemiology. From 1967 through 1976, the Centers for Disease Control received 858 Arizona subgroup cultures from human and nonhuman sources representing 143 different serotypes in 33 somatic groups; several serotypes had not been previously reported. The 374 cultures from humans represent 71 different serotypes; extraintestinal isolates were present in 31 (44%) serotypes. Compared with data from a previous 20 years of surveillance, the proportion of Arizona subgroup strains isolated from stools, blood, and other sites was remarkably stable, but several serotypes showed marked changes in their frequency of isolation. In total, the ratio of extraintestinal to intestinal isolates was 0.37, but marked serotype-specific variation was noted, suggesting differences in virulence associated with serotype.

The *Salmonella* Arizona subgroup contains gram-negative enteric bacteria that are closely related to other *Salmonella* subgroups biochemically, serologically, and genetically (7, 9, 20, 22, 23, 27; J. J. Farmer, III, A. C. McWhorter, D. J. Brenner, and G. K. Morris, Clin. Microbiol. Newsl. **6**:63–66, 1984). The Arizona subgroup is differentiated from other *Salmonella* subgroups by virtue of its ability to utilize malonate and liquefy gelatin, its inability to grow in the presence of KCN, and its frequent ability to ferment lactose. Strains of the Arizona subgroup have been considered uncommon human pathogens, and surprisingly little is known about their epidemiology.

Many Arizona subgroup strains rapidly (within 48 h) ferment lactose (21, 26). The common laboratory practice of discounting lactose-fermenting bacteria as nonpathogenic can result in overlooking the Arizona subgroup (as well as other lactose-positive *Salmonella* strains) as etiologic agents (11). Lysine-iron agar is of special value for detecting the Arizona subgroup (1, 10), and the production of hydrogen sulfide is a useful clue during routine screening.

It is possible that, similar to the case for other *Salmonella* strains, considerable pathologic diversity exists among the more than 400 described serotypes in the Arizona subgroup (11, 12, 24). This report summarizes information on the occurrence and distribution of various serotypes of the Arizona subgroup from cultures received by the Center for Disease Control (CDC) from 1967 through 1976. Data concerning the serotyping of Arizona subgroup cultures received at the CDC through December 1966 were previously reported (11, 24).

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MATERIALS AND METHODS

Nomenclature and classification. Bacteria in the Arizona subgroup were first called "*Salmonella arizona*" and "*Paracolobactrum arizonae*" (16) and were then known as "*Arizona arizonae*" (14, 19). These organisms were later called "*Arizona hinshawii*" in the United States and *S. arizonae* in most other countries (15–17). DNA relatedness studies showed that all *Salmonella* strains and all strains of "*A. hinshawii*" belonged to the same species (7, 22, 27). Six subspecies or subgroups can be distinguished within this single *Salmonella* species by their biochemical characteristics and their DNA relatedness (7, 9, 20, 22, 23, 27; Farmer et al., Clin. Microbiol. Newsl. **6**:63–66, 1984).

In the classification of Le Minor et al. (23), Arizona strains with monophasic flagellar antigens are in subgroup (subspecies) 3a, which is called *Salmonella* subsp. *arizonae*, and strains with disphasic (or triphasic) flagella antigens are in subgroup 3b, which is called *Salmonella* subsp. *diarizonae*. The classification of *Salmonella* organisms at the species level remains controversial, and the system of Le Minor et al. (23) is not used for reporting by the CDC.

Further details on the historical and present classification of *Salmonella* strains at the level of genus, species, subspecies, and serotype were given previously (9, 20, 22, 23; Farmer et al., Clin. Microbiol. Newsl. **6**:63–66, 1984). In the remainder of this report strains formerly called "*A. hinshawii*" will be referred to as the Arizona subgroup or as arizonae. *Salmonella* strains will refer to strains other than those in the Arizona subgroup.

Serotyping. The serotyping of Arizona subgroup strains has been done by two methods. Laboratories in the United States used antisera made from arizonae and thus developed

TABLE 1. Distribution of Arizona subgroup serotypes according to origin in cultures received by the CDC from 1967 to 1976

Serotype[a]	No. of cultures		Presence (X) of serotype in culture(s) from the following source(s)[b]:							
				Reptiles						
	Total	Human	Nonhuman mammals	Snakes	Turtles	Other	Amphibians	Fowl	Food, food products, and miscellaneous	Unknown
6,14:z_{10}:e,n,x,z_{15}(7a,7c:27:28)	1			X						
11:k:z_{53}(17:29:25)	4	3							X	
11:1,v:z_{53}(17:23:25)	2	2								
13,22:g,z_{51}:−(18:13,14:−)	2			X						
13,22:z_4,z_{32}:−(18:1,6,7:−)	3			X						
16:k:z(25:29:31)	1	1								
16:z_{10}:e,n,x,z_{15}(25:27:28)	12	6		X					X	X
17:r:z(12:24:31)	1			X						
17:z_4,z_{32}:−(12:1,6,7:−)	1		X[c]							
17:z_{10}:e,n,x,z_{15}(12:27:28)	10	2			X				X	
17:z_{29}:−(12:16,17,18:−)	1	1								
18:(k):z_{53}(7a,7b:22:25)	1								X	
18:z_4,z_{23}:−(7a,7b:1,2,6:−)	8	7								X
18:z_4,z_{32}:−(7a,7b:1,7,8:−)	151	75	X[d,e]		X			X[f]	X	X
18:NM(7a,7b:NM)	2	2								
21:g,z_{51}:−(22:13,14:−)	6	4		X						
21:k:z(22:29:31)	1			X						
21:z_4,z_{24}:−(22:1,3,11:−)	1									X
35:i:e,n,x,z_{15}(20:33:28)	2									X
35:k:z_{53}(20:29:25)	3			X						
35:1,v:z_{35}(20:23:21)	5	3		X						
35:r:e,n,x,z_{15}(20:24:28)	2	1							X	
35:r:z_{61}(20:24:41)	1								X	
35:z_4,z_{23}:−(20:1,2,6:−)	1					X				
38:(k):z_{35}(16:22:21)	13	8		X	X					
38:k:z_{53}(16:29:25)	1			X						
38:1,v:z_{53}(16:23:25)	2	1			X					
38:z_{10}:z_{53}(16:27:25)	1									X
40:z_4,z_{23}:−(10a,10b:1,2,5:−)	4	4								
40:z_4,z_{24}:−(10a,10b:1,3,11:−)	6	2						X		
40:z_{29}:−(10a,10b:16,17,18:−)	1					X				
40:z:−(10a,10c:31:−)	1									X
41:z_4,z_{23}:−(13:1,2,5:−)	8	6	X[g]						X	
41:z_4,z_{24}:−(13:1,3,11:−)	1	1								
41:z_4,z_{32}:−(1,6,7:−)	1	8								
42:k:z(15:29:31)	1			X						
42:(k):z_{35}(15:22:21)	4	1			X					
42:z_4,z_{23}:−(15:1,2,5:−)	1								X	
42:z:z_{52}(15:31:26)	1			X						
42:NM(15:NM)	2	1							X	
43:r:e,n,x,z_{15}(21:24:28)	2				X					
43:z_4,z_{23}:−(21:1,2,6:−)	1	1								
43:z_4,z_{24}:−(21:1,3,11:−)	2		X[h]							X
43:z_{52}:z_{53}(21:26:25)	1							X		
44:z_4,z_{23}:−(1,3:1,2,6:−)	1	1								
44:z_4,z_{23},z_{32}:−(1,3:1,6,7,9:−)	2	1		X						
44:z_4,z_{24}:−(1,3:1,3,11:−)	2	1			X					
45:z_4,z_{23}:−(11a,11b:1,2,5:−)	5								X	
45:z_4,z_{32}:−(11a,11b:1,7,8:−)	1		X[i]							

Continued on following page

TABLE 1—*Continued*

Serotype[a]	No. of cultures		Presence (X) of serotype in culture(s) from the following source(s)[b]:							
			Nonhuman mammals	Reptiles			Amphibians	Fowl	Food, food products, and miscellaneous	Unknown
	Total	Human		Snakes	Turtles	Other				
47:k:z_{53}(23:29:25)	1			X						
47:r:z_{53}(23:24:25)	3	3								
47:c:1,5,(7)(28:32:30)	1			X						
47:k:z(28:29:31)	1			X						
47:z_{52}:1,5,(7)(28:26:30)	1			X						
48:g,z_{51}:(5:13,14:−)	9	9								
48:(k):z_{53}(5:22:25)	1				X					
48:k:z_{53}(5:29:25)	5			X						
48:1,v:1,5,(7)(5:23:30)	1			X						
48:z:z_{52}(5:31:26)	2	2								
48:z_4,z_{23}:(5:1,2,5:−)	1	1								
48:z_4,z_{23}:−(5:1,2,5,6:−)	1			X						
48:z_4,z_{23}:−(5:1,2,6:−)	1			X						
48:z_4,z_{23}:−(5:1,6:−)	1					X				
48:z_4,z_{24}:−(5:1,3,11:−)	7	6		X						
48:z_4,z_{32}:−(5:1,6,7:−)	1									X
48:z_{36}:−(5:17,20:−)	1	1								
48:c:−(29:32:−)	1									X
48:i:z(29:33:31)	8	5		X	X		X			
48:i:z_{35}(29:33:21)	1			X						
48:k:1,5,(7)(29:29:30)	2	2								
48:r:z(29:24:31)	1			X						
50:g,z_{51}:−(9a,9b:13,14:−)	2	2								
50:k:z(9a,9b:29:31)	2	1		X						
50:k:z_{53}(9a,9b:29:25)	1	1								
50:r:z(9a,9b:24:31)	11	8				X			X	
50:r:z_{35}(9a,9b:24:21)	1									X
50:z_4,z_{23}:−(9a,9b:1,2,5:−)	3	3								
50:z_4,z_{32}:−(9a,9b:1,6,7:−)	1					X				
50:z_{52}:z_{53}(9a,9b:26:25)	1		X[j]							
50:k:z(9a,9c:29:31)	1									X
50:1,v:z_{35}(9a,9c:23:21)	24	2							X	X
50:r:z_{53}(9a,9c:24:25)	1								X	
50:z:z_{52}(9a,9c:31:26)	2								X	
50:z_{52}:1,5,(7)(9a,9c:26:30)	1			X						
51:z_4,z_{23}:−(1,2:1,2,5:−)	4	3		X						
51:z_4,z_{23}:−(1,2:1,2,6:−)	1	1								
51:g,z_{51}:−(1,2,:13,14:−)	1	1								
53:r:z_{35}(1,4:24:21)	1	1								
53:z_4,z_{23}:−(1,4:1,2,5:−)	5	4		X						
53:z_4,z_{24}:−(1,4:1,3,11:−)	1	1								
53:z_4,z_{32}:−(1,4:1,6,7:−)	1	1								
53:z_{29}:−(1,4:16,17,18:−)	1			X						
56:z_4,z_{23}:−(14:1,2,5:−)	3	1		X					X	
56:z_{29}:−(14:16,17,18:−)	1								X	
57:c:z(34:32:31)	1			X						
58:1,v:z_{35}(1,33:23:21)	1			X						
58:1,v:−(1,33:23:−)	1			X						
58:r:z_{53}(1,33:24:25)	1			X						
58:z_{35}:z_{52}(1,33:21:26)	5			X						X
59:1,v:z(19:23:31)	1			X						
59:1,v:z_{53}(19:23:25)	1			X						
59:z_{36}:−(19:17,20:−)	2	1	X[k]							

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TABLE 1—*Continued*

Serotype[a]	No. of cultures		Presence (X) of serotype in culture(s) from the following source(s)[b]:							
			Nonhuman mammals	Reptiles			Amphibians	Fowl	Food, food products, and miscellaneous	Unknown
	Total	Human		Snakes	Turtles	Other				
60:i:e,n,x,z_{15}(24:33:28)	2	1								X
60:k:z(24:29:31)	2				X					
60:r:e,n,x,z_{15}(24:24:28)	81	31		X	X					X
60:r:z(24:24:31)	42	9			X					X
60:z_{52}:1,5,(7)(24:26:30)	1				X					
60:r:z_{53}(24:24:25)	1									X
60:z_{10}:−(24:27:−)	1			X						
61:1,5,(7):−(26:30:−)	7	5			X					
61:c:1,5,(7)(26:32:30)	2	1			X					
61:c:z(26:32:31)	1	1								
61:c:z_{35}(26:32:21)	13	9			X					
61:i:e,n,x,z_{15}(26:33:28)	1				X					
61:i:z(26:33:31)	3	1			X					
61:i:z_{35}(26:33:21)	1			X						
61:k:1,5,(7)(26:29:30)	39	27	X[d]						X	X
61:1,v:1,5,(7)(26:23:30)	184	72	X[d]	X	X	X			X	
61:1,v:e,n,x,z_{15}(26:23:28)	1				X					
61:1,v:z(26:23:31)	1	1								
61:1,v:z_{35}(26:23:21)	11	3		X						
61:r:z_{35}(26:24:21)	1					X				
61:r:z_{53}(26:24:25)	5	2		X	X					
62:z_4,z_{32}:−(6:1,7,8:−)	1						X			
63:NM(8:NM)	1	1								
65:c:z(30:32:31)	3	1		X					X	
65:c:z_{53}(30:32:25)	1	1								
65:(k):z(30:22:31)	8	4		X	X		X			
65:1,v:z(30:23:31)	2	1			X					
65:1,v:z_{53}(30:23:25)	3	1			X		X			
65:z:z_{52}(30:31:26)	2			X						
65:z_{10}:e,n,x,z_{15}(30:27:28)	1			X						
65:z_{35}:z_{52}(30:21:26)	2			X						
65:z_{53}:−(30:25:−)	1						X			
R:i:z(R:33:31)	1	1								
R:1,v:1,5,(7)(R:23:30)	1				X					
R:1,v:z_{35}(R:23:21)	1	1								
R:r:e,n,x,z_{15}(R:24:28)	2	2								
R:z:−(R:31:−)	2								X	
R:z_4,z_{23}:−(R:1,2,5:−)	1	1								
R:z_4,z_{32}:−(R:1,7,8:−)	2	1						X		
Z:z_{10},e,n,x,z_{15}(R:27:28)	1								X	
R:z_{54}:−(R:34:−)	1			X						

[a] The *Salmonella* serotyping scheme antigenic formula is given, and the corresponding Arizona serotyping scheme antigens are in parentheses. NM, Nonmotile; R, rough.

[b] Number of serotypes represented: 143 (total), 73 (humans), 9 (other mammals), 51 (snakes), 25 (turtles), 7 (other reptiles), 6 (amphibians), 3 (fowl), 22 (food, food products, and miscellaneous), and 19 (unknown).

[c] Includes goats.

[d] Includes sheep.

[e] Includes dogs.

[f] Includes turkeys.

[g] Includes monkeys.

[h] Includes opposums.

[i] Includes swine.

[j] Includes moose.

[k] Includes ground squirrels.

an Arizona subgroup serotyping scheme, whereas in most other countries arizonae were typed with antisera made from strains in *Salmonella* subgroups 1, 2, 4, and 5, and thus serotyping employed the scheme used for these *Salmonella* subgroups. Although designated differently, most (but not all) of the heat-stable somatic (O) antigens and the flagellar (H) antigens in the Arizona subgroup and in other *Salmonella* subgroups are highly similar or identical (9, 11, 18, 20, 29). The CDC began serotyping arizonae with antisera prepared against *Salmonella* subgroups 1, 2, 4, and 5 and using the *Salmonella* serotyping scheme in July 1983. Because this study was completed before that date, all arizonae

were serotyped with Arizona subgroup antisera by using the Arizona subgroup serotyping scheme (8, 9, 11, 28). Details of both serotyping schemes and comprehensive listings of serotypes as designated by both schemes are given in *Bergey's Manual of Systematic Bacteriology* (20).

The CDC recommends that untyped Arizona subgroup strains be reported as "*Salmonella* species (formerly *A. hinshawii*)" (Farmer et al., Clin. Microbiol. Newsl. **6**:63–66, 1984). Strains of known serotype are reported by the CDC as *Salmonella* subgroup 3 (a or b), followed by the antigenic formula in the *Salmonella* antigenic scheme, with the corresponding Arizona antigenic formula in parentheses. For example: *Salmonella* subgroup 3b serotype 16:k:z (formerly *A. hinshawii* 25:29:31) (Farmer et al., Clin. Microbiol. Newsl. **6**:63–66, 1984).

To minimize confusion, all antigenic formulas in the text and tables of this paper are given by both schemes. The *Salmonella* serotyping scheme antigenic formula is given first, followed by the Arizona subgroup serotyping scheme antigenic formula in parentheses. In both schemes, strains in which the O antigen could not be determined because of autoagglutination are designated as rough (R). When only one H antigen was detected in a strain presumed to be diphasic, the "missing" antigen is indicated by a dash. Strains lacking motility are designated as nonmotile (NM).

Strain selection. We reviewed listings of all culture specimens identified as arizonae from the United States that had been accepted for serologic typing by the Enteric Laboratory Section, Enteric Diseases Branch, Center for Infectious Diseases, CDC, from January 1967 through December 1976. Sixty cultures submitted from other CDC laboratories and other federal agencies were excluded from consideration. The cultures from human sources were reviewed, and only the first specimen received from a person was further considered. In each case of multiple cultures from an individual, the cultures were of identical serotype.

RESULTS

From 1967 through 1976, a total of 858 Arizona subgroup cultures that met our inclusion criteria were received, representing 33 somatic groups and 143 serotypes (including the nine rough serotypes) (Table 1). Several serotypes have not been previously reported. For all of the more common serotypes isolated from humans, we also received cultures from animals, some of which were sent to the CDC in conjunction with epidemiologic investigations.

The specific number of cultures received from any particular animal would be misleading owing to surveillance artifacts, because multiple isolates were sent from outbreak clusters. Therefore, we indicated only whether any cultures received were from specific nonhuman origin. For similar reasons, in contrast to previous CDC reports (11, 24), we did not differentiate between the number of cultures and the number of foci. Seventeen serotypes occurred in both snakes and humans, representing 33% of the serotypes isolated from snakes and 23% of the serotypes isolated from humans. Of the four most common Arizona subgroup serotypes isolated from humans, three, 18:z_4,z_{32}:− (Arizona 7a,7b:1,7,8:−), 61:1,v:1,5,(7) (Arizona 26:23:30), and 61:k:1,5,(7) (Arizona 26:29:30), were the only serotypes isolated from sheep.

The 374 Arizona subgroup cultures from humans represent 71 different serotypes (including 5 rough serotypes). Although 82% of these serotypes included at least one stool-source isolate (Table 2), some of them, such as 18:z_4,z_{23}:− (Arizona 7a,7b:1,2,6:−), were associated primarily with extraintestinal tract sources; in total, extraintestinal sources were recorded for strains of 31 serotypes (44%). The clinical features of human infection with arizonae are described in detail in a separate report (S. H. Weiss, M. J. Blaser, R. E. Black, F. P. Paleologo, D. J. Brenner, submitted for publication).

The source-distribution pattern for the Arizona subgroup serotypes most commonly isolated from humans over time is shown in Table 3. Over the nearly 30 years reported, the proportion of all Arizona subgroup strains that were isolated from stools, blood, and other culture sites was remarkedly stable. All Arizona subgroup serotypes isolated from human extraintestinal sources are listed in Table 4, which compares the relative frequency of extraintestinal and intestinal isolation for each serotype. Although only 26% of all isolations from humans were from extraintestinal sources, two serotypes [18:z_4,z_{23}:− (Arizona 7a,7b-1,2,6:−) and 61:k:1,5,(7) (Arizona 26:29:30)] accounted for nearly half of the extraintestinal isolates and showed a high (≥1.0) extraintestinal-to-intestinal-source ratio (Tables 3 and 4). Although 39 extraintestinal Arizona subgroup isolates were serotype 18:z_4,z_{32}:− (Arizona 7a,7b:1,7,8:−), representing 18% of all extraintestinal isolates, the extraintestinal-to-intestinal-isolates ratio for that serotype was little different from that for all other strains.

DISCUSSION

The antisera made from *Salmonella* subgroups other than the Arizona subgroup (which will henceforth be used for serotyping arizonae) are less specific for arizonae than the previously used antisera made from strains of the Arizona subgroup. For example, the H antigen complexes 1,2,5 and 1,2,6, in the Arizona subgroup serotyping scheme both are represented by the single H antigen complex z_4,z_{23} in the *Salmonella* serotyping scheme (Table 1). This minimal loss of specificity does not appear to have any clinical relevance, although it seems to be of importance to the poultry industry, whereas the benefits from standardization and simplification of reagents are obvious and immediate. Because this is a transition period, we included both the *Salmonella* serotyping scheme and the Arizona serotyping scheme antigenic formulas to be consistent with prior literature and to link the two systems (Tables 1 to 4).

Snakes remain an important reservoir of arizonae. However, the common serotype 18:z_4,z_{32}:− (Arizona 7a,7b:1,7,8:−) isolated from humans was not isolated from snakes; this is consistent with other reports of infrequent isolation of 18:z_4,z_{32}:− from reptiles (5, 11, 24). Some observers report a serotype from snakes but not turtles, whereas we report the reverse, e.g., Arizona subgroup serotype 65:1,v:z (Arizona 30:23:31) (3). For this reason, the generic term reptile, rather than the specific reptilian species, might better serve the purpose of reservoir description.

The Arizona subgroup serotypes we identified from nonhuman mammals are similar to those of prior reports. Serotypes 61:1,5,(7):− (Arizona 26:30:−) and Rough:z_{53}:− (Arizona Rough:30:−) also have been reported from sheep. Serotype 61:1,v:1,5,(7) (Arizona 26:23:30), commonly isolated from humans, also has been isolated from cattle, and serotypes 61:1,v:z_{35} (Arizona 26:23:21) and 38:k:z_{53} (Arizona 16:29:25) have been isolated from rats (2, 24, 25).

All of our Arizona subgroup isolates from turkeys are serotype 18:z_4,z_{32}:− (Arizona 7a,7b:1,7,8:−). This agrees with other recent reports totaling 882 turkey isolates in which only 3 isolates were of other serotypes. These observations are in marked contrast to those of the past, when

TABLE 2. Sources of the Arizona subgroup serotypes isolated from humans from 1967 to 1976

Serotype[a]	No. of isolates from the following source:						
	Stool	Blood	Urine	Respiratory tract	Wound	Other	Unknown
11:k:z_{53}(17:29:25)	2						1
11:1,v:z_{53}(17:23:25)	2						
16:k:z(25:29:31)	1						
16:z_{10}:e,n,x,z_{15}(25:27:28)	5					1[b]	
17:z_{10}:e,n,x,z_{15}(12:27:28)	2						
17:z_{29}:−(12:16,17,18:−)	1						
18:z_4,z_{23}:−(7a,7b:1,2,6:−)	2	2			2	1	
18:z_4,z_{32}:−(7a,7b:1,7,8:−)	49	13	2	1	3	4[c]	4
18:NM(7a,7b:NM)	1			1			
21:g,z_{51}:−(22:13,14:−)	1	2		1			
35:1,v:z_{35}(20:23:21)	3						
35:r:e,n,x,z_{15}(20:24:28)	1						
38:(k):z_{35}(16:22:21)	7				1		
38:1,v:z_{53}(16:23:25)	1						
40:z_4,z_{23}:−(10a,10c:1,2,5:−)	2	1				1[b,d]	
40:z_4,z_{24}:−(10a,10c:1,2,11:−)	1	1					
41:z_4,z_{23}:−(13:1,2,5:−)	4	2					
41:z_4,Z_{24}:−(13:1,3,11:−)	1[d]						
41:z_4,Z_{32}:−(13:1,6,7:−)	1						
42:(k):z_{35}(15:22:21)	1						
42:NM(15:NM)	1						
43:z_4,z_{23}:−(21:1,2,6:−)		1[e]					
44:z_4,z_{23}:−(1,3:1,2,6:−)							
44:z_4,z_{23},z_{32}:−(1,3:1,6,7:−)	1						
44:z_4,z_{24}:−(1,3:1,3,11:−)	1						
47:r:z_{53}(23:24:25)	3						
48:g,z_{51}:−(5:13,14:−)	6		1		1		1
48:z:z_{52}:−(5:31:26)	2						
48:z_4,z_{23}:−(5:1,2,5:−)	1						
48:z_4,z_{24}:−(5:1,3,11:−)	6						
48:z_{36}:−(5:17,20:−)					1		
48:1:2(29:33:31)	5						
48:k:1,5,(7)(29:29:30)	1		1				
50:k:z(9a,9c:29:31)	1						
50:k:z_{53}(9a,9b:29:25)	1						
50:1,v:z_{35}(9a,9c:23:21)	2						
50:r:z(9a,9b:24:31)	5			1	1	1	
50:z_4,z_{23}:−(9a,9b:1,2,5:−)	3						
50:g,z_{51}:−(9a,9b:13,14:−)	2						
51:g,z_{51}:−(1,2:13,14:−)						1[f]	
51:z_4,Z_{23}:−(1,2:1,2,6:−)	1		2				
53:r:z_{35}:−(1,4:24:21)	1						
53:z_4,z_{23}:−(1,4:1,2,5:−)	4						
53:z_4,z_{24}:−(1,4:1,3,11:−)	1						
53:z_4,z_{32}:−(1,4:1,6,7:−)		1					
56:z_4,z_{23}:−(14:1,2,5:−)		1					
59:z_{36}:−(19:17,20:−)						1[b]	

Continued on following page

TABLE 2—*Continued*

Serotype[a]	No. of isolates from the following source:						
	Stool	Blood	Urine	Respiratory tract	Wound	Other	Unknown
60:i.e.,n,x,z_{15}(24:33:28)	1						
60:r:e,n,x,z_{15}(24:24:28)	30			1			
60:r:z(24:24:31)	6	1	2				
61:1,5,(7):−(26:30:−)	1		2		1	1	
61:c:1,5,(7)(26:32:30)	1						
61:c:z(26:32:31)	1						
61:c:z_{35}(26:32:21)	7		1				1
61:i:z(26:33:31)	1						
61:k:1,5,7(26:29:30)	9	1	3	6	2	4	2
61:1,v:1,5,7(26:23:30)	66	1	1			2[f]	2
61:1,v:z(26:23:31)	1						
61:1,v:z_{35}(26:23:21)				1			
61:r:z_{53}(26:24:25)	2						
63:NM(8:NM)			1				
65:c:z(30:32:31)				1			
65:c:z_{53}(30:32:25)	1						
65:(k):z(30:22:31)	4						
65:1,v:z(30:23:31)	1						
65:1,v:z_{53}(30:23:25)							1
R:i:z(R:33:31)				1			
R:1,v:z_{35}(R:23:31)	1						
R:r:e,n,,x,z_{15}(R:24:28)				1			1
R:z_4,z_{23}:−(R:1,2,5:−)						1[c]	
R:z_4,z_{32}:−(R:1,7,8:−)						1[c]	
Total	273	26	16	14	13	19	13

[a] The *Salmonella* serotyping scheme antigenic formula is given, and the corresponding Arizona serotyping scheme antigens are in parentheses. NM, nonmotile; R, rough.
[b] Abscess culture.
[c] Includes one synovial fluid.
[d] A blood culture was also received from the same patient (not tabulated).
[e] A urine culture was also received from the same patient (not tabulated).
[f] Ascites fluid.

other serotypes were frequently isolated from turkeys (11, 12, 24). As pathogens of turkeys, arizonae are of significant economic importance internationally (28). In 1956, Edwards and colleagues found it surprising that serotype 18:z_4,z_{32}:− (Arizona 7a,7b:1,7,8:−), which is a widely distributed pathogen of turkeys, had not been found in humans (12). It since has become the serotype most frequently isolated from humans.

TABLE 3. Distribution by source and period[a] of Arizona subgroup serotypes isolated from humans in the United States

Serotype[b]	No. of cultures in period(s)				% Stool culture isolates in period(s)				% Blood culture isolates in period(s)				% Other culture source isolates in period(s)			
	1	2	3	All	1	2	3	All	1	2	3	All	1	2	3	All
18:z_4,z_{23}:−(7a,7b:1,2,6:−)	98	47	7	152	45	34	29	41	24	21	29	24	31	45	42	35
18:z_4,z_{32}L−(7a,7b:1,7,8:−)	19	46	75	140	84	52	64	63	11	9	17	14	5	39	18	23
41:z_4,z_{23}:−(13:1,2,5:−)	1	5	6	12	100	20	67	50	0	0	33	17	0	80	0	33
48:g,z_{51}:−(5:13,14:−)	7	19	9	35	57	84	67	74	14	11	0	9	28	5	33	17
60:r:e,n,x,z_{15}(24:24:28)	6	16	31	53	100	75	97	91	0	6	0	2	0	19	3	7
60:r:z(24:24:31)	1	12	9	22	100	67	67	68	0	0	11	5	0	33	22	27
61:c:z_{35}(26:32:31)	0	4	9	13	0	75	78	77	0	0	0	0	0	25	22	23
61:k:1,5,(7)(26:29:30)	0	7	27	34	0	57	33	38	0	0	4	3	0	43	73	59
61:1,v:1,5,(7)(26:23:30)	7	31	72	110	100	71	92	86	0	0	1	1	0	29	7	13
Other	90	124	129	343	89	72	73	77	8	6	5	6	3	22	22	17
Total or avg	229	311	374	914	67	63	73	68	15	8	7	9	16	29	20	22

[a] Periods were: 1, data reported in 1959 by Edwards and Ewins (9); 2, cultures from July 1959 to December 1966 (23); 3, cultures from January 1967 to December 1976 (this report); and All, all the above data combined.
[b] The *Salmonella* serotyping scheme antigenic formula is given, and the corresponding Arizona serotyping scheme antigens are in parentheses.

TABLE 4. Comparative frequency of extraintestinal-to-intestinal isolation of all Arizona subgroup serotypes isolated from human sources[a,b] and received by the CDC through 1976

Serotype[c]	No. of isolates		Ratio[b,d]
	Extraintestinal	Intestinal	
17:z_{36}(12:17,20)	2	0	—[e]
18:z_4,z_{23}:−(7a,7b:1,2,6:−)	83	59	1.41
18:z_4,z_{32}:−(7a,7b:1,7,8:−)	39	88	0.44
21:g,z_{51}:−(22:13,14:−)	5	1	5.00
40:z_4,z_{23}:−(10a,10b:1,2,5:−)	2	36	0.06
41:z_4,z_{23}:−(13:1,2,5:−)	6	6	1.00
43:z_4,z_{23}:−(21:1,2,6:−)	2	1	2.00
48:g,z_{51}:−(5:13,14:−)	7	26	0.27
50:r:z(9a,9b:24:31)	4	7	0.57
51:z_4,z_{23}:−(1,2:1,2,5:−)	5	11	0.45
53:z_4,z_{23}:−(1,4:1,2,5:−)	2	6	0.33
60:r:e,n,x,z_{15}(24:24:28)	3	44	0.11
61:1,5,(7):−(26:30:−)	7	3	2.33
61:k:1,5,(7)(26:29:30)	18	13	1.38
61:1,v:1,5,(7)(26:23:30)	6	89	0.07
O Rough	4	1	4.00
Single extraintestinal isolations[f]	20	47	0.43
Above serotypes[g]	215[a]	438[h]	0.49
All serotypes[h]	215[a]	597	0.37

[a] Data of Edwards et al. (11), Martin et al. (24), and this report, accounting for 69, 57, and 89 extraintestinal cultures, respectively. (Serotypes 1,3:17,20:−, 9a,9b:13,15:−, and 10a,10b:1,2,36:− are no longer considered arizonae and are excluded.)

[b] Cultures of unknown source are excluded.

[c] The *Salmonella* serotyping scheme antigenic formulas are given, and the Arizona serotyping scheme antigens are in parentheses.

[d] Ratio of extraintestinal-to-intestinal cultures for each serotype.

[e] —, Undefined.

[f] Serotypes 51:g,z_{51}:−(1,2:13,14:−), 53:z_4,z_{23}:−(1,4:1,2,5:−), 53:1,5:z (1,4:30:31), 48:z_4,z_{23}:−(5:1,2,5:−), 48:z_4,z_{32}:−(5:1,2,10:−), 48: z_4,z_{24}:− (5:1,3,11:−), 48:z_{36}:−(5:17,20:−), 18:NM(7a,7b:NM), 63:NM (8:NM), 40:z_4,z_{32}:− (10a,10b:1,2,10:−), 40:z_4,z_{24}:−(10a,10b:1,3,11:−), 56:z_4,z_{23}:− (14:1,2,5:−), 38:(k):z_{35}(16:22:21), 59:z_{29}:−(19:16,18:−), 59:z_{36}:− (19:17, 20:−), 16:z_{10}: e,n,x,z_{15}(25:27:28), 61:1,v:z_{35}(26:23:21), 61:c:z_{35}(26: 32:21), 48:k:1,5(7)(29:29:30), and 65:c:z(30:32:31). NM, Nonmotile.

[g] Includes all serotypes with one or more extraintestinal cultures.

[h] Data of Edwards and Ewing (9), Martin et al. (24), and this report.

The frequency of human isolations of arizonae serotypes has indeed changed markedly over the years (Table 3). The two most common Arizona subgroup serotypes in our series, 18:z_4,z_{32}:− (Arizona 7a,7b:1,7,8:−) (20% of all isolates) and 61:1,v:1,5,(7) (Arizona 26:23:30) (19%), occurred much less frequently in the 1959 series (8 and 3%, respectively [11]). Conversely, the most common Arizona subgroup serotype before 1959, 18:z_4,z_{23}:− (Arizona 7a,7b:1,2,6:−) (43%), had become our 10th most common (2%). Edwards and colleagues (13) believed that host adaptation of serotypes occurs in the Arizona subgroup just as it does among other *Salmonella* subgroups, which a resultant change in transmission to and incidence of infection in humans.

Suprisingly, however, each serotype seems to have retained its own, relatively constant, pattern of human source isolation over the years (Table 3). This phenomenon might represent an artifact owing to biochemical characteristics (such as rapidity of lactose fermentation) of a given serotype, because selective culture media are usually used for gastrointestinal source material, whereas nonselective media are used for most extraintestinal source cultures. However, the biochemical characteristics of individual Arizona subgroup serotypes sometimes have been variable (11, 21). We suspect that the source-isolation pattern may be a marker for the human niche of a serotype. Thus, serotypes 18:z_4,z_{23}:− (Arizona 7a,7b:1,2,6:−), 21:g,z_{51}:− (Arizona 22:13,14:−), and 61:k:1,5,(7) (Arizona 26:29:30) appear to be the more invasive serotypes (Table 4) and are associated with mortality rates higher than those of the less invasive serotypes (Weiss et al., submitted). Thus, as has already been noted for other *Salmonella* subgroups (4, 6), certain Arizona subgroup serotypes appear to be associated with enhanced virulence for humans.

ACKNOWLEDGMENTS

We thank J. J. Farmer, III, and G. K. Morris for critically reading the manuscript and D. Anderson for her expert help in manuscript preparation.

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