Surveillance of *Salmonella* in Canada (1993 - 1996) P-1

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Abstrak

Selama periode 1993-1996 di Kanada, berdasarkan data laboratorium, telah dilaporkan sebanyak 29.670 kasus infeksi Salmonella. *Frekuensi 5 serotip* Salmonella *yang paling banyak dari sumber manusia adalah : 18,9%* S. Typhimurium, *15,5%* S. Enteritidis, *8,3%* S. Hadar, *7,9%* S. Heidelberg *dan 3,2%* S. Thompson. *Walaupun urutan dan frekuensi dari serotip tersebut bervariasi dari tahun ke tahun, kelima serotip tersebut merupakan 53,8% dari semua serotip* Salmonella *yang diisolasi di Kanada selama 1993-1996. Dari sumber bukan manusia,* S. Heidelberg *berada di peringkat tertinggi, yaitu 20,1% (2.343/11.657), diikuti oleh* S. Hadar *12,5% (1.458/11.657). Pada periode tersebut 2 serotipe* Salmonella *baru telah diidentifikasi oleh LCDC dan diberi nama oleh Institut Pasteur:* S. Surrey *yang diisolasi dari pasien yang mengadakan perjalanan ke India dan* S. Taiping *yang diisolasi dari ikan maw kering dari Hongkong. Pada masa kini terjadi peningkatan Salmonellosis pada manusia yang berkaitan dengan binatang piaraan eksotik. Dari tahun 1993 sampai 1995 diperkirakan 3% - 5% semua kasus pada manusia dihubungkan dengan paparan terhadap binatang piaraan eksotik, termasuk iguana, kura-kura,* Sugar gliders *dan landak. Selama periode ini, 188 kejadian luar biasa (KLB) dari berbagai serotip* Salmonella *telah diteliti. KLB utama disebabkan oleh serotip sebagai berikut:* S. Enteritidis, S. Newport, S. Stanley *dan* S. Typhimurium. *Studi tentang hubungan antara KLB dan pejamu binatang dari berbagai serotip dengan penentuan tipe faga menunjukkan bahwa unggas, telur, tunas alfalfa dan produk sapi yang terkontaminasi merupakan sumber infeksi yang umum pada manusia di Kanada. Selama perioda ini dijumpai peningkatan jumlah kasus* S. Typhimurium *tipe faga (PT) 104, yang biasa dikenal sebagai* definite type *(DT)104 (3 kasus pada tahun 1993 menjadi 144 kasus pada tahun 1996).* S. Typhimurium *DT104 ini dijumpai resisten terhadap satu atau beberapa antibiotika, yaitu ampisilin, kloramfenikol, streptomisin, sulfonamid dan tetrasiklin (tipe R ACSSuT). Satu kejadian dengan 10 kasus* S. Typhimurium *DT104, tipe R ACSSuT yang terjadi tahun 1995 ternyata bersumber dari daging yang terkontaminasi. Monitor* S. Typhimurium *DT104 selama tahun 1995 dan 1996 mendapatkan bahwa tipe R ACSSuT bertambah dari 38,3% pada tahun 1995 menjadi 65% pada tahun 1996. Surveilans dan identifikasi bahaya dengan menggunakan penanda fenotip memberikan informasi epidemiologik berharga pada insiden, kecenderungan dan faktor risiko yang berkaitan dengan KLB dan kasus klinik yang berhubungan dengan infeksi* Salmonella.

Abstract

In Canada, during 1993-1996 there were 29,670 laboratory reported cases of Salmonella *infections. The frequency of the five most common* Salmonella *serotypes from human sources were as follows:* S. Typhimurium *18.9%,* S. Enteritidis *15.5%,* S. Hadar *8.3%,* S. Heidelberg *7.9% and* S. Thompson *3.2%. Although the rank and frequency of these serotypes varied from year to year, these five common serotypes comprised 53.8% of the total* Salmonella *serotypes isolated in Canada during 1993-1996.* S. Heidelberg *ranked first at 20.1% (2,343/11,657) among nonhuman sources, followed by* S. Hadar *at 12.5% (1,458/11,657). In addition to these, during this period two new* Salmonella *serotypes identified by LCDC were designated by the Institut Pasteur:* S. Surrey *isolated from a patient involving travel to India and* S. Taiping *isolated from dried fish maw from Hong Kong. Recently, there has been an increase of salmonellosis in humans, which has been associated with exotic pets. From 1993 to 1995, an estimated 3% to 5% of all human cases were associated with exposure to exotic pets, including iguanas, pet turtles, sugar gliders and hedgehogs. During this period, 188 outbreaks belonging to various* Salmonella *serotypes were investigated. The major outbreaks belonged to the following serotypes:* S. Enteritidis, S. Newport, S. Stanley, *and* S. Typhimurium. *A study of outbreaks and animal-host associations of the various serotypes by phagetyping indicated that contaminated poultry, eggs, alfalfa sprouts and bovine products appeared to be the common sources of human infections in Canada. During this period, there has been an increased number of cases of* S. Typhimurium *phagetype (PT) 104, commonly known as definite type (DT) 104 (3 in 1993 to 144 in 1996) and they were found to be singularly or multiresistant to the following antibiotics: ampicillin, chloramphenicol, streptomycin, sulphonamide and tetracycline (R-type ACSSuT). One episode of 10 cases of* S. Typhimurium *DT104, R-type ACSSuT occurred in 1995 was acquired from contaminated meat. Monitoring of* S. Typhimurium *DT104 during 1995 and 1996 revealed that R-type ACSSuT increased from 38.3% in 1995 to 65% in 1996. Surveillance and hazard identification using phenotypic markers provide valuable epidemiological information on the incidence, trends and risk factors related to outbreaks and clinical cases associated with* Salmonella *infections.*

INTRODUCTION

Salmonellosis is one of the most important public health disease problems, affecting more people and animals than any other single disease[1]. In Canada,

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there was a total of 8057 laboratory-confirmed cases of salmonellosis in 1993, 7324 cases in 1994, 7138 cases in 1995[2], and 7319 cases in 1996. The incidence of human cases of salmonellosis is thought to be many times greater than the number of reported and confirmed cases, even in countries with well-organized surveillance activities[1]. In fact, it is estimated that each year in Canada alone, salmonellosis affects 2.4% of the total population, an equivalent of 627,200 cases of illness[3]. There can be little disagreement that with the impact of cost on medical care and the loss of productivity, salmonellosis is a very real and underestimated problem[1].

Surveillance activities of the National Laboratory for Enteric Pathogens involve the collection of national data on salmonellosis from federal, provincial, territorial and public health agencies. Monthly data representing cases of human disease and nonhuman isolates are analysed and disseminated in a timely fashion to health care professionals both nationally and internationally. National data can be used to investigate, identify and control outbreaks, monitor the trends of disease over time, determine risk factors, and detect emerging or re-emerging trends such as multiple drug resistance.

In this study, the prevalence of *Salmonella* serotypes and phage types is examined.

METHODS AND MATERIALS

The *Salmonella* cultures were submitted for identification, serotyping and for phage-typing by various provincial public health laboratories, federal laboratories and veterinary laboratories across Canada.

Serotyping: All serotypes were identified using the typing schemes published by the World Health Organization[4].

Phage typing: The standard Phage-typing technique described by Anderson and Williams[5] was employed throughout this investigation. Phages and typing schemes were developed at LCDC (Table 4), or were obtained from the International Collaborating Centre for Enteric Phage typing, Central Public Health Laboratory, Colindale (UK).

RESULTS AND DISCUSSION

During the four-year period (1993 - 1996), a total of 41,327 Salmonellae isolated from human and nonhuman sources were reported in Canada through a nationwide surveillance system of the National Enteric Reference Centre, LCDC. Of the total, 29,670 Salmonellae were isolated from human sources and the remaining 11,657 were isolated from nonhuman sources. In each of these years, increasing isolations of a few serotypes (*Salmonella* Typhimurium, *S.* Hadar, *S.* Enteritidis, *S.* Heidelberg) resulted in an increased number of cases in the annual total of reported cases of salmonellosis[2].

During the four-year period, the 10 most common serotypes accounted for 61.6% (18.252) of the human isolates and 60.0% (6993) of the nonhuman isolates (Table 1). Though the yearly rank of frequency of the

Table 1. Ten Most Common *Salmonella* Serotypes Isolated in Canada From Human & Non-human Sources (1993-1996)

Rank	Human	No. of Isolates* (%)	Non-human	No. of Isolates* (%)
1	*S.* Typhimurium	5598 (18.9)	*S.* Heidelberg	2343 (20.1)
2	*S.* Enteritidis	4593 (15.5)	*S.* Hadar	1458 (12.5)
3	*S.* Hadar	2469 (8.3)	*S.* Typhimurium	1044 (9.0)
4	*S.* Heidelberg	2345 (7.9)	*S.* Schwarzengrund	486 (4.2)
5	*S.* Thompson	963 (3.2)	*S.* Kentucky	332 (2.8)
6	*S.* Agona	605 (2.0)	*S.* Saintpaul	291 (2.5)
7	*S.* Newport	519 (1.5)	*S.* Anatum	283 (2.4)
8	*S.* Infantis	452 (1.5)	*S.* Senftenberg	276 (2.4)
9	*S.* Saintpaul	389 (1.3)	*S.* Enteritidis	255 (2.2)
10	*S.* Typhi	319 (1.1)	*S.* Infantis	225 (1.9)
Total of 10 Serotypes:		18252 (61.6)		6993 (60.0)
Total of Other Serotypes:		11418 (38.4)		4664 (40.0)
Grand Total: 29670 (100)			11657 (100)	

**preliminary data only for 1996*

Table 2. Human *Salmonella* infections in Canada associated with exotic pets, 1994 to 1996[11]

Salmonella serotype	No. of cases of infection	Location*	Epidemiological link
S. Poona	1	NF	Associated with pet turtle
S. Poona	1	AB	3-yr old boy; associated with pet iguana
S. Wassenaar ssp. IV	1	SK	Associated with pet iguana
S. Wassenaar ssp. IV	5	SK	Five cases in one family; associated with pet iguana
S. Tilene	5	AB	Three cases in one family; associated with pet sugar glider
S. Tilene	1	SK	4-mo-old baby boy; associated with hedgehog
S. Tilene	1	MB	2-yr-old baby boy; associated with hedgehog
S. Tilene	2	ON	Associated with hedgehogs
S. Jangwani	1	NS	Child visiting a home with baby turtles
S. Jangwani	9	QU	Associated with turtles
S. Montevideo	1	MB	Renal transplant recipient; associated with pet iguana
S. Marina ssp. IV	1	MB	Blood and urine of 11-yr-old boy; associated with pet iguana
S. Marina ssp. IV	2	MB	Twin baby brothers; associated with iguana in foster home
S. Marina ssp. IV	1	AB	Baby boy; associated with iguana in foster home
S. Braenderup	1	BC	Associated with pet turtle
S. Abaetetuba	2	BC	Family has pet iguana
S. Typhimurium	1	BC	6-yr-old boy; associated with pet hedgehog
S. Java	1	BC	Associated with turtle

**BC = British Columbia, AB = Alberta, SK = Saskatchewan, MB = Manitoba, ON = Ontario, QU = Quebec, NS = Nova Scotia, NF = Newfoundland*

10 most common *Salmonella* serotypes isolated from human and nonhuman sources varied, *S.* Typhimurium ranked first in human sources where as *S.* Heidelberg ranked first among nonhuman sources. *S.* Hadar's frequency increased rapidly because of its introduction to Canada by importation of turkey breeder stock, which acts as a reservoir. The isolation rate of *S.* Enteritidis from human sources also increased rapidly since 1985[6] and in 1993, for the first time exceeded that of *S.* Typhimurium[2]. In comparison to *S.* Enteritidis, *S.* Heidelberg was the most common serotype isolated from layer flocks and turkey flocks in Canada, but was less frequently isolated from human sources than *S.* Enteritidis[6]. One of the reasons may be that human hosts, in particular infants, the elderly and the immunocompromised, are more susceptible to *S.* Typhimurium and *S.* Enteritidis than to *S.* Heidelberg[7,8].

Recent *Salmonella* infections in Canada associated with exotic pets are shown in Table 2. At least 37 cases of human salmonellosis with a firmly established epidemiological link to exotic pets were documented in Canada during a 3-year period (1994 - 1996). These included cases of salmonellosis caused by serotypes *S.* Poona (1 case in association with a turtle and 1 case in association with an iguana), *S.* Wassenaar (6 cases in association with iguanas), *S.* Tilene (5 cases in association with sugar gliders and 4 cases in association with hedgehogs), *S.* Jangwani (10 cases in association with turtles), *S.* Montevideo (1 case in association with an iguana), and *S.* Marina (4 cases in association with iguanas) (Table 2). Among these, two family-related outbreaks occurred, one involving three cases of *S.* Tilene infection associated with pet sugar gliders and a second outbreak involving five cases of *S.* Wassenaar infection associated with a pet iguana (Table 2).

In 1975 Agriculture Canada enacted legislation banning the importation of turtles into Canada; however, imported embryonated turtle eggs may be a source of continuing human infection in Canada[9]. In the United States, *Salmonella* serotypes with the same epidemiological link to exotic pets have been observed as causes of disease in humans and have been associated with both morbidity and mortality[9].

During this period, 23 serotypes not previously reported in Canada were mainly associated with imported food products or travellers and immigrants (Table 3). Among them, two new serotypes, *S.* Surrey and *S.* Taiping were confirmed as a first-time isolation worldwide by the International Collaborating Centre for *Salmonella*. An important role of surveillance activity is the detection of outbreaks. The early detection of outbreaks provides for the development of effective intervention strategies to halt the spread

Table 3. First Isolation of *Salmonella* in Canada (1993-1996)

Serotype	Formula	Source
S. Ahuza	43:k:1,5	Human
S. Balboa	48:z41:- ssp V	Human
S. Brijbhumi	11:i:1,5	Human
S. Canastel	9,12:z29:1,5	Tortoise (Imported)
S. Caracas	6,14:g,m,s:-	Human
S. Elisabethville	3,10:r:1,7	Human
S. Fluntern	18:b:1,5	Iguana (Imported)
S. Galiema	6,7:k:1,2	Human
S. Georgia	6,7:b:e,n,z15	Human
S. Godesberg	30:g,m:-	Halawa (Imported)
S. Jangwani	17:a:1,5	Human
S. Kingabwa	43:y:1,5	Human
S. Lindern	6,14:d:e,n,x	Human
S. Milwaukee	43:f,g:-	Human
S. Mpouto	16:m,t:-	Human
S. Surrey	21:k:1,2,5	Human
S. Taiping	13,22:l,z13:e,n,z15	Dried Fish Maw (Imported)
S. Tilene	40:e,h:1,2	Human
S. Uno	6,8:z29:e,n,z15	Human
Salmonella arizonae	11:lv:1,5,7 ssp IIIb	Human
	48:lv:1,5,7 ssp IIIb	Snake (Imported)
	65:lv:z spp IIIb	Human
	40:z4,z23:- ssp IIIa	Snake (Imported)

Table 4. Summary of *Salmonella* Outbreaks Studied By Phage-typing in Canada (1993 TO 1996)

Serotype	No. of Outbreaks	No. of Cases	Phage Types [Outbreak Type*]
S. Dublin	1	2	-^ [C]
S. Enteritidis	74	355	1 [2F], 2 [F], 4 [2C,11F,I,U], 4a [F], 5a [C], 6a [F], 8 [Co,25F,2I,M,3R], 9b [F], 9c [F], 10 [Cn], 13 [C,3F,N], 13a [C, 6F], 28 [F], 37 [F], Atypical [C,F]
S. Hadar	5	52	2 [C,2F,2R]
S. Heidelberg**	15	66	6 [C,F,FD,H], 8 [2C,F,U]
S. Java & *S.* Paratyphi-B	10	24	1 variant [C,F], 1 var. 3 [C,F], 3 a 1 [F], Dundee [F], Worksop [3F], Untypable [F]
S. Newport**	2	131	2 [C,U]
S. Stanley	2	42	- [F,U]
S. Tennessee	2	11	- [C,U]
S. Thompson**	4	39	1 [C,F,R]
S. Typhimuirum	37	160	3 aero. [C], 10 [P], 12a [C], 66 [2C], 82 [N], 94 [C], 104 [C,CS,F,H], 108 [C,3F], 120 [F], 126 [F], 160 [C], 191 [F], 193 [F,R], 204 [R], 921 [C]***, Atypical [F]
S. Typhi	13	27	B1 [F,S], D1 [F], D8 [D], E1 [C,2F,L], O [F], 61 [F], I+IV (UVS) [2F]
Total	165	909	

A study of outbreaks and animal-host associations of the various serotypes by phagetyping indicated that contaminated poultry, eggs, alfalfa sprouts and bovine products appeared to be the common sources of human infections in Canada.

^ *- = not typed*

* *C=community, Cn=contact, Co=convention, CS=catering service, D=daycare, F=family, FD=family dinner, H=hospital, I=institution, L=lab-acquired, M=mobile lunch service, N=nursing home, P=party, R=restaurant, S=sausage factory staff, U=unknown*

** *Phagetyping schemes developed for these serotypes at LCDC*

*** *LCDC designation of new type*

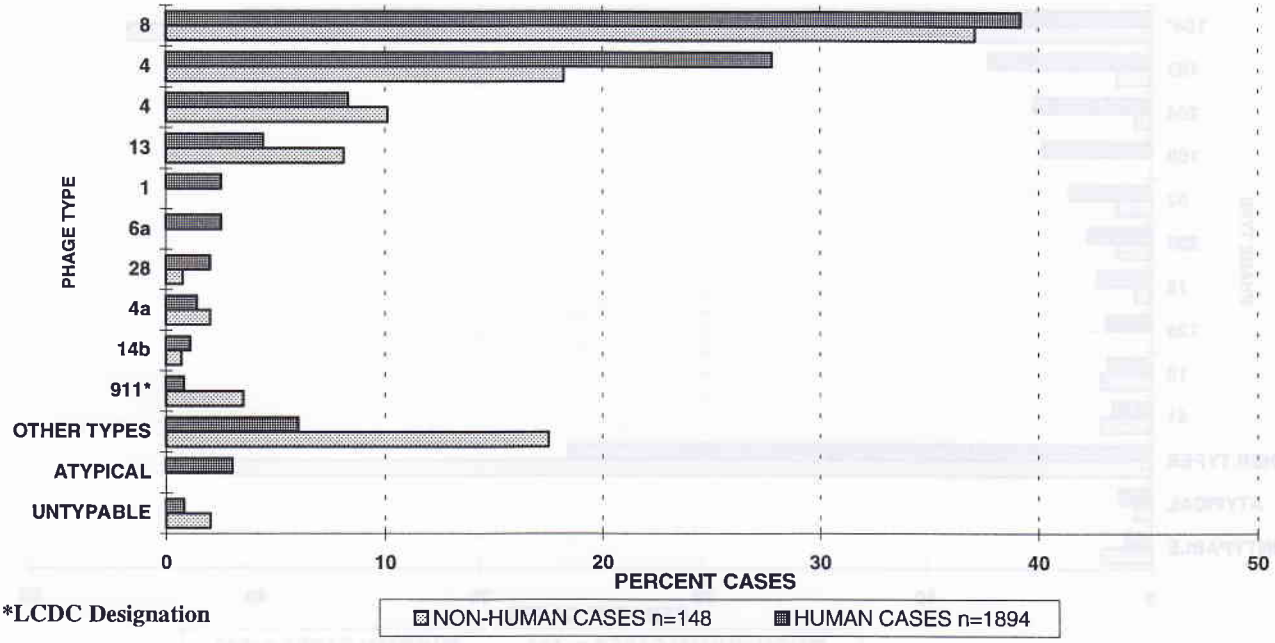

Figure 1. *Frequency of the 10 most common* S. Enteritidis *phage types in Canada, 1993-1996*

of the *Salmonella* within the community. Serotyping and phagetyping of *Salmonella* have been, and remain, the most useful laboratory tools for the identification of outbreaks. A total of 188 human outbreaks due to various *Salmonella* serotypes was reported during this four-year period. Of these, 165 *Salmonella* outbreaks were studied by phage typing (Table 4). The major outbreaks belonged to the following serotypes: *S.* Enteritidis, *S.* Newport, *S.* Stanley and *S.* Typhimurium. The *S.* Enteritidis strains that were isolated from the human outbreaks belonged to 14 different phagetypes. Phage type 8 was the most common among sporadic cases and from these outbreaks (Table 4, Figure 1). Though most of the human *S.* Enteritidis PT4 sporadic and outbreak cases were acquired while travelling abroad[10], 1996 surveillance data indicated that *S.* Enteritidis PT4 was established domestically, and the first major outbreak of S. Enteritidis PT4 occurred in Quebec and Ontario linked to the consumption of eggs (unpublished data). A major outbreak of *S.* Newport phage type 2 and *S.* Stanley (same phage pattern) which occurred during 1995 and 1996 were associated with contaminated alfalfa sprouts imported from abroad. The emergence and increased number of cases of *S.*Typhimurium DT104 in Canada have become a recent concern (Figure 2). This phage type replaced DT10 which was the most common in our previous survey[6]. Some of the *S.* Typhimurium DT104 isolates have been resistant to multiple antibiotics, such as ampicillin, chloramphenicol, streptomycin, sulphonamide and tetracycline (R-type ACSSuT). One episode of 10 cases of *S.* Typhimurium DT104, R-type ACSSuT occurred during 1995 was acquired from contaminated meat[2]. Monitoring of *S.* Typhimurium DT104, during 1995 and 1996 revealed that Rtype ACSSuT increased from 38.3% in 1995 to 65% in 1996 (Mike Mulvey, personal communication). During this period, *S.* Typhimurium strains belonging to as many as 15 different phage types were isolated from 160 cases in 37 outbreaks (Table 4). *S.* Typhi phage type E1 was common among sporadic and family contact cases. In Canada, the rare phage types, J1, K1, M1 and I+IV were observed among typhoid cases isolated from visitors or immigrants[2].

This surveillance study provides epidemiological information on the incidence, trends and risk factors related to Salmonella outbreaks and sporadic cases.

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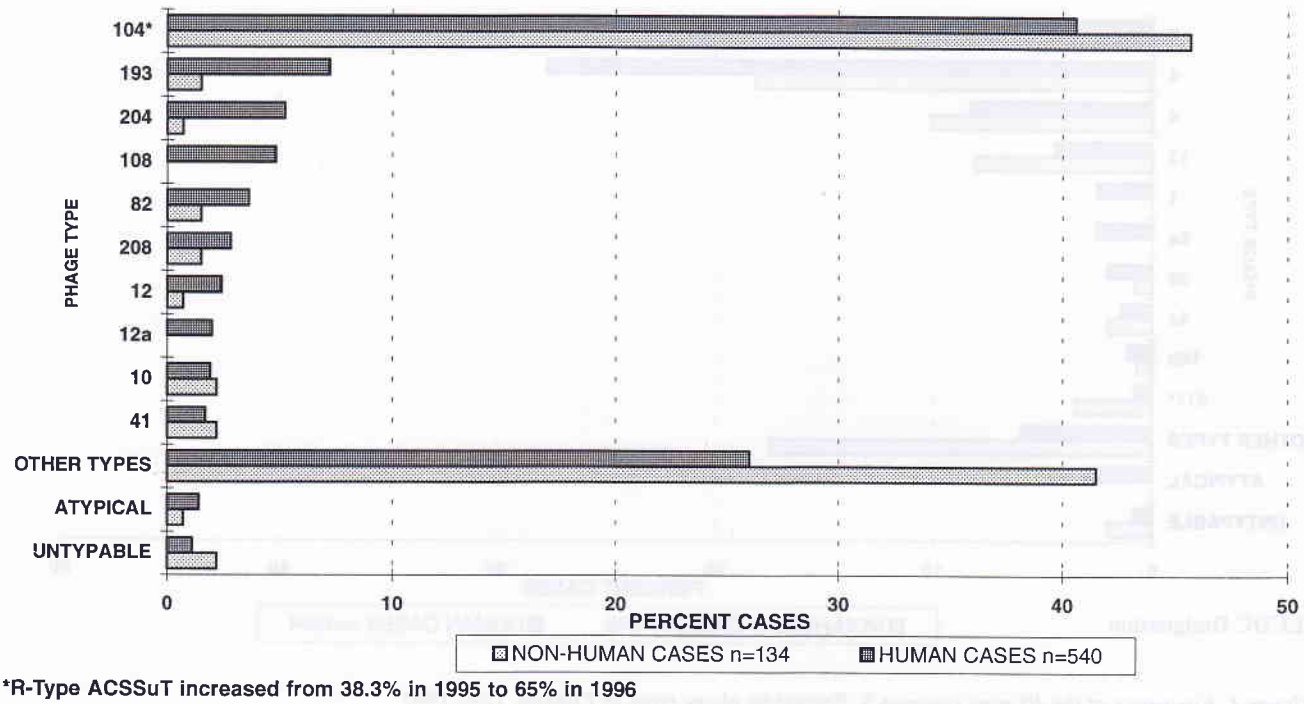

Figure 2. *Frequency of the 10 most common* S. Typhimurium *phage types in Canada, 1993-1996*

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