Case Report

Turtle-associated *Salmonella* septicaemia and meningitis in a 2-month-old baby

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A severe case of reptile-associated salmonellosis which caused septicaemia and meningitis in a 2-month-old baby is reported. The infrequent serotype *Salmonella enterica* subsp.(I) *enterica* serotype Abony (4,5:b:enx) was detected in the human sample as well as in the pet turtle's faeces. The importance of regulation and public awareness is highlighted.

Introduction

Salmonellae are motile Gram-negative bacilli which can infect or colonize a wide range of hosts. In humans, non-typhoidal *Salmonella* most often causes self-limiting gastroenteritis, but more severe symptoms such as sepsis and meningitis can also occur and can sometimes have a fatal outcome, especially in at-risk patients such as infants, the elderly or immunocompromised adults.

Human salmonellosis is a major worldwide public health problem with an estimated 1.4 million cases annually in the United States alone (Editorial team *et al.*, 2008). The incidence of salmonellosis worldwide is highest among children of 1–4 years of age.

In Belgium, non-typhoidal salmonellosis, together with campylobacteriosis, is the most frequently reported food-borne illness. Since 2005, approximately 3000–5000 human *Salmonella* infections have been reported annually in Belgium (<http://bacterio.iph.fgov.be>).

Salmonella infections are caused by consumption of contaminated food, person-to-person transmission, water-borne transmission and numerous environmental and animal exposures. Specifically, reptiles and other cold-blooded animals (often referred to as 'exotic pets') can act as reservoirs of *Salmonella*, and cases of infection have been associated with direct or indirect contact with these animals (Mermin *et al.*, 2004).

The infections in reptiles are usually asymptomatic, although clinical salmonellosis in reptiles has been reported with the following symptoms: septicaemia, salpingitis, dermatitis, osteomyelitis and granulomatous disease (Pasmans *et al.*, 2008).

The genus *Salmonella* comprises more than 2579 serotypes (Grimont & Weill, 2007). Among these, an increasing number of uncommon, but characteristic, serotypes associated with exotic pets are being observed in association with cases of salmonellosis in humans.

Reptile-associated *Salmonella* infections are often associated with an invasive disease and frequently lead to hospitalization. These complications occur more commonly in infants (Mermin *et al.*, 2004).

In this report, we present the case of a 2-month-old girl hospitalized for septicaemia and meningitis caused by *Salmonella enterica* subsp.(I) *enterica* serotype Abony, most likely due to indirect exposure to the family's pet turtle.

Case report

On 14 October 2008, a 2-month-old girl was hospitalized for septicaemia and meningitis due to *Salmonella*. Subsequent microbiological testing of the spinal fluid sample revealed the presence of *S.* Abony (4,5:b:enx). This strain of *Salmonella* is rare in humans in Belgium (3 *S.* Abony in 35 021 reported cases of *Salmonella* between 2003 and 2007) but it has previously been found in association with reptiles (Briones *et al.*, 2004).

The infant recovered after intravenous ceftriaxone treatment and hospitalization for 3 weeks without any sequelae. Two other cerebrospinal fluid punctures performed during the hospitalization were negative for *Salmonella*.

Paediatricians questioned the parents of the affected baby, and during the interview, it was discovered that the family had a pet turtle. Samples for microbiological analysis were

taken from the turtle faeces and from the water used to prepare the baby's feeding bottle. *Salmonella* was only detected in the faecal sample collected from the turtle living at the infant's home. Eight positive isolates from the faecal sample plated on XLD medium (International Medical Products) were selected for further identification according to the Kauffmann–White scheme. This was done to increase the chance of detecting different serotypes that could have been present in the faecal sample (Willis *et al.*, 2002). In total, six isolates were identified as *Salmonella* serotype Abony (4,5:b:enx), one as *Salmonella* serotype 4,5:b:– and one as *Salmonella* serotype Solna (28:a:1,5). As the enx sequence was detected in the *Salmonella* serotype 4,5:b:– strain with a multiplex PCR specific for the detection of second-phase flagellar antigens (Echeita *et al.*, 2002), it must be a derivative of *S.* Abony.

The antibiotic susceptibility for all of the *Salmonella* isolates from the baby and from the turtle faeces was determined by the standard disc diffusion susceptibility method according to Clinical and Laboratory Standards Institute guidelines (CLSI, 1998). The tested antibiotics were: ampicillin, amoxicillin + clavulanic acid, cefotaxime, chloramphenicol, tetracycline, spectinomycin, nalidixic acid, ciprofloxacin, streptomycin, kanamycin, gentamicin, sulfonamides, trimethoprim and co-trimoxazole (trimethoprim–sulfamethoxazole). All the *S.* Abony isolates were susceptible to the 13 tested antibiotics, while the *S.* Solna isolate was resistant to ampicillin, tetracycline, streptomycin, sulfonamide and co-trimoxazole.

To determine the genetic relatedness between the eight *S.* Abony isolates (one isolate from the baby and seven isolates from the turtle faeces), a PFGE analysis was performed according to the PulseNet protocol (www.cdc.gov/pulsenet) with the restriction enzymes *Xba*I, *Bln*I and *Spe*I. Among the eight *S.* Abony isolates, three very similar profiles were observed. Two different but closely related profiles were observed in the turtle faeces, showing the diversity among the turtle isolates (Fig. 1).

Discussion

The present study indicates that *Salmonella* septicaemia and meningitis in a 2-month-old baby can be attributed to indirect exposure to the exotic pet present at the infant's home. It also shows that salmonellosis associated with the

importation of exotic pets is a major public health problem, especially in young infants throughout the world.

In the United States, reptile-associated salmonellosis through direct or indirect contact has been estimated for 6% of human *Salmonella* infections. During the period 2006–2008, there have been three reports of reptile-associated salmonellosis outbreaks in the United States (CDC, 2007, 2008). One case even had a fatal outcome.

In Europe, even if the source of infection is not routinely identified, which makes the case numbers very difficult to determine so they are probably underestimated, the possible exposure to reptiles is usually revealed in the course of additional epidemiological investigation. About 90% of all reptiles carry and shed *Salmonella* in their faeces. This means that exotic pets represent important reservoirs of *Salmonella* infection. Variable excretion rates make carrier identification difficult. Treatment of asymptomatic carriers by antibiotic therapy is ineffective and moreover it can induce antibiotic resistance (Woodward *et al.*, 1997).

In the present report, two different serotypes, *S.* Abony and *S.* Solna, were detected in the single turtle faecal sample. Previous studies have already shown that up to five different serotypes with different levels of virulence can be isolated from a single reptile (Willis *et al.*, 2002).

Three different, but closely related, PFGE profiles were found, which shows the diversity of *S.* Abony in this study. The genetic diversity among the *S.* Abony isolates in this present study could be due to random genetic events, including point mutations, insertion and deletions of DNA (Tenover *et al.*, 1995). Usually, humans can become infected by reptiles through direct (primary by the faecal–oral way, but transmission by claw scratches and bites has also been reported) or indirect (e.g. visits from people who own reptiles, cleaning cages, etc.) contact. In this study, the baby was most likely infected by indirect contact with the pet turtle. The risk of acquiring a *Salmonella* infection is elevated for young children (as a result of poor hygiene), elderly persons and immunocompromised hosts.

Reptile import restrictions and public information campaigns have demonstrated the effectiveness of public health measures against reptile-associated salmonellosis. For

Fig. 1. PFGE image, generated by Fingerprinting II Informatix software, showing the three different profiles of *S.* Abony after restriction of the bacterial genome with *Spe*I, *Xba*I and *Bln*I. One strain was isolated from the baby and two strains were isolated from the turtle's faeces.

instance, in Sweden, the strict regulation of import of exotic pets taken between 1970 and 1994 led to a huge decrease in the number of reported reptile-associated salmonellosis cases (de Jong *et al.*, 2005). In the United States, the sale of small turtles (i.e. those with a carapace length of less than 4 inches) is prohibited to prevent reptile-associated salmonellosis (CDC, 2007, 2008).

The reptile-associated salmonellosis case described here and cases reported elsewhere in Europe highlight the necessity of public awareness. The Centers for Disease Control and Prevention has developed recommendations for preventing reptile-associated salmonellosis (<http://www.cdc.gov/healthypets/animals/reptiles.htm>) especially focusing on children, immunocompromised adults and pregnant women.

Owners of reptiles, as well as doctors, should be aware of the possibility of acquiring a zoonosis, such as salmonellosis, and should know how to prevent contracting it.

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