

Reptile-related salmonellosis

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J R Soc Med 2001;94:124–126

Forty years ago in the USA, cases of salmonella infection were traced to the keeping of terrapins (turtles) as pets. On epidemiological enquiry, it emerged that such infections were happening on a vast scale, affecting some 280 000 people a year¹. The first attempt at control was to demand rigorous cleansing procedures on terrapin ranches—ranging from chlorine-based rinses to exposure of eggs and embryos to antibiotics (often gentamicin sulphate)^{2,3}. However, about one in five terrapins certified as ‘sterilized’ proved positive for salmonellae⁴; moreover, the isolates were commonly antibiotic-resistant³. In 1975 the US Government banned the marketing of hatchlings within the USA and this action was followed by a clear decline in the incidence of turtle-related salmonellosis⁵. The ban did not apply to reptiles other than terrapins; nor did it apply to exports, which rose from four or five million a year in the 1970s to over seven million in the 1990s. About eight million reptiles are now kept as pets in the USA, and the past decade has seen a substantial rise in the incidence of reptile-related salmonellosis (now 76 000–140 000 per year) despite strong advice from various quarters on how to prevent it⁶.

In Europe, a ban on the primary terrapin trade was imposed in 1997—not because of the threat to health but because the species might constitute an invasive ‘alien’ organism. Consequently, the number of pet terrapins has greatly declined; but, as in the USA, they have often been replaced by other reptiles such as lizards and snakes. There are probably more than half a million reptiles in British homes, and reptile-related salmonellosis is increasingly reported⁷. Two infant fatalities have focused public attention on the issue, but formal estimates of incidence are at present lacking. Salmonellosis in general is under-reported.

REPTILES AND SALMONELLAE

Salmonella species seem to be an essentially normal component of reptilian intestinal flora. 90% or more of reptiles harbour salmonellae^{8,9}, sometimes strains that are highly invasive and virulent in man^{8,10}. Because salmonella

colonization can never be ruled out with confidence, the usual view is that all reptiles should be regarded as carriers.

Salmonella species commonly encountered in reptile-related salmonellosis (RRS) include *S. java*, *S. stanley*, *S. marina*, *S. poona* and *S. pomona*^{3,11–13}. No serotype is reptile-specific, although subspecies III (formerly *S. arizona*) is most common in snakes, and subspecies IV (*S. marina*) is most common in iguana lizards (Angulo F, personal communication to C. Warwick). Several different species may be isolated from a single reptile², but the other strains commonly associated with salmonellosis in man, notably *S. typhimurium* and *S. enteritidis*, are seldom encountered. Salmonellae are highly durable outside of the host and have proved viable after 89 days in tapwater and 30 months in reptile stool¹⁰.

While most reports specify that reptile-borne salmonellae are excreted in faeces, other potential sources of infection must not be overlooked. Urine can act as an additional reservoir for microbes in freshwater terrapins because adult females may draw contaminated water into the bladder before searching for a nest area, with the intention of excreting the liquid onto the ground to moisten conditions for laying². Faecal debris may also become temporarily trapped in the cloacal region of many reptiles, contaminating the urine as it is passed. Infected faecal or other matter can be rapidly dispersed over a reptile’s body; thus any surface area of the animal (whether a semi-aquatic or a terrestrial species) should be regarded as potentially contaminated. In captivity, this is true of the entire home cage environment, and possibly beyond.

TRANSMISSION

The primary transmission route for reptile-borne salmonellae is faecal–oral ingestion. However, lizards¹⁴, terrapins and tortoises can also transmit infection by claw scratches and possibly via bites or open lesions. Contaminated reptile cagewater, faeces or urine could conceivably infect the human body via the ears or eyes.

The route of transmission may not be obvious. In one US study most RRS patients had only indirect, often very slight, contact with a reptile¹. The disease is also acquired in households where reptiles are not kept, when outsiders inadvertently introduce the pathogens^{1,15}. RRS cases

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superficially present as other salmonellosis ('food-poisoning') and the association with reptiles may go unperceived. Especially when atypical salmonellae are isolated, clinicians should enquire about contact with reptiles, remembering that this may be indirect (e.g. via a reptile keeper visiting the household).

PREVENTION

Formal advice from the UK Communicable Diseases Surveillance Centre and the Department of Health resembles that issued by the US Centers for Disease Control. Box 1 summarizes the recommendations, which discourage reptile contact in groups at special risk—children under five, the elderly, immunocompromised persons, and pregnant women. The term 'immunocompromised' is likely to be misunderstood. To many people it means AIDS-type illnesses. US authorities have offered some examples which include not only chemotherapy and immunosuppressant therapy but also infection with colds or flu. RRS is not, of course, restricted to high-risk categories, however defined. Many of those affected are healthy adults.

The general public, medical professionals, veterinarians and others have not fully appreciated the extent to which reptile-borne salmonellae can survive in and on household items as well human vectors. The principal protection measure usually advised, after contact with a reptile, is hand-washing. This strategy, however, is not conspicuously successful even in healthcare professionals at work, who comply poorly with established hand-washing requirements^{1,16}.

Where children handle a reptile, adult supervision can ensure that they do not kiss it or place their fingers into their own mouths before washing their hands with bactericidal soap. However, this may not be sufficient because the entire surface of the reptile is likely to be contaminated and the animal has probably contacted the child's clothes and areas of skin beyond the hands (for example, a snake draped around the neck and shoulders, or a lizard held against the chest); then even thorough cleaning of the child's hands will not in itself eliminate the risk of infection. Cleaned hands may be quickly recontaminated by the child's clothes or other nearby items. Even where the reptile and a vulnerable person do not meet, the keeper may still act as a vector via, for instance, contaminated garments. Thus, while a responsible adult may conscientiously isolate an animal from vulnerable household members and be punctilious in matters of hygiene after handling animals, there is still a risk of causing infection in others.

Commercial dealers and reptile keepers have, over the past decade, staged one-day exotic animal 'shows', 'expos' and similarly titled events in many parts of the US and UK which typically involve hiring schools, community centres

Box 1 British and American advice on prevention of reptile-related salmonellosis

Pet store owners, veterinarians, and others should inform owners and potential purchasers about the risk of acquiring salmonellosis from reptiles

Always wash hands thoroughly with soap and water after handling reptiles or reptile cages

Persons at increased risk for infection or serious complications of salmonellosis (e.g., children aged less than 5 years and immunocompromised persons) should avoid contact with reptiles

Pet reptiles should be kept out of households where children aged less than 5 years or immunocompromised persons live or a baby is expected

Pet reptiles should not be kept in child care centres

Pet reptiles should not be allowed to roam freely throughout the home or living area

Pet reptiles should be kept out of kitchens and other food-preparation areas to prevent contamination. Kitchen sinks should not be used to bathe reptiles or to wash their dishes, cages, or aquariums. If bathtubs are used for these purposes, they should be cleaned thoroughly and disinfected with bleach.

and leisure centres as venues. The animal trading that often occurs at such events permits free contact between reptiles and people. In the UK these events have been subject to various challenges on grounds of public health, animal welfare, and legal issues. It is of particular concern, with respect to public health, that while attendance is purely a matter of individual choice, other members of the general public are unlikely to be aware of the potential risks of contracting RRS when the venue reverts to its usual functions. Because children often attend such centres, and because salmonellae can remain viable for long periods in the general environment, 'post-show' contamination is a hazard.

ACTION

Salmonellae are not the only potentially pathogenic organisms that are frequently carried by reptiles. With reptile-keeping a well-established activity, investigation into other zoonoses is desirable.

The international trade in reptiles may bring diseases from remote parts of the world and epidemiological investigation will be hampered by the diversity of animals captured, the wide range of collection sites, haphazard mixing of species and species identification difficulties.

US authorities are currently considering a detailed proposal calling for the original national ban on hatchling terrapins to be extended to all reptiles¹⁷. Reptile-keeping is entirely non-essential. The UK Government is considering further measures to limit RRS. Routine advice, such as that on hand-washing, is clearly not

enough. Advice to avoid contact with reptiles takes no account of indirect infection. The only effective way to curtail RRS would be to abolish the national and international trade in reptiles.

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