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Review

Salmonellosis: A food borne zoonotic and public health disease in Egypt

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Abstract

Salmonellosis is an important food borne disease of public health significance. Global estimates of the disease burden shows more than 20 million cases and 0.15 million deaths annually. The disease caused by a variety of *Salmonella* organisms worldwide. *Salmonella* pathogens are belonging to family Enterobacteriaceae that are known to infect many hosts inducing variable clinical diseases pictures. Typhoidal and non-typhoidal *Salmonellae* are common diseases among Egyptians with severe socioeconomic losses. Different species of animals and poultry as well as their products are the main sources and reservoirs for zoonotic human illness. Enteric fever and gastroenteritis are the main clinical manifestations in patients. Great attention toward salmonellosis drug resistance, prevention and control should be considered.

Key words: Animals; Egypt; human; poultry; public health; *Salmonella* spp.

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Introduction

Salmonellosis is considered as one of the most important life threating bacterial zoonotic disease of human as well as animals and poultry species. There are more than 2500 serovars of *Salmonella* worldwide. In humans, *Salmonella enterica* Typhi (*S.* Typhi) and *Salmonella enterica* Paratyphi (*S.* Paratyphi) cause typhoid fever and paratyphoid fever, respectively [1], while salmonellosis is an overarching term which includes invasive infection with all serovars of salmonella, as well as the normally gut restricted infections of food poisoning. [2]. Non-typhoidal salmonellosis is caused by several other *Salmonella* serovars rather than serovars Typhi and Paratyphi [3]. Animals and poultry are commonly infected with *S.* Enteritidis and *S.* Typhimurium that can be transmitted to human [4]. Animal products including; poultry meat, eggs and milk, water, domestic and wild animals, rodents and pets have been implicated as important sources for human salmonellosis outbreaks [5]. It has been found that poultry sectors alone can account for up to 50% of salmonellosis outbreaks [6,7]. Although human infection with *Salmonella* serovars occurs worldwide, the actual burden is poorly understood in most countries where the disease is endemic. *Salmonella's* infections are endemic in some developing countries, including Egypt and represent a serious public health hazard [8]. Egypt is at a crossroads that connects Africa, Asia and Europe. Egypt is located in the North-Eastern part of Africa continent and has 27 governorates with about 100 million inhabitants. Numerous zoonotic diseases are of importance in Egypt; one of them is *Salmonella* infection. Accordingly, in this review article, we will focus on the incidence of *Salmonellae* infections among Egyptians, sources and reservoirs of infection, the clinical picture of the disease, drug resistance and the possible prevention and control regimen.

Incidence among Egyptians

The high incidence of salmonellosis in Egypt may be related to scarce information on the disease significance and distribution, behavioral, environmental and socioeconomic factors as well as the lack of information about the possible means of transmission and the suitable control measures. The first recorded cases of typhoid fever among Egyptians was early in 1901 [9]. The Egyptian Ministry of Health and Population, the U.S. Naval Medical Research Unit-3 and the Centers for Disease Control and Prevention in 2001 made a piolet study to measure the incidence of typhoid fever in Lower Egypt and the results estimated 13 cases /100,000 persons per year [10]. Reported in 2006 a study conducted in Fayoum governorate estimated the incidence of typhoid fever to be 59/100,000 persons/year and the highest incidence occurred among school-aged children [11]. Out of 128 consecutive children and adult patients in Benha Fever

Hospital, 34 were infected with typhoid fever [12]. The incidence of *S.* Typhi infection increased among patients with chronic hepatitis C virus [13,14]. Moreover, non-typhoidal *Salmonellae* were identified as 22 isolates out of 500 stool samples of cases with gastroenteritis in El-Menya governorate [15].

Sources and reservoirs of infection

Live chickens as well as chicken products are incriminated as major sources of human food borne salmonellosis [16]. In broiler chicken farms of Egypt, El-Shaboury and Basha [17] identified 5 *Salmonella* strains as *S.* Typhimurium in Alexandria, while Mohamed *et al*. [18] serotyped isolates as *S.* Enteritidis and *S.* Typhimurium in Assiut governorates. Another trial was carried out to investigate the zoonotic potential of *Salmonellae* and the role of live chicken and frozen chicken meat as sources in the epidemiology of the human food borne gastroenteritis [19]. Polymerase chain reaction was used for detection of the similarity between different *Salmonellae* serovars from different sources and the results yielded similar amplified DNA bands in *S.* Enteritidis and *S.* Typhimurium of the same chickens and human origin. Similarly, *S.* Enteritidis was identified from chicken's meat and patient with food poisoning signs in Dakhlia governorate [20]. Later on, *Salmonellae* infections were isolated from broiler flocks in Eastern Egypt [21] as well as from Northern Egypt [22]. Recently in 2019, different serovars of *Salmonella* (*S.* Typhimurium, *S.* Enteritidis, *S.* Anatum, *S.* Heidelberg, *S.* Muenster and *S.* Kentucky) were found in chicken's meat products that sold in local supermarkets [23]. From different poultry species, *S.* Enterica was isolated and characterized from pigeons [24] as well as from ducklings in Cairo [25]. Poultry products also are considered as the most important sources of *Salmonellae* transmission to human [26]. Abdel-Aziz [27] molecularly detected *Salmonella* serovars in chicken carcasses in South Egypt region using genus specific primers for the *invA* gene. A recent study carried on 420 samples representing cloacal swabs broiler chickens, environmental farm samples and freshly dressed chicken carcasses. The results revealed that 120 samples were *Salmonellae* positive where *S.* Enteritidis was the most predominant serotype [28]. It was detected that cross-contamination with droppings, instruments and workers hands occurred during slaughtering, de-feathering and scalding; this led to heavy contamination of chicken meat with *Salmonellae* [29]. Eggshell contamination among Egyptian layers flocks plays an important role in disease transmission to human [30,31]. Considering the role of milk, dairy handlers and dairy products in transmission of *Salmonellae* to human, 2 out of 40 faecal samples from apparently healthy dairy handlers were found positive [32]. Furthermore, it was found that *S.* Enterica was present in food samples taken from butchers, street venders, slaughterhouses and retail markets [33,34]. Regarding isolation of *Salmonella* from seafood products, it was found in 9.8% of 225 seafood samples collected from Alexandria province markets [35]. Moreover, diarrheic calves and camels were also regarded as additional sources of different species of *Salmonellae* [36,37]. Transmission from human to human was reported through faecal-oral route [38].

The clinical picture

Different *Salmonellae* serovars have been incriminated as a major and serious food borne zoonosis of public health significance. Outbreak and sporadic cases of typhoid fever in human ae common all over the world [39-42]. Typhoid fever is usually manifested by gastrointestinal symptoms, but some cases may show various clinical syndromes like disseminated intravascular coagulation and acute respiratory distress syndrome [43]. The clinical disease usually appears after 12-72 hours of infection and is characterized by diarrhea with fever, nausea, vomiting, abdominal pain, headache, bradycardia, and cough [44,45]. Without antibiotic treatment, the illness usually lasts 4 - 7 days before complete recovery. In older, very young or immuno-suppressed patients the severity of the disease increases and the diarrhea can be severe requiring hospitalization. In such patients, infection may spread and invade the hepatobiliary system causing death especially without antibiotic treatments [1]. Complicated cases show liver cirrhosis, renal failure, acute pancreatitis, malignancies as well as liver abscess [46-48].

Drug resistance

Due to the extensive hazards of using different antibiotics, especially in zoonotic infections, the presence of bacterial resistance in strains infecting humans has become very common. Transmission between animals to human occurs through direct contact of people with animals, through the environment or the consumption by humans of meat, eggs or products containing eggs or meat, and [16]. The emergence of cephalosporin resistant *Salmonella* in Egypt has been reported [49]. The widespread prevalence of multidrug-resistant (MDR) isolates has been recorded and, for example this has influenced the

impact of typhoid fever in developing countries [50,51]. In *S.* Enterica AMR genes were detected in 68% of isolates from meat and dairy products [34]. Moreover, AMR genes of *S.* Typhimurium from Egyptian chicken meat and humans was also recorded against chloramphenicol, streptomycin, gentamicin, trimethoprim-sulfamethoxazole, ampicillin and tetracycline [52]. Lately in 2019, Elkenany *et al*. [28] demonstrated AMR genes in 76.7% of *S.* Enterica strains isolated from broiler chicken farms and chicken carcasses in retail shops at El-Sharkia province. In a study carried out in Lower Egypt, AMR genes of *Salmonella* Typhi isolated from 29% patients showed resistance to chloramphenicol, ampicillin and trimethoprim-sulfamethoxazole [11]. Multiple quinolones resistance was reported in diarrheic Egyptian patients with *Salmonella* typhoid infection [53,54]. High percentages of patients with non-typhoid *Salmonella* isolates were resistant to ampicillin, tetracycline, trimethoprim-sulphamethoxazole and chloramphenicol [15]. Similarly, high prevalence of AMR genes of non-typhoid *Salmonella* isolates to tetracycline and chloramphenicol was also detected [55]. A total of 76 non-typhoid *Salmonellae* were isolated from human and poultry in Egypt and Algeria and the isolates showed high incidence of cephalosporin's resistance [56]. A recent work of Eissa *et al*. [12] demonstrated that patients with typhoid fever showed resistance to combined treatment with ciprofloxacin and Cefotax.

Prevention and control

To reduce the risk of salmonellosis, it is very important to improve the biosecurity and management practices in animal and poultry flocks. Trials for protection of poultry flocks against different species of *Salmonella* infections using locally prepared autogenous bacterins were done with successful and promising results [57-60]. Intervention strategies including *Salmonellae* monitoring programs along the farm-to-table continuum should be planned [61].

Lohiniva *et al*. [62] advocated frequent, thorough and proper hands and body washing as well as improving the water supply and sanitary conditions. It is very crucial to regulate application of antimicrobials in Egyptian Veterinary field and study the antibiotic sensitivity profile to reduce the problem of MDR *Salmonella* and consequently alleviate the serious public health hazard [55]. Symptomatic treatment of especially in very young and the elderly patients using electrolyte therapy and antibiotics. Inactivated and live vaccines for prevention and control typhoid fever has been developed [63].

Conclusions

Infection with *Salmonellae* is of great zoonotic and public health importance in Egypt. So, collaboration between human and veterinary practitioners is very crucial to increase the awareness and education toward the disease importance especially among susceptible risky groups. Last but not least, there is an urgent need for strengthening environmental and behavioral intervention plans to reduce the burden of the disease.

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