



Role of Enterotoxin-Producing Staphylococci in Zoonotic Infections in Iran

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Abstract

Context: *Staphylococcus* spp. are enterotoxin-producing zoonotic agents which cause a variety of infections such as mastitis in animals as well as human wound bite infections. This review was conducted to determine the prevalence of staphylococcal species especially enterotoxin-producing species in Iran.

Evidence Acquisition: For this review, words of "*Staphylococcus*", "zoonotic", "prevalence", "animals", "human" and "Iran" were searched in the internet search engines such as Google Scholar, PubMed, Google, Science Direct and so on. Patients with no history of contact with animals were also included in the study for comparison. Both animal and human coagulase positive isolates were included. Data was analyzed with Graph Pad Prism 6, meta-analysis section. A total of 20 previous studies (450 clinical samples) were found. *Staphylococcus intermedius* was the most predominant isolate identified in animals. Other coagulase positive species such as *S. hyicus* and *S. simulans* were isolated with lower prevalence, and *S. delphini* was not detected.

Conclusion: *Staphylococcus intermedius* was the most prevalent isolate identified in animals, with potential of causing infections in humans. Other coagulase positive species such as *S. hyicus* and *S. simulans* were isolated with lower prevalence, and *S. delphini* was not detected.

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Context

Typical opportunistic pathogens of coagulase positive *Staphylococcus* spp. are capable of causing a wide spectrum of different purulent and toxin-mediated diseases such as enteric infections.¹ *Staphylococcus intermedius* is very similar to *S. aureus* in phenotypic characteristics and similarly produces enterotoxins.²⁻⁴ Pigment production, hemolysis, alkaline phosphatase and urease positive tests, mannitol and maltose fermentation and susceptibility to novobiocin and Polymyxin B are characteristics of *S. intermedius*.^{2,5} Originally regarded as a single species, molecular characterization has placed *S. intermedius* in a new classification as *S. intermedius* group (SIG), which includes *S. intermedius*, *S. pseudintermedius*, and *S. delphini*.^{6,7} These species cause diseases in human and animals (especially people who keep pets at home). *S. aureus* is a human commensal, while other coagulase positive species are present in animals. It has been revealed that *S. intermedius* mostly infects dogs (resides on the skin or mucosal surfaces).⁸ The general transferability of these species between pets and humans has increased during

recent years.^{9,10} Staphylococcal species are able to express a wide spectrum of virulence factors, such as coagulase, cell wall components, hemolysins, proteases, enterotoxins, toxic-shock syndrome (TSS), and exfoliating toxins.¹¹ Enterotoxins produced by these species are pyrogenic components not inactivated by gastrointestinal enzymes and thermal process and lead to diarrhea. Enterotoxins are members of superantigens and more than 20 different types have been recognized, however some most important agents include SEA, SEB, SEC, SED and SEE.^{12,13} On the other hand, increasing antibiotic resistance among coagulase positive staphylococci is an ongoing concern.¹⁴ Differentiation of coagulase positive staphylococci except for *S. aureus* by phenotypic tests is a difficult and unreliable or insufficient process in laboratory settings.¹⁵ Considering this, several methods have been introduced for the identification of these strains,¹⁶ for example a molecular test including *hsp60* and *sodA* genes could differentiate them.¹⁷ *S. intermedius* is the predominant infectious agent among non-*S. aureus* coagulase positive species in Iran according to previous reports. The aims

of this study were uncovering the prevalence and clinical importance of coagulase positive staphylococci except for *S. aureus* with a deep focus on *S. intermedius* in Iran.

Inclusion and Exclusion Criteria

For this review, words of “*Staphylococcus*”, “zoonotic”, “prevalence”, “animals”, “human” and “Iran” were searched in the internet search engines such as Google Scholar, PubMed, Google, Science Direct and so on. Patients with no history of contact with animals were also included in the study for comparison. Both animal and human coagulase positive isolates were included. Data was analyzed with GraphPad Prism 6, meta-analysis section.

The Burden of *Staphylococcus intermedius* Infections

Among 20 previously published data, *S. intermedius* was the most predominant species identified in animal infections in Iran (Figure 1).^{1,18} Although this species was predominant in several infection sites such as otitis media, the wound infection caused by *S. aureus* was significantly higher in herds. The hemolytic pattern of staphylococci was in disparity, but higher among coagulase positive than that among coagulase negative species, showing a higher virulence among coagulase positive strains. Other coagulase positive species such as *S. hyicus* and *S. simulans* were isolated with lower prevalence, and *S. delphini* was not detected in the country.¹⁹ The prevalence of these species isolated from mastitis infection was significantly higher compared to the normal milk samples.

The Status of Zoonotic Staphylococcal Infections

Staphylococci isolated from animals contain a variety of virulence factors and thus cause a wide range of infections.²⁰ *S. intermedius* as infectious agent of domestic animals (mostly dogs, cats and pigeons) causes zoonotic infection in a wide range.^{21,22} It is difficult to identify *S. intermedius* and *S. pseudintermedius* using conventional microbiological tests. Molecular diagnostic tools change the understanding of the epidemiology of these 2 organisms.²³ The precise identification of these isolates is important in human infections compared to animal infections because they are misdiagnosed instead as *S. pseudintermedius* with phenotypic tests. In South Africa, isolates of *S. intermedius* from dog pyoderma were resistant to a few antibiotics including ampicillin and tetracycline. Prevalence of resistance to methicillin was also low.²⁴ *S. intermedius* was not detected in water resources but enterotoxin-producing strains were identified in 8 out of 27 mastitis samples in Brazil. Other enterotoxin-producing staphylococcal species were also mostly identified.²⁵ Data from Iran showed that *S. intermedius* was the most predominant animal coagulase positive species, infecting human. Other coagulase positive species such as *S. hyicus* and *S. simulans* were isolated with lower prevalence, and *S. delphini* was not detected. The prevalence of these species in mastitis infection was significantly higher

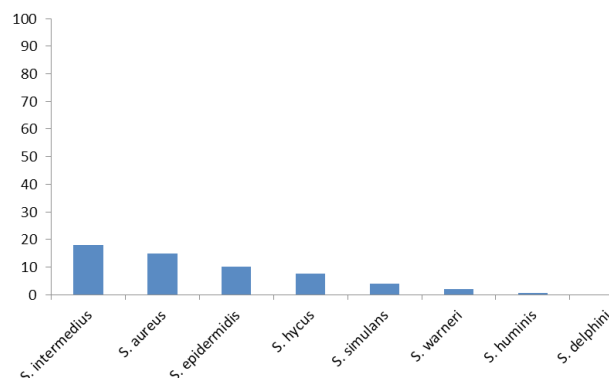


Figure 1. *Staphylococcus* spp. Isolated From Animals in Iran.

compared to the normal milk samples. Other studies from several countries have revealed that *S. intermedius* and *S. pseudintermedius* strains are major human infection-causing agents among coagulase positive staphylococci collected from dogs and cats or in total from animal infections.^{26,27} These isolates similar to the studies from Iran, have caused a wide variety of infections.^{28,29} There is a need for identification of *S. intermedius* which has been demonstrated to produce enterotoxins and also other staphylococcal species from livestock specimens in order to prevent or control their transmission to human.^{1,30} Further investigations are needed in the country to isolate and characterize *S. intermedius*, especially enterotoxin-producing and pathogenic strains.

Conclusion

Staphylococcus intermedius was the most predominant isolate identified in animals with the potential of causing infections in humans; however, unlike several studies, the production of enterotoxins was not investigated in the country. Other coagulase positive species such as *S. hyicus* and *S. simulans* were isolated with lower prevalence, and *S. delphini* was not detected.

Authors' Contributions

AG designed the study; SAM and FN helped in data analysis and manuscript style. MM participated in data collection and writing.

Ethical Approval

This study was ethically approved by Shahrekord University of Medical Sciences.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

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