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STAPHYLOCOCCAL ENTEROTOXINS IN DOMESTIC CATS: AN UNDEREXPLORED RISK TO HUMAN HEALTH

Enterotoksin Stafilokokus pada Kucing Domestik: Risiko Tersembunyi terhadap Kesehatan Manusia

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Abstract

Companion animals, especially domestic cats, are known to be colonized by *Staphylococcus aureus*, which produces exotoxins known as staphylococcal enterotoxins (SEs). However, the role of cats as reservoirs of enterotoxin-producing strains and their impact on human health remain insufficiently understood. This study narratively reviewed existing literature to examine the relationship between feline-associated *S. aureus* and the effects of SEs on human health. Findings indicate that cats can harbor *S. aureus* in multiple anatomical sites and act as asymptomatic carriers, with some isolates possessing enterotoxin genes such as sea, seb, and sec. Evidence also suggests potential bidirectional transmission between cats and humans, particularly in close-contact environments. The stability and superantigenic properties of SEs contribute to their role in foodborne illness and immune-mediated conditions. However, most studies focus on gene detection rather than active toxin production, and direct evidence linking feline-associated strains to human disease remains limited. These findings highlight a potential zoonotic risk and emphasize the need for a One Health approach to surveillance and prevention.

Keywords: *Staphylococcus aureus*, zoonotic transmission, feline, intoxication, one health

Abstrak

Hewan pendamping, khususnya kucing domestik, diketahui dapat terkolonisasi oleh *Staphylococcus aureus* yang menghasilkan eksotoksin yang dikenal sebagai enterotoksin stafilokokus (SEs). Namun, peran kucing sebagai reservoir strain penghasil enterotoksin serta dampaknya terhadap kesehatan manusia masih belum sepenuhnya dipahami. Studi ini merupakan tinjauan literatur naratif yang bertujuan untuk mengkaji hubungan antara *S. aureus* yang berasosiasi dengan kucing dan efek enterotoksin terhadap kesehatan manusia. Hasil kajian menunjukkan bahwa kucing dapat membawa *S. aureus* pada berbagai lokasi anatomi dan berperan sebagai carrier asimtomatik, dengan beberapa isolat memiliki gen enterotoksin

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seperti *sea*, *seb*, dan *sec*. Bukti juga menunjukkan adanya potensi transmisi dua arah antara kucing dan manusia, terutama pada lingkungan dengan kontak erat. Stabilitas serta sifat superantigen dari SEs berkontribusi terhadap perannya dalam penyakit bawaan makanan dan kondisi imunopatologis. Namun, sebagian besar penelitian masih berfokus pada deteksi gen dibandingkan produksi toksin aktif, dan bukti langsung yang mengaitkan strain asal kucing dengan penyakit pada manusia masih terbatas. Temuan ini menyoroti adanya potensi risiko zoonosis dan menegaskan pentingnya pendekatan One Health dalam upaya surveilans dan pencegahan.

Kata kunci: *Staphylococcus aureus*, transmisi zoonosis, kucing, intoksikasi, one health

INTRODUCTION

Staphylococcal enterotoxins (SEs) are extracellular virulence factors produced by *Staphylococcus aureus*, characterized by their heat stability and resistance to proteolytic enzymes (Cieza *et al.*, 2024). Functionally, SEs belong to the family of superantigens, a group of molecules that bypass conventional antigen processing by directly cross-linking major histocompatibility complex (MHC) class II molecules on antigen-presenting cells with specific Vβ regions of T-cell receptors (Schmiedeke, 2024). This atypical interaction results in the massive, non-specific activation of T lymphocytes and the subsequent release of pro-inflammatory cytokines, a phenomenon often described as a “cytokine storm” (Schmiedeke, 2024). Clinically, this underpins both the acute emetic response observed in staphylococcal food poisoning and the broader spectrum of immune-mediated pathologies associated with superantigen exposure, including toxic shock syndrome (Cieza *et al.*, 2024). The stability, potency, and widespread distribution of SE-producing strains, including those harbored by domestic animals, highlight their critical role in mediating disease and their importance in both food safety and zoonotic risk assessments, which culminates into One Health concerns.

Despite a growing body of literature documenting the presence of *Staphylococcus aureus* in companion animals, particularly domestic cats (Abdulrahman, 2025; Sarker *et al.*, 2025; Zafir *et al.*, 2022), investigations remain largely limited to colonization patterns and host-associated occurrence. In contrast, research on staphylococcal enterotoxins has been predominantly conducted in human clinical and foodborne contexts, with minimal consideration of animal-associated sources. This separation indicates a fragmented research approach that restricts a comprehensive understanding of zoonotic risk. From a One Health perspective, although the relations between human and animal health is widely recognized, the potential role of cats as reservoirs of enterotoxin-producing *Staphylococcus aureus* strains with implications for human health remains insufficiently explored.

Therefore, this review aims to bridge this gap by synthesizing existing evidence on *Staphylococcus aureus* colonization in cats and the role of enterotoxins in human disease within a unified One Health framework. The review employed reputable peer-review article on the topic of *Staphylococcus aureus*, Staphylococcal enterotoxins, *felines*, and human disease relations with the pathogens to understand the zoonotic potential between the two.

RESEARCH METHODS

Research Objects

This study was conducted as a narrative literature review focusing on the association between staphylococcal enterotoxins in cats and potential impacts on human health by synthesizing experimental and observational existing literature on the topic.

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Data Collection Methods

The authors utlilized Google Scholar, PubMed, ScienceDirect, and Scopus database to collect the literature. The search mainly used some keywords, such as Staphylococcal enterotoxins, *Staphylococcus aureus* in domestic cats, and human infection. The author put limitation on the year of publication between 2016 and 2026 for majority of the paper. The initial data collected 142 articles after the screening process was done the number for selected data shrinked to 58 and out of which only 24 primary studies and key reviews were selected. To narrow down process the keywords used were "*Staphylococcus aureus*, Staphylococcus enterotoxins, Domestic cats, feline, MRSA and human infection." The inclusion criteria involved peer-reviewed original research and comprehensive reviews or studies published between 2016 to 2026 reporting isolation, prevalence or colonization of *Staphylococcus aureus* from either domestic cats or stray cats. The exclusion criteria were studies on non-feline species, non-peer-reviewed literature, and paper which published before 2016.

Data Analysis

The selected literature was then analyzed qualitatively and grouped into thematic categories, including prevalence of staphylococci in cats, molecular characteristics of enterotoxin-producing strains, and possible transmission routes between animals and humans. Findings were synthesized descriptively to provide an overview of current knowledge and to identify gaps requiring further research.

REVIEW DISCUSSION

Prevalence of *Staphylococcus aureus* in Domestic Cats

Staphylococcus aureus is a Gram-positive coccus that can exist both as a ubiquitous commensal organism and an opportunistic pathogen (Foster, 2004). It asymptomatically colonizes the anterior nares, skin, and mucosal surfaces of approximately 20–30% of the human population. At the same time, it is also being frequently isolated from a variety of animal hosts, including companion animals such as cats (Brown *et al.*, 2014). This commensal persistence is facilitated by an array of adhesion factors, immune evasion strategies, and biofilm-forming capabilities that enable the bacterium to establish stable niches without eliciting overt host damage. However, under adverse conditions, *S. aureus* can turn into a pathogenic state and cause a spectrum of diseases ranging from skin and soft tissue infections to invasive conditions such as bacteremia, endocarditis, even sepsis (Foster, 2004). The remarkable pathogenic versatility of *S. aureus* is largely attributed to its extensive repertoire of virulence determinants as well as its capacity for rapid genetic adaptation (Zhu *et al.*, 2023). This can be observed in the emergence of methicillin-resistant *S. aureus* (MRSA) strains. Importantly, the presence of *S. aureus* in animal reservoirs underscores its zoonotic potential, which turn it as a critical interface organism in the context of One Health, where human, animal, and environmental health are intrinsically interconnected.

Although classical staphylococcal enterotoxins (sea, seb, sec, sed, and see) are well-known causes of human foodborne illness, their distribution patterns differ significantly when found in animal sources. Among S. aureus isolates from companion animals and those associated with felines, the *sec* gene is consistently the most prevalent classical enterotoxin variant, often followed by *sea* and *seb* (Becker *et al.*, 2001; Rana *et al.*, 2024). The high prevalence of *sec* in animal-origin strains is closely linked to host-adaptation mechanisms, as specific allelic variants of the *sec* gene (such as *sec canine* or *sec bovine*) have evolved to overcome immune barriers in non-human species. In contrast, *sed* and *see* genes are still quite rare or completely missing in cat clinical or commensal isolates, as they are mostly limited to human clinical

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strains or dairy-related food contamination incidents (Wang *et al.*, 2018). However, it is important to note that emerging molecular data shows that newer enterotoxin variants within the enterotoxin gene cluster (egc), including *seg*, *seh*, and *sei*, are becoming increasingly common and highly prevalent in domestic animal isolates, occasionally surpassing classical genes (Abdel-moein & Samir, 2011; Rana *et al.*, 2024). This changing genetic pattern highlights how unstable horizontal gene transfer is when mediated by plasmids and pathogenicity islands in shared domestic settings.

As companion animals become more embedded in modern life, the relationship between humans and pets has shifted from incidental cohabitation to intimate contact. This closeness brings obvious benefits for mental well-being, but it also creates more frequent openings for microbial exchange between pets and human, especially common companion like domestic cats (Bierowiec *et al.*, 2016; Du *et al.*, 2021; Older *et al.*, 2023). From a public-health perspective, these companion animals therefore merit attention as potential reservoirs and vectors for bacterial pathogens that can colonize or infect people and contaminate household environments (Khairullah *et al.*, 2023).

Elnageh *et al.* (2021) discovered that domestic cats can harbor a diverse range of *Staphylococcus* spp., namely *S. aureus*, *S. felis*, *S. sciuri*, *S. capitis*, and *S. cohnii*, showing how complex the feline staphylococcal microbiota is. Among these, *Staphylococcus aureus* is of particular concern due to its well-established role as an opportunistic pathogen in both animals and humans (Elnageh *et al.*, 2021), as well as its ability to produce virulence factors such as enterotoxins and exhibit antimicrobial resistance (Afnani *et al.*, 2022).

Staphylococcal enterotoxins (SEs)

Staphylococcal enterotoxins (SEs) are a related family of secreted exotoxins produced primarily by *Staphylococcus aureus* (Tam & Torres, 2019). From a microbiological standpoint, SEs belong to the group of pyrogenic toxin superantigens (PTSAgs), which are capable of bypassing conventional antigen processing by directly cross-linking major histocompatibility complex class II (MHC II) molecules on antigen-presenting cells with specific Vβ regions of T-cell receptors (Schmiedeke, 2024). This atypical interaction leads to massive, non-specific T-cell activation and the release of pro-inflammatory cytokines such as interleukin-2, tumor necrosis factor-α, and interferon-γ, ultimately resulting in systemic immune dysregulation (Krakauer, 2019).

Despite the normal asymptomatic colonization of *S. aureus* in feline species, infections are frequently reported in clinical settings. *S. aureus* is known as opportunistic invader that causes problems like pyoderma, flare-ups, purulent ophthalmic diseases, and allergic dermatitis. The epidemiologic data is obtained mostly from infectious or clinical population rather than healthy species, which shows varying prevalence due to the anatomical factors and underlying pathology. The isolation rate varies from 3% (Cengiz *et al.*, 2023), 25% (Maslikov *et al.*, 2019), and reached up to 41% (Alnajmawe & Ahmed, 2025) during diagnostic molecular evaluations in feline populations presented with ocular clinical infection and eye discharge. Localized clinical sample data from investigative diagnosis reveals *S. aureus* being recovered from different infection types, in which 44% were from contaminated wounds and 66% were from clinical otitis externa infections (Gómez-Beltrán *et al.*, 2020). When these feline clinical isolates are recovered from active lesions, they frequently exhibit multi-drug resistance profiles or present as methicillin-resistant *S. aureus* (MRSA), which severely complicates therapeutic management in veterinary clinics (Arefin *et al.*, 2025; Gómez-Beltrán *et al.*, 2020).

More than 20 distinct SEs and enterotoxin-like proteins have been identified until now, including the classical types SEA, SEB, SEC, SED, and SEE, which are most commonly

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implicated in staphylococcal food poisoning, as well as newer variants such as SEG, SEH, SEI, and members of the enterotoxin gene cluster (egc) (Cieza *et al.*, 2024). These toxins are encoded by genes located on mobile genetic elements, such as prophages, plasmids, and pathogenicity islands. This location eases horizontal gene transfer between strains, which then enhances their epidemiological spread. Moreover, SEs are highly resistant to heat, proteolytic enzymes, and environmental stress (Cieza *et al.*, 2024). These characteristics of SEs allow them to retain biological activity even after bacterial cells are dead. This is also the key factor in foodborne intoxication.

The production of SEs is regulated by global virulence regulatory systems such as the accessory gene regulator (agr) quorum-sensing system, linking toxin expression to bacterial population density and environmental conditions. Collectively, these features underscore the dual significance of SEs as both mediators of acute gastrointestinal disease and modulators of host immune responses, making them critical targets in the study of staphylococcal pathogenesis and zoonotic transmission.

Domestic Cats as SEs Reservoirs and Virulence Threat on Human Health

Colonization of *S. aureus* in cats has been documented across multiple anatomical sites, including the nasal cavity, skin, oral cavity, and perineal region, which are recognized as key ecological niches for *staphylococcal* persistence (Elnageh *et al.*, 2021; Zafir *et al.*, 2022). The nasal cavity, in particular, is considered a primary reservoir that facilitates both maintenance within the host and transmission between individuals. The presence of *S. aureus* in these sites suggests that cats can serve as asymptomatic carriers, contributing to environmental contamination and potential zoonotic spread.

Reported prevalence rates of *S. aureus* in cats vary considerably across studies (Table 1). This variability is influenced by several factors, including geographic location, differences in sampling techniques, detection methods, and the characteristics of the cat population studied, such as household pets, veterinary clinic patients, or stray and feral animals. Additionally, factors such as antibiotic exposure, hygiene practices, and the level of human–animal interaction may further affect colonization dynamics that has not yet been highlighted in the existing research. Collectively, these variations underscore the need for standardized methodologies and broader epidemiological surveillance to accurately assess the role of cats as reservoirs of *S. aureus*.

According to Table 1, there is a huge variance observed in *S. aureus* prevalence throughout the cat population, in which the lowest is at 2% in Malaysia (Afshar *et al.*, 2023) while the highest is 73.8% in Australia (Ma *et al.*, 2020) could be justified with ecological and critical methodological discrepancies. Higher colonization rates (73.8%) being observed in Australian cohort can be because of the damaged barriers or prior antimicrobial selective pressure mostly in chronically diseased or clinic admitted population. Meanwhile, healthy population, domestic or stray, exhibit lower baseline prevalence. Furthermore, sampling anatomical diversity severely skews these numbers; studies pooling swabs from multiple anatomical niches (nares, oropharynx, perineum, and open wounds) yield substantially higher recovery rates than those confined strictly to a single site like the eyes or oral cavity. Finally, detection sensitivities differ heavily between standard phenotypic culture isolation and advanced molecular tools like PCR or DNA arrays, which can capture low-abundance or fastidious staphylococcal populations that classic microbiology might miss.

One clear link between cats and human health is the carriage of *Staphylococcus aureus* and methicillin-resistant *S. aureus* (MRSA) in cats, especially in the nasal cavity. The strongest risk factors were household exposure to healthcare workers, treatment of the cat with antibiotics in

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the previous year, and the presence of dogs in the same household. These researches do not prove zoonotic transmission because no human samples were collected, but it does show that cats can carry strains with public-health relevance and may participate in household circulation of MRSA. This argument is supported by Zafir *et al.* (2022) who reported that closer contact between cats and humans increases the possibility of zoonotic transmission of *Staphylococcus aureus*. Similarly, Abdulkhuder *et al.* (2025) demonstrated, through 16S rRNA gene analysis, there is a potential zoonotic transmission of *Staphylococcus aureus* in cats and humans' direct relations. From another perspective, Bierowiec *et al.* (2016) found that close human–cat interaction is associated with an 8.8% increased risk of *S. aureus* colonization in cats. Collectively, these findings highlight the role of close human–animal contact as a key factor influencing both colonization dynamics and the potential for zoonotic transmission, reinforcing the relevance of a One Health approach.

On the other hand, while the studies summarized in Table 1 provide deep insight of the prevalence of *Staphylococcus aureus* and the characterization of MRSA in cats, there remains a lack of evidence regarding the presence of enterotoxin genes in feline *S. aureus* isolates. In general, research on staphylococcal enterotoxins in cats is extremely scarce and outdated, with most studies originating from mid-20th century. Early investigations demonstrated that these toxins, produced by *Staphylococcus aureus*, are responsible for rapid-onset symptoms such as nausea, vomiting, and abdominal cramps following ingestion of contaminated food (Dack, 1963). Unlike many bacterial toxins, SEs are remarkably resistant to heat and enzymatic degradation, allowing them to retain biological activity even after food processing or cooking (Bergdoll *et al.*, 1967). Subsequent experimental work further clarified that the pathogenicity of SEs is not solely dependent on bacterial viability, but rather on the presence of preformed toxins, showing their significance as agents of intoxication rather than infection (Casman *et al.*, 1967). These early findings laid the groundwork for understanding SEs as potent virulence factors with direct implications for public health and food safety.

In relation with human health, the transmission of Staphylococcal Enterotoxins from cats has a chain of events. There are three primary routes of the transmission. First is the direct contact, such as petting or caressing, which allows bacteria from cat's skin to colonize human hands (Abdel-moein & Samir, 2011). Second is environmental contamination that can harbor *S. aureus* (Grispoldi *et al.*, 2021). If bacterial counts grow under favorable conditions, preformed enterotoxin could accumulate. For example, if cat-vomited milk left at room temperature. Third is the raw pet food. Numerous studies show raw meat diets often contain antibiotic-resistant bacteria, including S. aureus (Bierowiec *et al.*, 2016; Davies *et al.*, 2019). Handling raw pet food without proper hygiene can introduce enterotoxigenic staph into the home environment. Pets eating raw diets may also shed more bacteria in saliva or feces.

In humans, ingestion of SEs causes self-limited gastroenteritis (Argudín *et al.*, 2010), but other SE-mediated effects are medically significant. The clinical timeline of toxin action, such as rapid vomiting within 2–6 hours of ingestion, which means pet-related intoxication cases might be dismissed as nonspecific food poisoning unless specifically investigated (Fisher *et al.*, 2018). Aside from that, superantigen activity can exacerbate atopic dermatitis and asthma by skewing immune responses (Bachert *et al.*, 2002), and has been implicated in immune thrombocytopenia and rheumatoid arthritis flare-ups (Langford *et al.*, 1978).

Although direct evidence of cat-origin SE illness is lacking, there are suggestive signals. In one of the more recent investigations, Abdel-Moein and Samir (2011), demonstrated that feline *Staphylococcus aureus* isolates possibly harbor enterotoxin genes with potential zoonotic implications. Therefore, further and updated investigation regarding the prevalence of Staphylococcal enterotoxins in domestic cats is needed immediately.

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One Health Perspectives

From a One Health perspective, Staphylococcal Enterotoxins represent a critical intersection between human, animal, and environmental health, particularly in the context of companion animals such as cats (Bijoy *et al.*, 2025). While definitive cases of cat-origin SE illness in humans are not documented, molecular and epidemiological evidence points to plausible pathways. The ability of *Staphylococcus aureus* to colonize multiple hosts and persist in shared environments facilitates the circulation of enterotoxin-producing strains across species boundaries. Cats, as asymptomatic carriers, can harbor strains possessing enterotoxin genes and contribute to their dissemination through direct contact, environmental contamination, or indirect routes such as food handling (Aydin *et al.*, 2011). Moreover, the localization of enterotoxin genes on mobile genetic elements enhances the potential for horizontal gene transfer within microbial communities present in humans, animals, and the environment (Cieza *et al.*, 2024). This interconnectedness underscores the importance of integrated surveillance systems that combine veterinary, clinical, and environmental microbiology to monitor the spread of virulent and toxin-producing strains. In addition, antimicrobial use in both human and veterinary medicine may co-select for strains carrying both resistance determinants and enterotoxin genes, further complicating control efforts. Therefore, addressing the risks associated with staphylococcal enterotoxins requires a comprehensive One Health approach that emphasizes coordinated research, responsible antimicrobial stewardship, and improved hygiene practices at the human–animal–environment interface.

CONCLUSION AND SUGGESTIONS

Conclusion

In conclusion, staphylococcal enterotoxins represent a critical virulence factor of *Staphylococcus aureus* with significant implications for human health due to their potent superantigenic activity, environmental stability, and role in foodborne and immune-mediated diseases. This review highlights that domestic cats can act as asymptomatic carriers of *S. aureus*, including strains harboring enterotoxin genes, thereby positioning them as potential reservoirs within the human–animal interface. Although direct evidence linking feline-associated enterotoxigenic strains to human disease remains limited, the demonstrated capacity for colonization across multiple anatomical sites, environmental persistence, and documented interspecies transmission underscores a plausible zoonotic risk. Variability in reported prevalence further reflects the influence of methodological and ecological factors, emphasizing the need for standardized surveillance approaches. From a One Health perspective, the interconnected dynamics between humans, animals, and the environment facilitate the dissemination of virulent and potentially antimicrobial-resistant strains, reinforcing the importance of integrated research and control strategies.

Suggestions

Future studies should prioritize the detection of active toxin production, longitudinal transmission analysis, and risk quantification to better define the public health significance of feline-associated *S. aureus* and to inform evidence-based prevention measures.

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REFERENCES

Abdel-Moein, K. A., & Samir, A. (2011). Isolation of enterotoxigenic *Staphylococcus aureus* from pet dogs and cats: A public health implication. *Vector-Borne and Zoonotic Diseases, 11*(6), 627–629. https://doi.org/10.1089/vbz.2010.0272

Abdulrahman, R. (2025). Occurrence of methicillin-resistant *Staphylococcus aureus* in healthy pets in Duhok Province, Kurdistan Region, Iraq. *Open Veterinary Journal*, *15*(6), 2449. https://doi.org/10.5455/OVJ.2025.v15.i6.17

Afnani, D. A., Fatih, N., Effendi, M. H., Tyasningsih, W., Ramandinianto, S. C., Widodo, A., Hendriana, K., & Riwu, P. (2022). Profile of multidrug resistance and methicillin-resistant *Staphylococcus aureus* (MRSA) isolated from cats in Surabaya, Indonesia. *Biodiversitas, 23*(11), 5703–5709. https://doi.org/10.13057/biodiv/d231121

Afshar, M. F., Zakaria, Z., Cheng, C. H., & Ahmad, N. I. (2023). Prevalence and multidrug-resistant profile of methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus pseudintermedius* in dogs, cats, and pet owners in Malaysia. *Veterinary World, 16*, 536–545. https://doi.org/10.14202/vetworld.2023.536-545

Alnajmawe, N. D., & Ahmed, I. M. (2025). Isolation and molecular diagnosis of *Staphylococcus aureus* from eye infections in domestic cats in Mosul City. *Iraqi Journal of Veterinary Sciences*, *39*(1), 193–198. https://doi.org/10.33899/ijvs.2025.151178.3741

Arefin, K. S. Al, Rana, E. A., Islam, M. S., Hossain, B., Rahman, M. A., & Barua, H. (2025). Molecular prevalence and antimicrobial resistance profile of *Staphylococcus aureus* and *Staphylococcus pseudintermedius* isolated from hospital-visited cats. *Veterinary Medicine International*, *2025*(1), 1–14. https://doi.org/10.1155/vmi/4879266

Argudín, M. Á., Mendoza, M. C., & Rodicio, M. R. (2010). Food poisoning and *Staphylococcus aureus* enterotoxins. *Toxins*, *2*(7), 1751–1773. https://doi.org/10.3390/toxins2071751

Aydin, A., Sudagidan, M., & Muratoglu, K. (2011). Prevalence of staphylococcal enterotoxins, toxin genes and genetic relatedness of foodborne *Staphylococcus aureus* strains isolated in the Marmara region of Turkey. *International Journal of Food Microbiology*, *148*(2), 99–106. https://doi.org/10.1016/j.ijfoodmicro.2011.05.007

Bachert, C., Gevaert, P., & Van Cauwenberge, P. (2002). *Staphylococcus aureus* enterotoxins: A key in airway disease? *Allergy*, *57*(6), 480–487. https://doi.org/10.1034/j.1398-9995.2002.02156.x

Becker, K., Keller, B., von Eiff, C., Bröker, B. M., Lübritz, G., Etienne, J., & Peters, G. (2001). Enterotoxigenic potential of *Staphylococcus intermedius*. *Applied and Environmental Microbiology*, *67*(12), 5551–5557. https://doi.org/10.1128/AEM.67.12.5551

Bergdoll, M. S., Chu, F. S., Borja, C. R., Huang, I., & Weiss, K. F. (1967). The staphylococcal enterotoxins. *Japanese Journal of Microbiology,* *11*(4), 358–368. https://doi.org/10.1111/j.1348-0421.1967.tb00358.x

Bierowiec, K., Płoneczka-Janeczko, K., & Rypuła, K. (2016). Prevalence and risk factors of colonization with *Staphylococcus aureus* in healthy pet cats kept in city households. *BioMed Research International*, *2016*, 1–10. https://doi.org/10.1155/2016/3070524

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https://doi.org/10.24843/bulvet.2026.v18.i03.p22

Bijoy, M. M. K., Dudayev, Z., Mahim, U. F., Ahmed, E., Ashraf, M. N., Rimi, S. S., Islam, M. S., Zinnah, M. A., & Islam, M. S. (2025). Emergence of multidrug-resistant and virulent *Staphylococcus aureus* in domestic cats in Bangladesh: Possible risks of zoonoses. *The Microbe*, *7*, Article 100313. https://doi.org/10.1016/j.microb.2025.100313

Brown, A. F., Leech, J. M., Rogers, T. R., & McLoughlin, R. M. (2014). *Staphylococcus aureus* colonization: Modulation of host immune response and impact on human vaccine design. *Frontiers in Immunology*, *4*, Article 507. https://doi.org/10.3389/fimmu.2013.00507

Casman, E. P., Bennett, R. W., Dorsey, A. E., & Issa, J. A. (1967). Identification of a fourth staphylococcal enterotoxin. *Journal of Bacteriology*, *94*(6), 1875–1882. https://doi.org/10.1128/jb.94.6.1875-1882.1967

Cavana, P., Robino, P., Stella, M. C., Bellato, A., Crosaz, O., Fiora, S. R., & Nebbia, P. (2023). Staphylococci isolated from cats in Italy with superficial pyoderma and allergic dermatitis: Characterisation of isolates and their resistance to antimicrobials. *Veterinary Dermatology*, *34*(1), 14–21. https://doi.org/10.1111/vde.13127

Cengiz, S., Okur, S., Oz, C., Turgut, F., Gumurcinler, B., Sevuk, N. S., Kekec, A. I., Cepoglu, H., Sevimli, U., & Adiguzel, M. C. (2023). Prevalence and clonal diversity of methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus pseudintermedius* isolated from dogs and cats with eye discharge. *Acta Microbiologica et Immunologica Hungarica*, *70*(2), 134–141. https://doi.org/10.1556/030.2023.01899

Cieza, M. Y. R., Bonsaglia, E. C. R., Rall, V. L. M., Santos, M. V. dos, & Silva, N. C. C. (2024). Staphylococcal enterotoxins: Description and importance in food. *Pathogens*, *13*, Article 676. https://doi.org/10.3390/pathogens13080676

Dack, G. M. (1963). Staphylococcus enterotoxin: A review. *Japanese Journal of Medical Science and Biology*, *16*(1), 1–12. https://doi.org/10.7883/yoken1952.16.1

Davies, R. H., Lawes, J. R., & Wales, A. D. (2019). Raw diets for dogs and cats: A review, with particular reference to microbiological hazards. *Journal of Small Animal Practice*, *60*(6), 329–339. https://doi.org/10.1111/jsap.13000

Du, G., Huang, H., Zhu, Q., & Ying, L. (2021). Effects of cat ownership on the gut microbiota of owners. *PLoS ONE*, *16*(6), 1–14. https://doi.org/10.1371/journal.pone.0253133

Elnageh, H. R., Hiblu, M. A., Abbassi, M. S., Abouzeed, Y. M., & Ahmed, M. O. (2021). Prevalence and antimicrobial resistance of *Staphylococcus* species isolated from cats and dogs. *Open Veterinary Journal*, *10*(4), 452–456. https://doi.org/10.4314/ovj.v10i4.13

Fisher, E. L., Otto, M., & Cheung, G. Y. C. (2018). Basis of virulence in enterotoxin-mediated staphylococcal food poisoning. *Frontiers in Microbiology*, *9*, 1–18. https://doi.org/10.3389/fmicb.2018.00436

Foster, T. J. (2004). The *Staphylococcus aureus* "superbug." *The Journal of Clinical Investigation*, *114*(12), 1693–1696. https://doi.org/10.1172/JCI200422123

Gómez-Beltrán, D. A., Villar, D., López-Osorio, S., Ferguson, D., Monsalve, L. K., & Chaparro-Gutiérrez, J. J. (2020). Prevalence of antimicrobial resistance in bacterial isolates from dogs and cats in a veterinary diagnostic laboratory in Colombia from 2016–2019. *Veterinary Sciences*, *7*, Article 173. https://doi.org/10.3390/vetsci7040173

Grispoldi, L., Karama, M., Armani, A., & Cenci-Goga, B. T. (2021). *Staphylococcus aureus* enterotoxin in food of animal origin and staphylococcal food poisoning risk assessment from farm to table. *Italian Journal of Animal Science*, *20*(1), 677–690.

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June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p22

https://doi.org/10.1080/1828051X.2020.1871428

Haenni, M., Châtre, P., Dupieux-Chabert, C., Métayer, V., Bes, M., Madec, J.-Y., & Laurent, F. (2017). Molecular epidemiology of methicillin-resistant *Staphylococcus aureus* in horses, cats, and dogs over a 5-year period in France. *Frontiers in Microbiology, 8,* Article 2493. https://doi.org/10.3389/fmicb.2017.02493

Khairullah, A., Sudjarwo, S., Effendi, M. H., Ramandinianto, S. C., Gelolodo, M. A., Widodo, A., Riwu, K. H. P., & Kurniawati, D. (2023). Pet animals as reservoirs for spreading methicillin-resistant *Staphylococcus aureus* to human health. *Journal of Advanced Veterinary and Animal Research, 10*(1), 1–10. https://doi.org/10.5455/javar.2023.j641

Krakauer, T. (2019). Staphylococcal superantigens: Pyrogenic toxins induce toxic shock. *Toxins, 11*(3), 178. https://doi.org/10.3390/toxins11030178

Langford, M. P., Stanton, G. J., & Johnson, H. M. (1978). Biological effects of staphylococcal enterotoxin A on human peripheral lymphocytes. *Infection and Immunity, 22*(1), 62–68. https://doi.org/10.1128/iai.22.1.62-68.1978

Ma, G. C., Worthing, K. A., Ward, M. P., & Norris, J. M. (2020). Commensal staphylococci including methicillin-resistant *Staphylococcus aureus* from dogs and cats in remote New South Wales, Australia. *Microbial Ecology, 79*(1), 164–174. https://doi.org/10.1007/s00248-019-01382-y

Maslikov, S. N., Belyi, D. D., Samoiliuk, V. V., Vakulik, V. V., & Spitsyna, T. L. (2019). Pathogenetic role of *Staphylococcus aureus* in purulent keratoconjunctivitis in cats. *Regulatory Mechanisms in Biosystems, 10*(4), 507–512. https://doi.org/10.15421/021974

Older, C. E., Hoffmann, A. R., & Diesel, A. B. (2023). The feline skin microbiome: Interrelationship between health and disease. *Journal of Feline Medicine and Surgery, 25*(7). https://doi.org/10.1177/1098612X231180231

Qekwana, D. N., Sebola, D., Oguttu, J. W., & Odoi, A. (2017). Antimicrobial resistance patterns of *Staphylococcus* species isolated from cats presented at a veterinary academic hospital in South Africa. *BMC Veterinary Research, 13*(1), 286. https://doi.org/10.1186/s12917-017-1204-3

Rana, E. A., Nizami, T. A., Islam, S., Rahman, H., Hoque, A., Rahman, M., Ahmed, E., Nizami, T. A., & Islam, S. (2024). Antimicrobial resistance and virulence profiling of *Staphylococcus pseudintermedius* isolated from cats, Bangladesh. *Veterinary Quarterly, 44*(1), 1–11. https://doi.org/10.1080/01652176.2024.2326848

Sarker, H., Hassan, J., Rahman, A. K. M. A., Korber, D. R., & Alam, M. M. (2025). Zoonotic potential of methicillin-resistant *Staphylococcus aureus* isolated from pets and their owners in Bangladesh. *Scientific Reports, 15*(1), 1–12. https://doi.org/10.1038/s41598-025-02638-z

Schmiedeke, F. (2024). *The human antigen-specific immune response to Staphylococcus aureus T cell superantigens* (Doctoral dissertation, Universität Greifswald). https://epub.ub.uni-greifswald.de/frontdoor/deliver/index/docId/11756/file/24-11-07_Dissertation_Schmiedeke_F.pdf

Sfaciotte, R. A. P., Parussolo, L., Melo, F. D., Pompelli, L. H., Israel, N. D., Schwarz, D. G. G., da Costa, U. M., & Ferraz, S. M. (2025). Prevalence, identification and antimicrobial sensitivity profile of methicillin-resistant *Staphylococcus* colonizing dogs, cats and humans in a veterinary hospital, Brazil. *Research in Veterinary Science, 193*, Article 105793. https://doi.org/10.1016/j.rvsc.2025.105793

Volume 18 No. 3: 707-719
June 2026
https://doi.org/10.24843/bulvet.2026.v18.i03.p22

Tam, K., & Torres, V. J. (2019). *Staphylococcus aureus* secreted toxins and extracellular enzymes. In V. A. Fischetti, R. P. Novick, J. J. Ferretti, D. A. Portnoy, M. Braunstein, & J. I. Rood (Eds.), *Microbiology Spectrum, 7*(2). https://doi.org/10.1128/microbiolspec.GPP3-0039-2018

Wang, W., Lin, X., Jiang, T., Peng, Z., Xu, J., Yi, L., & Li, F. (2018). Prevalence and characterization of *Staphylococcus aureus* cultured from raw milk taken from dairy cows with mastitis in Beijing, China. *Frontiers in Microbiology, 9*, 1–16. https://doi.org/10.3389/fmicb.2018.01123

Warueu, Y. K. K., Khairullah, A. R., Effendi, M. H., Lukiswanto, B. S., Afnani, D. A., Kurniawan, S. C., Silaen, O. S. M., Riwu, K. H. P., Widodo, A., & Ramandinianto, S. C. (2023). Detection of methicillin-resistant *Staphylococcus aureus* and multidrug resistance isolated from cats in animal clinics at Sidoarjo District, East Java, Indonesia. *Biodiversitas Journal of Biological Diversity, 24*(1), 106–111. https://doi.org/10.13057/biodiv/d240114

Zafir, Z., Alsadi, I., Gomaa, A., Saleh, A., & Hamad, R. (2022). Occurrence of methicillin-resistant *Staphylococcus aureus* in cats and man. *Alexandria Journal of Veterinary Sciences, 75*(1), 34–40. https://doi.org/10.5455/ajvs.111225

Zhu, Z., Hu, Z., Li, S., Fang, R., Ono, H. K., & Hu, D.-L. (2023). Molecular characteristics and pathogenicity of *Staphylococcus aureus* exotoxins. *International Journal of Molecular Sciences, 25*(1), 1–25. https://doi.org/10.3390/ijms25010395

Figure

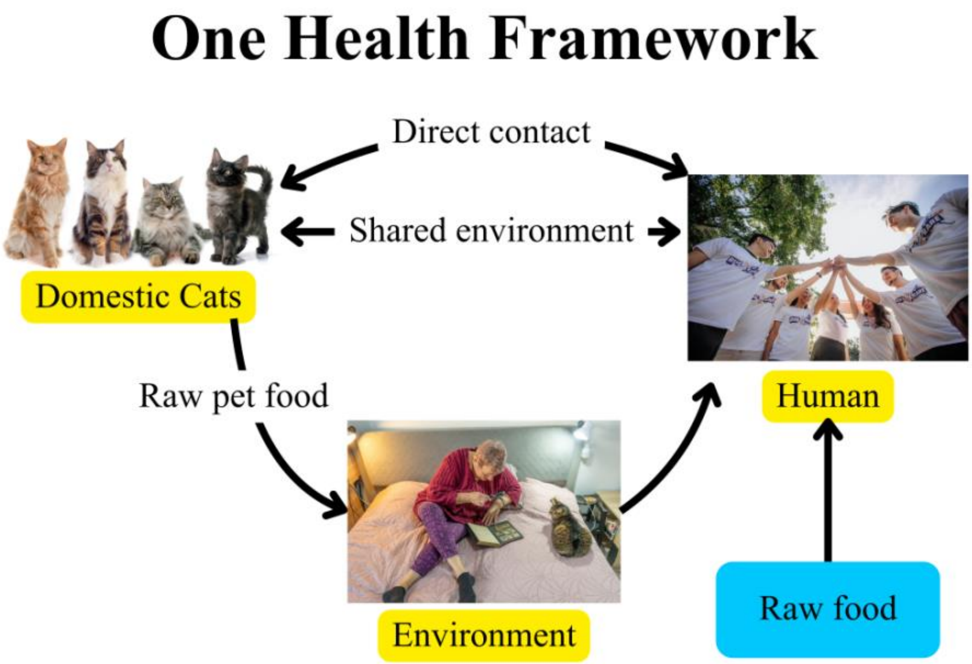

Figure 1. One Health Framework

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Table

Table 1. Comparison on studies about *Staphylococcus aureus* in cats

Country	Sample Sources	Detection Methods	Population Type	Prevalence (%)	Key Findings	Author (Year)
Bangladesh	mouth, ear, perineum	Culture isolation on MSA and PCR	Hospital-visit cats	30	Detections of *Staphylococcus* spp., resistance, and identification of risk factor in cats	(Arefin *et al.*, 2025)
Libya	Nasal	Culture isolation and PCR	Household cats	23	Detections of Staphylococcus spp. and antimicrobial resistance	(Elnageh *et al.*, 2021)
Malaysia	Oral and nasal	Culture isolation and PCR	Domestic and stray cats	2	Detections of *S. aureus* and *S. pseudintermedius*	(Afshar *et al.*, 2023)
Turkiye	Eyes	Culture isolation	Domestic cats	3	Detections of *S. aureus* and *S. pseudintermedius*	(Cengiz *et al.*, 2023)
Indonesia	Nasal	Culture isolation and Kirby-Bauer diffusion	Hospital-visit cats	7	Detections of *S. aureus* and antimicrobial resistance profile	(Waruwu *et al.*, 2023)
Ukraine	Eyes	Culture isolation and immunoblotting	Household cats	25	Investigating *S. aureus* in purulent keratoconjunctivitis	(Maslikov *et al.*, 2019)
Iraq	Eyes	Culture isolation and PCR	Domestic cats	41	Molecular diagnosis of *S. aureus* from eye infections	(Alnajmawe & Ahmed, 2025)
Colombia	Wounds, urine, ears, nasal	Culture isolation and Kirby-Bauer diffusion	Household cats	Ears (66.7), Wound (44.8)	Detections of bacterium and antimicrobial resistance	(Gómez-Beltrán *et al.*, 2020)

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Brazil	Nasal	Antimicrobial susceptibility profile test and PCR	Hospital-visit cats	44	Identification of *Staphylococcus* and the antimicrobial sensitivity profile of the MRS	(Sfaciotte *et al.*, 2025)
France	Nasal	Antimicrobial susceptibility profile test and DNA arrays	Domestic cats	26.5	Investigating molecular epidemiology of MRSA	(Haenni *et al.*, 2017)
Poland	Eyes, nares, anus, and groin	Culture isolation and DNA arrays	Household cats	17.5	Detections of prevalence and risk factors of *S. aureus* colonization	(Bierowiec *et al.*, 2016)
Italy	Skin	Culture isolation and *16S*-rRNA sequencing	Hospital-visit cats	38	Characterisation of *Staphylococi* isolates and their resistance to antimicrobials	(Cavana *et al.*, 2023)
Australia	Nares, oropharynx, perineum, and wounds	Culture isolation	Household cats	73.8	Detection of commensal *Staphylococci* and MRSA	(Ma *et al.*, 2020)
South Africa	Urine, ears, skin	Antimicrobial susceptibility profile test	Domestic cats	3.2	Detection of antimicrobial resistance patterns	(Qekwana *et al.*, 2017)