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Review Article

Management of *Staphylococcus aureus* Health Risk Factors in Algeria

Yahiaoui Wafa Ilhem[1], Khelifi Touhami Nadjet-Amina[1,*], Dahmani Hichem[1], Ouchene Nassim[1], Mebkhout Faiza[1,2], and Abdellaoui Lynda[1,2]

[1] Institute of Veterinary Sciences, University SaadDahlab Blida 1, Street Soumaa, 09000, Blida, Algeria
[2] HASAQ Laboratory, National Superior Veterinary School, 16000, Algiers, Algeria

*** *Corresponding author:*** Khelifi-Touhami Nadjet-Amina, Institute of Veterinary Sciences, University of SaadDahlab Blida 1, Road of Soumaa, BP 270, Blida, 09000, Algeria. Email: khelifinaa@gmail.com

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ABSTRACT

One Health is defined as the collaborative effort of multiple health science professions and their related disciplines and institutions to attain optimal health for people, domestic animals, wildlife, plants, and the environment. This study aimed to present different strategies of Algerian Veterinary Services to manage *Staphylococcusaureus* (*S. aureus*) health risk factors. *Staphylococcus aureus* is an animal and human opportunistic bacterium that causes a wide range of severe diseases. Its danger lies in its potential for transmission from animals to humans and conversely. This zoonotic potential is now well recognized, with the consideration that contact with animals is one of the most important factors influencing colonization and infection in human populations. Given the importance and interdependence of human and animal health linked to *S. aureus* health risk factors, it is logical to take a One Health approach when addressing this problem. It can be concluded some measures are necessary for the management of *S. aureus* in food hygiene. These may include launching a control and monitoring plan for residues in food of animal origin and animal feed, as well as a PASCRA plan for the detection of contaminants, such as antibiotic residues, or monitoring of contamination levels in live animals and food products of animal origin at different stages of the production chain.

1. Introduction

Staphylococcus aureus (*S. aureus*) is an animal and human opportunistic bacterium capable of causing a wide range of severe diseases, especially food poisoning and methicillin-resistant *S. aureus* (MRSA) infections[1]. Its danger lies in its potential for transmission from animals to humans and vis-a-versa[2]. This zoonotic potential is now well recognized, considering that contact with animals is one of the most important factors influencing colonization and infection in human populations[3].

Staphylococcus aureus becomes resistant to antibiotics used to combat infection by acquiring resistance mechanisms[4]. The phenomenon is a serious public and animal health problem, and that is why *S. aureus* is on the World Health Organization's (WHO) high-priority list of antibiotic-resistant pathogens[5]. Methicillin-resistant *S. aureus* remains a worldwide public health problem and has been reported from both hospital and non-hospital reservoirs, with the appearance of community-associated MRSA (CA-MRSA), then livestock-associated MRSA (LA-MRSA)[6].

The data suggest a high prevalence and a wild diffusion of toxicogenic *S. aureus* isolates *TSST-1* (22.2%), *EDINB* (29.6%), and *EtD* (11.1%) encoding genes. The detection of clonal complexes specific to animals in humans (CC97, CC130, CC133, ST398, and ST705) indicates the ability to cross the species barrier and jump between humans and several animal species, supporting the hypothesis that animals are potent reservoirs of multidrug-resistant and toxicogenic bacteria[7]. In Algeria, a high prevalence of Panton-Valentine Leukocidin (PVL) and MRSA strains in food is constated, and inadequate hygiene and sanitation practices are attributed to this problem[6]. Isolated *S. aureus*

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strains mainly represent a high multidrug resistance to penicillin, oxacillin, tetracycline, erythromycin, and vancomycin[4]. Therefore, it is considered an enormous health concern.

One Health is the collaborative effort of multiple health science professions to attain optimal health for people, animals, and the environment[8].

The role of the Veterinary Services Department is to implement and ensure the application of legislative and regulatory provisions in the field of animal health and veterinary public health. The direction des services vétérinaires (DSV) also collaborates with other ministries within the framework of a multidisciplinary approach. The main objective of this paper was to take stock of the national and international One Health strategies initiated by or involving the Algerian Veterinary Services to manage *S. aureus* risk factors.

2. National programs

The state is the guarantor of the organization of an efficient health system through the establishment and sufficient funding of centralized human and animal health organizations, such as Ministry of Health and Ministry of Agriculture and Fisheries. The two ministries should be intimately linked through a One Health approach, followed by health services provided throughout their territories, such as hospitals and medical practices for human health as well as veterinary services and practices[9].

3. Food security management

Food safety is linked to efficient veterinary services provided throughout the animal's life. Governments must also consider the external determinants of health. Moreover, transport systems, trade, immigration, or the environment can affect animals' health[9].

In the event of foodborne outbreaks, veterinarians play a crucial role in traceability investigations aiming at tracing back the farm of origin, as well as designing and implementing corrective measures once the source is identified[10]. Veterinarians of public hygiene office must collaborate closely with other professional categories and stakeholders, particularly human and environmental health professionals and epidemiologists[9]. The Directorate of Veterinary Services, under the supervision of the Ministry of Agriculture and Rural Development, acts in the animal health protection field by applying the law n° 88-08 of 26.01.1988, relating to veterinary medicine and animal health protection[10]. As such, its mission, in particular, is to implement and ensure the application of legislative and regulatory provisions in the field of animal health and veterinary public health[10].

At the local level, the veterinary services are represented by a Wilaya Veterinary Inspection (WVI) positioned at the level of the Directorate of Agricultural Services (DAS). It is under the authority of a Wilaya veterinary inspector. A group of veterinarians responsible for epidemiological surveillance network, food hygiene, and pharmacovigilance assist Wilaya Veterinary Inspectorate. Other veterinarians in different positions, such as those at hygiene offices and subdivisions, slaughterhouses, and border posts, as well as private veterinarians, work under the authority of the Wilaya veterinary inspector[10].

Intermenstrual instruction between the Ministry of Agriculture and the Ministry of the Interior number 421/ SIM, relating to the assignments and activation of veterinarians at the level of municipal health offices, defines veterinarians' role and intervention in the municipal hygiene office as inventory, control and monitoring of establishments of all kinds handling animal products, control and monitoring of all storage places for animal and fishery products[9]. Other responsibilities include control of the hygiene quality of foodstuffs (fresh, frozen, deep-frozen, or canned animal products) and market presence for consumption, control of the hygiene quality of products intended for animal consumption or level of storage (raw material) of production (finished products) and distribution, control at the level of the cattle markets, technical approval for the establishment of the various buildings for breeding, slaughtering, processing and/or storage of animal products and participation with doctors in health education at the municipal level[10].

4. Multisectoralantimicrobial resistance committee

Algeria had a legal framework (n° 17-310) relating to the creation, missions, organization, and functioning of the multisectoral committee for the fight against antimicrobial resistance[11].

The national multisectoral committee report to the minister responsible for health. It is a permanent body for consultation, concertation, coordination, monitoring, and evaluation of the national plan activities to combat antimicrobial resistance. As such, the committee is responsible for developing a national plan for combating antimicrobial resistance, determining the mechanisms for its implementation, and providing the coordination, monitoring and evaluation of the activities foreseen in the national plan to combat antimicrobial resistance. In addition, the committee is in charge of proposing any measure aimed at strengthening the national plan to combat antimicrobial resistance, initiating training, information, awareness, and communication actions inherent in the fight against antimicrobial resistance, and proposing any research activities related to its missions. Under the central administration of the ministry of health, population, and hospital reform, the national multisectoral committee sits at the level of the national public health institute[11].

5. Food contaminant and residue program

In 2012, the ministry of agriculture, rural development, and fisheries launched a control and monitoring plan for

residues in food of animal origin and animal feed, referred to as the PASCRA plan through its veterinary services directorate. This plan is an essential tool for detecting a contaminant or monitoring contamination levels on a regular and prolonged basis in foods of animal origin. In this regard, analyses are carried out on a sample selected from a target population to implement actions (sanctions management measures)[12]. The target samples in the PASCRA plan are live animals and food products of animal origin at different stages of the production chain[12]. The involved contaminants include veterinary drug residues, anabolic substances, heavy metals, and microbiological contaminants.

6. International programs and cooperation

Governments are responsible for the surveillance and control of diseases in their territory through the ministries of health, agriculture, and veterinary services. Globalization results in a flow of people, animals, and goods across borders and highlights the inability of governments to act alone on the determinants of health. Their sole action, without international cooperation, cannot guarantee the health status of individuals in their country. Governments must adopt transnational strategies, with the governments of border countries and international associations[13].

Algeria has embarked on the path of international coordination of control systems relating to animal and human health and food safety on the global legal basis of the notification of animal and human diseases. Diseases must be the subject of the immediate and transparent notification. The notification allows for the rapid dissemination of information on animal diseases, including zoonosis.

The world organization for animal health, The Food and Agriculture Organization of the United Nations (FAO), and the World Health Organization (WHO) work together to set up intersectoral mechanisms to carry out risk assessments during outbreaks of foodborne illness or other crises affecting health security. This collaboration has led to the International Food Safety Authorities Network (INFOSAN)[13], and Global Early Warning and Response System for Major Animal Diseases, including Zoonosis (GLEWS) and Global Antimicrobial Resistance and Use Surveillance System (GLASS).

Numerous countries and several international agencies have now included a One Health Approach within their action plans to address antimicrobial resistance[14]. The WHO has a Global Network for the Surveillance of Bacterial Resistance to Antibiotics, of which Algeria is a member. Global Antimicrobial Resistance and Use Surveillance System was launched to support a standardized approach to collect, analyze, and report antimicrobial resistance data globally, to support decision-making, to motivate local actions, national and regional, and to provide the evidence base for action and advocacy[15].

Algeria transmits epidemiological information to WHO as part of international collaboration through a GLASS-Algerian network monitoring of antimicrobial resistance (AARN) network collaboration as an Algerian antimicrobial resistance surveillance network.

Created in 2002, the AARN launched a bacteriological laboratory at Institute Pasteur responsible for monitoring antibiotic resistance in humans and animals[16]. World health organization encourages GLASS member countries to strengthen the platform's capacity to be linked to other antimicrobial resistance surveillance systems, including in animal health[15]. During the initial implementation of the GLASS system, the results of susceptibility testing samples to test antimicrobials will be classified according to the guidelines of the Clinical and Laboratory Standards Institute (CLSI)[16].

7. Conclusion

The veterinary services are in charge of epidemiological surveillance, food safety, and hygiene control in slaughterhouses, butcheries, meat-selling centers, and fisheries. It can be concluded that launching a control and monitoring plan for residues in food of animal origin and animal feed, a PASCRA plan for the detection of contaminants, such as antibiotic residues, or the monitoring contamination levels in live animals and food products of animal origin at different stages of the production chain are necessary for the management of *S. aureus* in food hygiene.

Declarations

Competing interests

The authors declared that there is no competing interest.

Authors' contribution

Yahiaoui Wafa Ilhem conceived and designed the research and wrote the manuscript. Dahmani Hichem, Mebkhout Faiza, and Abdellaoui Lynda revised the draft of the manuscript. Nassim Ouchene and Nadjet Amina KhelifiTouhami revised the draft of the manuscript, removed the language errors, and checked the final version of the article. All authors checked and confirmed the final draft of the manuscript.

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Ethical considerations

The authors have checked all ethical issues, including plagiarism, double submission, and data originality.

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