Horses in Denmark Are a Reservoir of Diverse Clones of Methicillin-Resistant and -Susceptible Staphylococcus aureus

Denmark is a country with high prevalence of livestock-associated methicillin-resistant Staphylococcus aureus (MRSA) clonal complex (CC) 398 in pigs. Even though pig farming is regarded as the main source of human infection or colonization with MRSA CC398, 10-15% of the human cases appear not to be linked to pigs. Following the recent reports of MRSA CC398 in horses in other European countries and the lack of knowledge on S. aureus carriage in this animal species, we carried out a study to investigate whether horses constitute a reservoir of MRSA CC398 in Denmark, and to gain knowledge on the frequency and genetic diversity of S. aureus in horses, including both methicillin-resistant and -susceptible S. aureus (MSSA). Nasal swabs were collected from 401 horses originating from 74 farms, either at their farms or prior to admission to veterinary clinics. Following culture on selective media, species identification by MALDI-TOF MS and MRSA confirmation by standard PCR-based methods, S. aureus and MRSA were detected in 54 (13%) and 17 (4%) horses originating from 30 (40%) and 7 (9%) farms, respectively. Based on spa typing, MSSA differed genetically from MRSA isolates. The spa type prevalent among MSSA isolates was t127 (CC1), which was detected in 12 horses from 11 farms and represents the most common S. aureus clone isolated from human bacteremia cases in Denmark. Among the 17 MRSA carriers, 10 horses from three farms carried CC398 t011 harboring the immune evasion cluster (IEC), four horses from two farms carried IEC-negative CC398 t034, and three horses from two farms carried a mecC-positive MRSA lineage previously associated with wildlife and domestic ruminants (CC130 t528). Based on whole-genome phylogenetic analysis of the 14 MRSA CC398, t011 isolates belonged to the recently identified horse-adapted clone in Europe and were closely related to human t011 isolates from three Danish equine veterinarians, whereas t034 isolates belonged to pig-adapted clones. Our study confirms that horses carry an equine-specific clone of MRSA CC398 that can be transmitted to veterinary personnel, and reveals that these animals are exposed to MRSA and MSSA clones that are likely to originate from livestock and humans, respectively.