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Occurrence of *satA* and *vgb* Genes in Streptogramin-Resistant *Enterococcus faecium* Isolates of Animal and Human Origins in The Netherlands

Enteroccocci have emerged as an important cause of nosocomial infections. Infections caused by multiresistant enterococci are treated with vancomycin or another glycopeptide. In recent years the usage of vancomycin and the isolation rate of vancomycin-resistant enterococci (VRE) have steadily increased in both Europe and the United States (8). Despite the fact that VRE infections are a hospital problem and the human usage of glycopeptides is in hospitals, VRE have been isolated from the fecal flora of healthy humans without a known hospital connection, from animals, and from the environment (1, 5, 9). One of the few options for treatment of vancomycin-resistant *Enterococcus faecium* infection is quinopristin-dalfopristin, a mixture (30:70 ratio) of two streptogramins: dalfopristin (streptogramin A) and quinopristin (streptogramin B) (6). A related mixed compound virginiamycin has been used in Europe for many years as a feed additive to enhance growth in food animals. High numbers of virginiamycin-resistant *E. faecium* have been isolated from the feces of food animals, and these were also resistant to quinopristin-dalfopristin, indicating cross-resistance between virginiamycin and quinopristin-dalfopristin (2, 13, 15).

Two genes, *satA* and *vgb*, encoding streptogramin resistance in *E. faecium* have been detected in clinical isolates. The bacteria were determined to be streptogramin-resistant *E. faecium* (SREF) by an agar diffusion technique (3, 11). *satA* encodes resistance to the streptogramin A component (11), while *vgb* encodes resistance against the streptogramin B component (3). Streptogramin B resistance is also encoded by the *erm* genes referred to as "MLS_B resistance genes" (14).

In this study we examined SREF isolates from The Netherlands for resistance to quinopristin-dalfopristin and virginiamycin and for the presence of the two known streptogramin resistance genes in enterococci. In addition, the genotypes were determined by pulsed-field gel electrophoresis (PFGE) after *Sma*I digestion (12). A total of 51 SREF isolates from fecal samples of healthy (sub)urban residents ($n = 5$), farmers ($n = 19$), poultry ($n = 22$), and pigs ($n = 5$) were tested. MICs were defined by agar diffusion methods according to the guidelines of the National Committee for Clinical Laboratory Standards (NCCLS) (10). The presence of *satA* and *vgb* was established by PCR with specific primers, giving amplicons of 272 bp for *satA* and 570 bp for *vgb*. Two isolates (KH 36syn and K 36syn) with identical PFGE patterns were from a poultry farmer (KH 36syn) and his animals (K 36syn).

All isolates were resistant to quinopristin-dalfopristin (MIC $\geq$ 32 mg/liter) and to virginiamycin (MIC $\geq$ 16 mg/liter). The breakpoint for quinopristin-dalfopristin has been suggested to be 4 mg/liter (7). Since virginiamycin is not used for therapy, no breakpoint has been established by NCCLS, but a breakpoint of 4 mg/liter for virginiamycin has been suggested because of the observed distribution of MICs in an *E. faecium* population (2). All strains were resistant to both quinopristin-dalfopristin and virginiamycin.

The *satA* gene was detected in 14 (58%) of the SREF isolates of human origin—10 farmers (52%) and 4 suburban residents (80%)—and in 5 (19%) isolates of animal origin—1 porcine isolate (20%) and 4 poultry isolates (18%). The two PFGE-identical SREF isolates both contained the *satA* gene. The *vgb* gene was found in a single isolate of human origin (KH 6syn). The study showed that the *satA* gene encoding streptogramin A resistance was present in SREF isolates of animal and human origins outside hospitals. The *vgb* gene encoding streptogramin B resistance was found in one human isolate only. These genes have previously been found only in SREF isolates from hospitalized patients (4, 11). *satA* was more frequently found among isolates from humans than among isolates from animals. The fact that PFGE-identical isolates with the *satA* genes were found in a farmer and his animals indicates that transfer of SREF between animals and humans occurs. Other resistance genes encoding streptogramin resistance were probably present in the remaining isolates. The *erm* genes, encoding resistance to streptogramin B compounds, also confer resistance to macrolides and lincosamides. As both groups of antibiotics are widely used in human and veterinary medicine and the macrolide tylosin as growth promoter, the selection for these genes must be high and needs further investigation.

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