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PREVALENCE OF ENTEROTOXIGENIC STAPHYLOCOCCI IN NOSE, THROAT AND SKIN LESIONS IN MEAT-WORKERS

By

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DANIELSSON, MARIE-LOUISE and BO HELLBERG: *Prevalence of enterotoxigenic staphylococci in nose, throat and skin lesions in meat-workers.* Acta vet. scand. 1984, 25, 242—249. — The frequency of enterotoxigenic coagulase-positive and coagulase-negative staphylococci in nose and throat and in hand lesions was investigated in 86 meat cutters and dressers. Enterotoxin-producing staphylococci were demonstrated in nasal swabs from 22 % of clinically well workers and from 42 % of a group with mild coryza. The corresponding rates in throat swabs were 6 and 12 %. Four of 16 superficial lesions of the hand harbored enterotoxigenic staphylococci. The implications for contamination of food and outbreaks of staphylococcal food poisoning are discussed.

food poisoning; contamination; slaughter hygiene; microbial flora; public health.

Staphylococci have a wide environmental distribution and occur frequently on the skin and in the upper respiratory tract of man and animals. Many staphylococcal strains vegetate harmlessly on skin and mucous membranes, but potentially pathogenic strains can cause a wide range of infections, such as abscesses, meningitis, osteomyelitis, pyemia and suppuration of wounds. Certain strains, moreover, may cause food poisoning. The first recorded outbreak of staphylococcal food poisoning, in which 300 persons fell ill after eating Cheddar cheese, was described by *Vaughn* in 1884. Upon ingestion of a substance extracted from the cheese, *Vaughn* experienced the same symptoms as in the patients. Microscopy of the cheese revealed spherical microorganisms and it was concluded that a poison produced by these bacteria was responsible for the symptoms.

Nowadays it is recognized that staphylococcal food poisoning is caused by enterotoxins produced by certain strains of staphylococci. Seven enterotoxins (A, B, C₁, C₂, D, E and F) have hitherto been purified and identified (Casman 1960, Bergdoll *et al.* 1965, 1967, 1971, 1981, Avena & Bergdoll 1967, Borja & Bergdoll 1967, Casman *et al.* 1967).

Staphylococci are known to multiply even under seemingly unfavorable environmental conditions, e.g. in 15 % saline solution (Buchanan & Gibbons 1974). The production of staphylococcal enterotoxins also is fairly insensitive to the environmental influence. Thus, enterotoxin may be generated in the pH range 4.0—9.8 (Genigeorgis *et al.* 1971), in 10 % saline solution (McLean *et al.* 1968) and at temperatures of 13—45°C (Scheusner *et al.* 1973). Most common foodstuffs therefore are suitable media for the growth of enterotoxigenic staphylococci and production of enterotoxin.

Handling of food can provide ample opportunities for contamination with staphylococci of human origin. The aims of the present study therefore were:

1. to calculate the frequency of staphylococci in the nose, throat and skin lesions of workers in the meat industry, and
2. to investigate the enterotoxin-producing ability of the isolated strains.

MATERIAL AND METHODS

Isolation and identification

Samples were taken from 86 workers in different meat-dressing plants. They were classified as clinically healthy (37 persons), having mild coryzal symptoms (33 persons) and non-coryzal but with minor skin lesions on the hands (16 persons). From each subject, swab samples were taken from the nose (vestibulum nasi) and throat. When appropriate, swabs were also taken from hand lesions. Altogether 188 specimens were collected — 86 from nose, 86 from throat and 16 from skin. Each specimen was placed in a separate sterile glass tube and immediately transported to the laboratory. The specimens were cultured on Blood Agar Base (Oxoid, England) supplemented with 5 % sterile, defibrinated bovine blood and incubated at 37°C for 24 and 48 h.

Based on colony appearance and cell morphology, 5 suspected staphylococcal colonies were isolated from each agar plate. All

gram-positive, spherical cells which were catalase-positive and fermented and oxidated glucose were regarded as staphylococci (*Recommendations* 1965, *Buchanan & Gibbons* 1974). In addition, the strains were tested for coagulase activity in rabbit plasma. When staphylococci were isolated from more than 1 sampling site in the same person, the strains were tested for hemolysin production (bovine erythrocytes), DNase activity, aerobic acid from mannitol and appearance on ETGP (egg yolk tellurite glycine pyruvate) agar (*Baird-Parker* 1962).

Enterotoxin production

The strains were tested for production of enterotoxins A, B and C₁, using antisera and reference enterotoxins from Serva Feinbiochemica (Heidelberg, Germany). In order to obtain a concentrated enterotoxin solution, the 'cellophane sac culture technique' described by *Donnelly et al.* 1967 was used. The enterotoxins were determined serologically, using *Wadsworth's* (1957) miniaturization of the gel double-diffusion test according to *Ouchterlony* (1949). The test was performed as described by *Crowle* (1958) and *Zehren & Zehren* (1968).

RESULTS

The results of the investigation are surveyed in Tables 1 and 2. Since both *Staphylococcus aureus* and *S. epidermidis* can produce enterotoxin, we have not distinguished between these species in presentation of the results. Altogether 169 staphylococcal strains were isolated. Staphylococci were invariably found in at least one of the three investigated sites. The nose provided the highest number of positive swabs. The frequency of nose swabs showing staphylococci was not significantly different in the apparently healthy persons (34 of 37) than in those with mild coryzal symptoms (31 of 33). The throat likewise gave similar yield of staphylococci in the healthy group and in the mildly coryzal workers (Table 1).

By contrast, the frequency of enterotoxin-producing staphylococci in nose swabs was clearly higher in coryzal (42 %) than in well (22 %) workers (Table 2). The corresponding frequencies from the throat swabs were 12 and 6 %. Staphylococci were isolated from 13 of 16 skin lesions and in 4 cases these staphylococci were enterotoxin-producing.

Table 1. Frequency of staphylococci isolated from meat cutters and dressers.

| Group | No of workers | Number of workers with staphylococci in | | | | | | |
|------------------|---------------|---|-------------|------------------|---------------|---------------|-----------------|------------------------|
| | | nose only | throat only | skin lesion only | nose + throat | nose + lesion | throat + lesion | nose + throat + lesion |
| Clinically well | 37 | 25 | 3 | — | 9 | — | — | — |
| Slightly coryzal | 33 | 22 | 2 | — | 9 | — | — | — |
| Hand lesions | 16 | — | 1 | — | 2 | 5 | 1 | 7 |

Table 2. Frequency of enterotoxin-producing staphylococci isolated from meat cutters and dressers.

| Group | No of workers | Number of workers with enterotoxigenic staphylococci in | | | | | | |
|------------------|---------------|---|-------------|------------------|---------------|---------------|-----------------|------------------------|
| | | nose only | throat only | skin lesion only | nose + throat | nose + lesion | throat + lesion | nose + throat + lesion |
| Clinically well | 37 | 7 | 1 | — | 1 | — | — | — |
| Slightly coryzal | 33 | 12 | 2 | — | 2 | — | — | — |
| Hand lesions | 16 | 3 | 1 | 2 | — | 1 | — | 1 |

Altogether 44 enterotoxin-producing staphylococcal strains were isolated. The dominant enterotoxin type was A (34 of the 44 strains). Enterotoxin B was produced by 4 strains and C₁ also by 4 strains, while 1 strain produced both A and C₁ and another both B and C₁. No relationship was demonstrated between the site from which staphylococci were isolated and the type of enterotoxin they produced. Six of the 44 enterotoxin-producing staphylococcal strains were coagulase-negative (3 giving enterotoxin type A, and 3 type C₁).

DISCUSSION

The literature contains few reports concerning enterotoxin-producing staphylococci isolated from healthy persons (*Moore & Bower* 1971, *Economopoulou* 1972, *Untermann* 1972, *Mochmann et al.* 1976). These reports, moreover, deal only with *Staphylococcus aureus*. This is a serious defect, since *S. epidermidis* also

can produce enterotoxin and thus cause food poisoning (*Omori & Kato 1959, Bergdoll et al. 1967, Breckinridge & Bergdoll 1971*). In our investigation as many as 14 % of the enterotoxin-producing strains were of epidermidis type. Five of the 6 coagulase-negative enterotoxin-producing strains were isolated from nasal swabs.

Enterotoxigenic staphylococci, coagulase-positive or negative, in the nose can involve high risk of food contamination. The bacteria are readily transferred from nose to hands. If contaminated hands infect foodstuffs, and these are stored for too long at unsuitably high temperature, enterotoxin production may take place, with attendant risk of staphylococcal food poisoning. In the present study, the pronounced increase of swabs showing enterotoxin-producing staphylococci in connection with coryza was particularly alarming.

The skin lesions of the hands were found to harbor enterotoxin-producing staphylococci in 4 of the 16 investigated cases. None of the lesions was suppurating, and they were regarded by the workers as harmless scratches. This type of injury is common in the meat industry, since knives and carcass bones readily damage the hands. Because of the high frequency, sick-listing of workers for such minor trauma is not realistic. What, then, is the risk of food poisoning from handling of raw meat by persons with hand injuries? *McCoy (1966)* showed that staphylococci do not grow on raw meat unless the surface is free from the micro-organisms normally present there. He also showed that production of enterotoxin is completely inhibited by this microflora. Accordingly, it may be acceptable to permit handling of raw meat despite *small* lesions of the hands. The available literature contains no reports of staphylococcal food poisoning caused by contaminated raw meat.

On the other hand, precautions should be accentuated in regard to hand lesions in persons working with ready-cooked foods. These products generally have been heat-treated and their normal microflora thereby destroyed. Contamination with enterotoxigenic staphylococci consequently involves a risk of enterotoxin production. Accordingly, staphylococcal food poisoning from 'ready-to eat' dishes infected by organisms from hand wounds is not uncommon (*Breckinridge & Bergdoll 1971, Center for Disease Control 1975*) Processed food may be contaminated also by contact with coryzally infected persons. In our study as many as 42 % of the workers with slight colds harbored entero-

toxigenic staphylococci in the nose. Unless hand hygiene is meticulous, nasal staphylococci are readily transferred to handled food. For persons engaged in food processing, therefore, temporary transfer to work not involving handling of food is recommended during episodes of colds or hand injuries.

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SAMMANFATTNING

Förekomst av enterotoxinproducerande stafylokocker i näshåla, svalg och sårskador hos styckare.

Undersökningen omfattar 86 köttstyckare, som delades in i tre grupper — kliniskt friska, lätt förkylda samt individer med sårskador på händerna. I gruppen kliniskt friska hade 22 % av individerna enterotoxinproducerande stafylokocker i näshålan och 6 % i svalget. I gruppen lätt förkylda var motsvarande förekomst 42 % resp 12 %. Enterotoxinbildande stafylokocker isolerades från 4 av 16 undersökta „små-sår“. Merparten av de isolerade stammarna bildade enterotoxin A.

I artikeln diskuteras riskerna för kontaminering av livsmedel med enterotoxinproducerande stafylokocker samt riskerna för matförgiftningar.

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