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An Investigation of Characteristics Promoting the Horizontal Transmission of Cephalosporin-Resistant Enterobacteriaceae

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To better understand the factors predisposing the horizontal transmission of third-generation cephalosporin-resistant enterobacteriaceae, isolates obtained from a prospective, repetitive point prevalence study conducted by von Baum et al. at Heidelberg University Hospital were further investigated. In that study it was found that 10% of the rectal swabs obtained from patients on the intensive care units contained cephalosporin-resistant Enterobacteriaceae. Whereas the majority of the 334 resistant strains were sporadic and thus isolated from only one patient,eleven of the strains were transmitted between patients.

The β-lactamases produced by the resistant bacteria were isolated by ultrasonic treatment of bacterial suspensions. The isoelectric points were determined for 170 samples by the use of analytical isoelectric focussing. The isoelectric points ranged from 5.3 to 8.6, with majority of the β-lactamases (87%) showing pI values of 7.1 or higher. These β-lactamases are produced by AmpC cephalosporin-resistant bacteria. The remaining 13% have isoelectric points below 7.0, and thus indicate ESBLs derived from TEM and SHV bacteria.

Reactions were carried out on 165 samples to see if the β-lactamases are inhibited by clavulanic acid, EDTA, or pCMB. The majority (68%) of the β-lactamases were inhibited by clavulanic acid, whereas only 8% were inhibited by EDTA. Almost all (96%) of the β-lactamases were inhibited or decomposed by pCMB. Based on this information, the β-lactamases were classified according to the scheme proposed by Bush, Jacoby, and Meideros.

It was determined that the transmitted strains did not display any common features with respect to the isoelectric point or inhibition by clavulanic acid, EDTA, or pCMB, and consequently classification. The results for the transmitted strains were comparable to those obtained for the entire collective. Therefore these factors are not associated with horizontal transmission of resistant bacteria.

Another factor that might predispose bacteria to increased transmission is survival on the hands of health care workers. To investigate this possibility, five transmitted and five sporadic bacteria were inoculated on the fingertips of ten test persons.

In the experiments four fingers of each hand were inoculated with bacteria and washed at t=0, 15, 30, and 45 min. The number of colony forming units counted at t=0 was determined to be the maximum amount that could be recovered from the fingers of a particular test person. This value varied from 14.0% to 109.2 %, but there was only a minor difference between the transmitted and sporadic strains (50.9% and 48.8%, respectively).

In terms of survival of the bacteria on the fingertips, there were no significant differences between the transmitted and sporadic strains. Therefore survival on hands is not associated with horizontal transmission of resistant bacteria. Nonetheless, this mode of transmission cannot be excluded. Although there was usually a large drop off in the number of viable bacteria after 15 min, small amounts of bacteria could be recovered from the fingertips of volunteers for basically all the strains. Therefore transmission via the hands of health care workers is possible for several minutes after contamination.

In the inoculation experiments one test person consistently displayed better survival of CREs on the fingertips compared to the other nine test persons. This indicates that certain people do retain and give up viable bacteria to a larger extent. Any health care workers that display this same characteristic may be more prone to function as vectors in the transmission of resistant bacteria between patients.

Although survival on hands does not correlate with increased transmission of resistant bacteria, the results show that the bacteria do survive for periods of time long enough for transmission to occur from health care worker to patient. Furthermore, it was observed that certain people display better survival of bacteria on fingertips, and are possibly more likely to function as vectors in the horizontal transmission of resistant bacteria. Therefore hand disinfection remains an important method for reducing the spread of resistant bacteria, and proper hand hygiene should be practiced by all people involved in patient care.