Raman spectroscopy in clinical microbiology

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Clinical microbiology is probably the slowest of the laboratory-supported disciplines in a hospital. However, in clinical diagnostic microbiology, the speed at which laboratory results become available can mean the difference between life and death. The sooner the cause of an infection is known, the sooner an optimised therapy can be started.

Over the last years, we have been developing a rapid microorganism identification method that can satisfy this ‘need for speed’ (1-4). The method is based on confocal Raman microspectroscopy. It is possible to obtain Raman spectra directly from microbial microcolonies on the solid culture medium, which have developed after only 6 hours of culturing for most commonly encountered organisms.

In order to evaluate the potential of our approach, we performed a prospective clinical pilot study. Parallel to the routine diagnostic laboratory, we performed Raman identifications on blood samples of hospitalised patients. Before actually starting with the trial, we first build a reference library of Raman spectra from bacterial and yeast pathogens, with a high prevalence in blood stream infections. The database contained the spectra of 106 individual bacterial strains and 34 yeast strains. This library was used to develop identification models, based on linear discriminant analysis, by which newly measured Raman spectra could be classified.

During a 4-month period, a total of 135 blood cultures was collected from 92 patients. 20 samples were excluded from the study because they either contained species that were not included in the database (17 samples) or contained mixed cultures (3 samples). Whereas routine identification has a typical turnaround time of 1 to 2 days, Raman spectra were collected of microcolonies, 6 hours after microbial growth was detected by an automated blood culture system. High identification accuracy was achieved of the 115 samples analysed by Raman spectroscopy (92.2%, 106/115). The same study was performed in the Robert Koch Institute (Berlin, Germany) using FT-IR and this yielded equally good results. This is once again proof that vibrational spectroscopies enable simple, rapid and accurate microbial identification. These advantages can be easily transferred to other applications in diagnostic microbiology, e.g. to accelerate identification of fastidious microorganisms.

References


