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Distinguishing between Bacterial and Viral Infections Based on Peripheral Human Blood Tests Using Infrared Microscopy and Multivariate Analysis

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Abstract : Viral and bacterial infections are responsible for variety of diseases. These infections have similar symptoms like fever, sneezing, inflammation, vomiting, diarrhea and fatigue. Thus, physicians may encounter difficulties in distinguishing between viral and bacterial infections based on these symptoms. Bacterial infections differ from viral infections in many other important respects regarding the response to various medications and the structure of the organisms. In many cases, it is difficult to know the origin of the infection. The physician orders a blood, urine test, or 'culture test' of tissue to diagnose the infection type when it is necessary. Using these methods, the time that elapses between the receipt of patient material and the presentation of the test results to the clinician is typically too long (> 24 hours). This time is crucial in many cases for saving the life of the patient and for planning the right medical treatment. Thus, rapid identification of bacterial and viral infections in the lab is of great importance for effective treatment especially in cases of emergency. Blood was collected from 50 patients with confirmed viral infection and 50 with confirmed bacterial infection. White blood cells (WBCs) and plasma were isolated and deposited on a zinc selenide slide, dried and measured under a Fourier transform infrared (FTIR) microscope to obtain their infrared absorption spectra. The acquired spectra of WBCs and plasma were analyzed in order to differentiate between the two types of infections. In this study, the potential of FTIR microscopy in tandem with multivariate analysis was evaluated for the identification of the agent that causes the human infection. The method was used to identify the infectious agent type as either bacterial or viral, based on an analysis of the blood components [i.e., white blood cells (WBC) and plasma] using their infrared vibrational spectra. The time required for the analysis and evaluation after obtaining the blood sample was less than one hour. In the analysis, minute spectral differences in several bands of the FTIR spectra of WBCs were observed between groups of samples with viral and bacterial infections. By employing the techniques of feature extraction with linear discriminant analysis (LDA), a sensitivity of ~92 % and a specificity of ~86 % for an infection type diagnosis was achieved. The present preliminary study suggests that FTIR spectroscopy of WBCs is a potentially feasible and efficient tool for the diagnosis of the infection type.

Keywords : viral infection, bacterial infection, linear discriminant analysis, plasma, white blood cells, infrared spectroscopy
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