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Detection and Identification of Antibiotic Resistant UPEC Using FTIR-Microscopy and Advanced Multivariate Analysis

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Abstract : Antimicrobial drugs have played an indispensable role in controlling illness and death associated with infectious diseases in animals and humans. However, the increasing resistance of bacteria to a broad spectrum of commonly used antibiotics has become a global healthcare problem. Many antibiotics had lost their effectiveness since the beginning of the antibiotic era because many bacteria have adapted defenses against these antibiotics. Rapid determination of antimicrobial susceptibility of a clinical isolate is often crucial for the optimal antimicrobial therapy of infected patients and in many cases can save lives. The conventional methods for susceptibility testing require the isolation of the pathogen from a clinical specimen by culturing on the appropriate media (this culturing stage lasts 24 h-first culturing). Then, chosen colonies are grown on media containing antibiotic(s), using micro-diffusion discs (second culturing time is also 24 h) in order to determine its bacterial susceptibility. Other methods, genotyping methods, E-test and automated methods were also developed for testing antimicrobial susceptibility. Most of these methods are expensive and time-consuming. Fourier transform infrared (FTIR) microscopy is rapid, safe, effective and low cost method that was widely and successfully used in different studies for the identification of various biological samples including bacteria; nonetheless, its true potential in routine clinical diagnosis has not yet been established. The new modern infrared (IR) spectrometers with high spectral resolution enable measuring unprecedented biochemical information from cells at the molecular level. Moreover, the development of new bioinformatics analyses combined with IR spectroscopy becomes a powerful technique, which enables the detection of structural changes associated with resistivity. The main goal of this study is to evaluate the potential of the FTIR microscopy in tandem with machine learning algorithms for rapid and reliable identification of bacterial susceptibility to antibiotics in time span of few minutes. The UTI E.coli bacterial samples, which were identified at the species level by MALDI-TOF and examined for their susceptibility by the routine assay (micro-diffusion discs), are obtained from the bacteriology laboratories in Soroka University Medical Center (SUMC). These samples were examined by FTIR microscopy and analyzed by advanced statistical methods. Our results, based on 700 E.coli samples, were promising and showed that by using infrared spectroscopic technique together with multivariate analysis, it is possible to classify the tested bacteria into sensitive and resistant with success rate higher than 90% for eight different antibiotics. Based on these preliminary results, it is worthwhile to continue developing the FTIR microscopy technique as a rapid and reliable method for identification antibiotic susceptibility.

Keywords : antibiotics, E.coli, FTIR, multivariate analysis, susceptibility, UTI
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