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Automatic detection of pneumocystis jiroveci in microscopic images: adaeq learning-based approach
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Objective: Pneumocystis jiroveci Pneumonia is one of the diseases that most affect immunocompromised patients today, and under certain circumstances, it can be fatal. One of the most widely used techniques in diagnostic laboratories for the detection of its etiologic agent is optical microscopy. However, some of the disadvantages of this technique are its low sensitivity, low accuracy, and high dependence on an expert to make the diagnosis. Thus, this work aims to develop a computational tool based on a deep learning approach to automatically detect the presence of P. jiroveci Pneumonia from optical images, and to increase the accuracy of this conventional technique.
Methods: The study involved 98 randomly selected, from whom respiratory samples (bronchial lavage, and bronchoalveolar lavage) were collected. Methanemic silver staining was then used to prepare the samples. Subsequently, the slides of the analyzed patients were observed using the Leica DM500 microscope using a Leica DFC50 HD camera, and the optical images were taken in at least four random positions on the specimen holder. Thus, an image dataset of 98 different patients was created to detect whether a patient is positive or negative for P. jiroveci Pneumonia. Finally, a deep learning approach based on convolutional neural networks (CNN) was proposed and evaluated to improve the accuracy of the microscopic technique. The proposed CNN model incorporates global and local features for pixel-wise segmentation.
Results: First, the dataset was processed and segmented using the connected-components methodology. Likewise, the segmented images were labeled with the help of an expert to train the algorithm. To validate the response of the proposed deep learning approach the obtained results were compared with the obtained conventional image classification techniques like co-occurrence matrix and K-NN. The obtained results reveal that the proposed methodology allows to increase the accuracy of the P. jiroveci Pneumonia identification up to 98%, while the co-occurrence matrix and K-NN only achieve accuracies of 88% and 95%, respectively.
Conclusion: It is possible to demonstrate that techniques based on digital image processing are a useful tool to support the processes of analysis and diagnosis of samples in medical patients with P. jiroveci Pneumonia. Additionally, the obtained results demonstrate that methods based on deep learning allow us to develop more precise and accurate analysis methodologies for the analysis of patient samples with P. jiroveci Pneumonia. Our model can be improved by adding new layers, but this would introduce even more hyperparameters that should be adjusted. We intend to extend our model architecture in other areas of medical imaging with the usage of deep learning and computer vision techniques.
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The relationship between virulence of Candida albicans and environmental oxygen concentration
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Objective: Candida albicans is known to colonize human skin and mucosal membranes, and cause candidiasis under various immunocompromising conditions. Among these Candida species, C. albicans is reported to be the most frequently isolated species, and could colonize on skin, vagina, gastrointestinal tracts, and medical devices. Environmental factors including oxygen concentration is thought to affect the capability of colonization and virulence of Candida species. However, most previous research was performed under aerobic conditions, and few research focused on hypoxic conditions instating inside the human body. In this study, we focused on this aspect, we performed experimental model using culture C. albicans under various oxygen concentrations to evaluate the effect of environmental oxygen concentration on virulence. Through our studies, we aimed to clarify the actual behavior of C. albicans in the human body.
Methods: In this study, fully C798E mice, 7-8 weeks old, were used and injected via lateral tail vein to cause C. albicans dissemination. Mice were divided into 4 groups according to the pre-culture conditions: aerobic, microaerobic (5% oxygen concentration), microaerobic (5% oxygen concentration), anaerobic. Under each oxygen condition, C. albicans was grown at 25°C for 2 days on 2% agar plates or 2 days on YPD agar and then inoculated in YPD broth for 16-24 h. After incubation, C. albicans cell was collected, washed, resuspended in sterile PBS, and injected into each mouse at 2.3 ± 0.5 × 10⁷ colony-forming units. In this study, we reference strain (SC5314) and one clinical isolated strain from bloodstream infection were used. These infected mice were euthanized 2 or 4 days after injection, and organ (kidney and brain) fungal burdens were evaluated.
Results: In the kidney’s fungal burdens were significantly higher in the microaerobic groups than those in the aerobic or anaerobic groups 2 and 4 days after injection. There was no significant difference between 5% oxygen concentration pre-culture group and 5% oxygen concentration pre-cultured group. On gross examination, disseminated lesion formations were visible in the kidney of the microaerobic group. Furthermore, the fungal burdens of brain were significantly higher in the microaerobically pre-cultured groups than in the aerobically or anaerobically pre-cultured groups. This tendency was similar for both the reference and clinically isolated strain. Conclusion: Our results indicated that C. albicans could become more virulent under hypoxia, especially under microaerobic conditions. We assumed that these virulence factors of C. albicans were elevated under microaerobic conditions. These results would contribute to the artificial cultivation of C. albicans. In the future, we will continue to evaluate factors related to this change in virulence and pathological analysis of infected organs.
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Pulmonary fungal infection in Sudan, a retrospective study from the Mycology Reference Laboratory
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Objective: Pulmonary fungal infections are life-threatening diseases, if not diagnosed and properly treated may lead to serious complications. In chronic cases, the condition might mimic tuberculosis and may be misdiagnosed. The aim of this retrospective study is to determine the frequency of fungi among the respiratory samples received at the mycology reference laboratory over 5 years period and to provide a view of the burden of pulmonary fungal disease in the country.
Methods: A total of 713 samples span two years at the Mycology Reference Laboratory, Khartoum, Sudan, between 2015-2019 were analyzed. These samples were collected from different health care centers in Khartoum state. For every sample, direct microscopy using 20% KOH and methylene blue stain was performed. In addition, cultures were made by inoculating every sample in three tubes of tellurium-dextrose agar (SDM containing thallium) and tubes were incubated at 37°C for 2 and up to 7 days. Isolated fungi were identified phenotypically using the Atlas of Clinical Fungi guidelines. Results: Out of the 713 samples, 231 (32.5%) were positive for fungi, both in the direct microscopy and culture. Cultures were identified as Aspergillus species 168 (16%), with 5% (16) were found to represent Candida species. Conclusion: Our study showed a high number of fungi is associated with pulmonary conditions in Sudan. Risk factors might include post tuberculosis, Asthma, HIV, and CNDP.