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Introduction to Virus Diagnosis and Treatment

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There are more than 320,000 mammalian viruses, of which a little over 200 are known to infect humans (Anthony *et al.*, 2013; Woolhouse *et al.*, 2012). The number, however, is steadily increasing. During recent years, we have witnessed the emergence of new viral diseases, such as MERS (Memish *et al.*, 2020), infection caused by Zika virus (Rather *et al.*, 2017), and the COVID-19 pandemic caused by SARS-CoV-2 in 2020 (Hu *et al.*, 2020).

Viral diagnostics is increasingly important in clinical medicine. The growing number of new diseases, the expansion of specific antiviral drugs and the need for effective vaccines poses a challenge for the diagnostic tools available. This volume focuses on clinical virology. It leads us through the presentation of traditional, modern and future diagnostic tools and provides views on how to implement these tools in various clinical settings.

Electron microscopy is a highly valued method allowing visualization of virus particles and combined with antibody-based labeling approaches. It is still the method of choice for identifying ultrastructural changes associated with virus-host cell invasion and replication. Molecular methods, in particular the PCR, have replaced viral culture in many laboratories, limiting the use of this traditional method of virus detection or replacing it altogether. We have to realize that most viruses cannot be grown easily or cannot be grown *in vitro* at all. In special circumstances, however, viral culture may still be needed. Traditional serological assays have largely been replaced by enzyme immunoassays and serodiagnostics are at their best in identifying and pinpointing the time of primary infection, in assessing immune status vs. susceptibility, and in pre-transplant donor-recipient matching.

Challenges with conventional diagnostic methods have been stated in several studies. Only 62% of viral respiratory infections among children can be confidently attributed to known pathogens (Arnold *et al.*, 2008) and in another study, it was demonstrated that in 42.7% of cases of viral gastroenteritis, the pathogen could not be identified with conventional methods (Vu *et al.*, 2019). It has been estimated that up to 40% of viral encephalitis infections remain undiagnosed with modern clinical tests (Kennedy *et al.*, 2017). Therefore, new approaches, like microarrays, sensitive multianalyte methods on microfluidic platforms, and high throughput sequencing (HTS) are needed. In addition, we have to also realize that pathogens can follow a hit-and-run procedure before a clinical syndrome is detected or diagnosed. The data provided with new technology could not only augment diagnostics and help to choose the correct therapy, but also facilitates virological research, since more precise, low-cost and accessible solutions are necessary.

The ongoing COVID-19 outbreak emphasizes the importance of biosafety and biosecurity procedures as well as quality assurance and standardization of diagnostic assays to ensure the appropriate performance of the assays used. Many laboratories already have accreditation according to ISO15189:2015, but as more and more hospitals undergo comprehensive on-site surveys conducted by Joint Commission International (JCI) in order to achieve accreditation, this also highlights the accreditation status of the laboratories they use.

Viruses have a quite simple structure with an encapsidated nucleic acid. They borrow molecular equipment from host cells to complete their replication cycle, thus having only a few targets for antiviral agents. In addition to high costs, the existing antiviral treatments still have safety and efficacy challenges. Fortunately, success stories have also been seen with, for instance, treatment of HIV-1 and hepatitis C, encouraging the development of therapies targeting different steps in the viral replication cycle. Updated reviews about management and treatment of clinically relevant viral diseases will be presented.

Vaccine development normally consists of a series of steps that can take many years. However, urgent need, as noted for the development of a SARS-CoV-2 vaccine, may change the development process. Some of the steps in the research and development process are happening in parallel, while still maintaining strict clinical and safety standards. As an example of triumph of vaccine efficacy, will be the permanent cessation of poliovirus.

The number of potentially pathogenic viruses is very large, while the resources for disease research and development (R&D) are limited. To ensure efforts under WHO's R&D Blueprint are focused and productive, a list of diseases and pathogens are prioritized for R&D in public health emergency contexts. The priority 10 viral diseases are discussed.

In the future, with the developing techniques, the clinical virology laboratories are able to produce an enormous amount of detailed data about viruses, pathogenesis and recovery from the infection. The leading challenge is to fully utilize this data in the patient's clinical management and treatment. The prerequisite for this is good communication and collaboration between laboratory personnel, researchers and clinicians. The improved exchange of information and growing information and knowledge, in turn, significantly aids clinicians in battling viral infections.

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