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Significance of Various Approaches of Neurovirology

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Abstract

Neurovirology has grown in importance in the last 30 years, with applications in both human disease and neuroscience. This analysis of the field attempts to classify several of the main neurovirological approaches, both "classical" and "newer," and show how they have been used to learn about pathogenesis, clinical investigation, and other aspects of the field.

Introduction

Over the last 30 years, neurovirology has grown to become a global specialty that encompasses virology, neurosciences and clinical neurology, molecular biology, and immunology.

According to Richard T Johnson, one of the field's founders, "the word neurovirology is a general one that is used to include studies of the pathogenesis of viral infections of the nervous system (both in humans and laboratory animal models), in vitro studies of the effects of viruses on established neural cell types, and in vivo studies of the effects of viruses on defined neural cell types" the use of genetically modified viruses as vectors to transmit therapeutic genes into the human central nervous system, as well as the use of viruses as methods in neuroanatomical and developmental research (CNS) [1]. It also covers the diagnosis and epidemiology of CNS viral infections, as well as the discovery of novel antiviral agents for disease treatment. A clear example of the above is the use of acyclovir for the successful treatment of herpes simplex encephalitis [2]. As a result, it's a field with a lot of use in both human illness and certain areas of neuroscience. Clinical and fundamental neurovirological research will also supplement each other.

Neurovirological disease has a significant global effect. In HIV infection, for example, nervous system involvement is very normal, with 10% of AIDS patients diagnosed with neurological symptoms and over 80% of AIDS patients being neurologically compromised at necropsy. Clinicians have had to deal with the difficulty of an evolving neurological disease profile of HIV infection since the advent of highly active retroviral therapy (HAART). There are also a number of different CNS viruses, such as influenza, whose neuropathogenesis is unknown. Furthermore, the immunosuppression that comes with more successful antibacterial treatment has sparked interest in better neurovirological disease treatment, while more widespread international air travel has raised the profile of viral infections of the nervous system, such as Japanese encephalitis, that originate in Africa and Asia. As a result, both host and viral factors may be playing a role in the evolving trend of neurovirological disease.

Laboratory Methods in Detail

Tissue culture of the nervous system

This is included because it has a long history of use. Cultures of dissociated or explanted CNS or peripheral nervous system tissues containing recognisable neural cells are a valuable in vitro instrument for studying virus–neural cell interactions under precisely regulated environmental conditions. While no machine will ever fully replicate the dynamics of an in vivo scenario, such research has yielded a variety of useful data.

Virus Isolation

The traditional way of determining the viral aetiology of a neurological disease is to isolate viruses from human tissues and bodily fluids. Viruses may be identified by their ability to cause a cytopathic effect on sensitive indicator cells [3].

Electron Microscopy

This method has shown to be effective in detecting viruses in neurological disorders. For example, electron microscopy was used to show that the papovavirus virus was the cause of progressive multifocal leucoencephalopathy [4], and it was also used to show that herpes simplex virus was present in brain biopsies of patients with herpes simplex encephalitis [5].

Serological Analyses

A substantial increase in viral antibody titre in paired serum or cerebrospinal fluid (CSF) samples provides compelling proof of a recent virus infection as the cause of a neurological disease, and it has also shown to be a valuable instrument in epidemiological research.

Viral Antigen Detection

While the presence of viral antigens in tissues and body fluids of patients offers clear proof of a virus's involvement in a disease, some of the caveats listed above apply here as well, including the risk of viral contamination and the possibility of a coexisting but aetiologically unrelated viral infection.

Polymerase Chain Reaction

Both CNS virus identification and pathogenic experiments have been revolutionised by PCR (see Morrison for a detailed description [6]). To provide rapid and large amplification of target nucleic acid, PCR employs oligonucleotide primers, an ingenious thermal cycling process, and a special thermostable DNA polymerase (DNA or cDNA).

In Situ Hybridisation

In situ hybridization (ISH) is one of the most useful methods for studying viral pathogenesis currently available. Nucleic acid probes are

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pretreated and hybridised in situ with portions of related tissues or cell cultures mounted onto glass slides, either radiolabelled (for example, with 35S) or chemically labelled (for example, with digoxigenin) [7,8].

Gene Microarrays

One of the most interesting and promising developments in fundamental and applied molecular biology in recent years has been the introduction of gene microarrays, which can analyse thousands of different genes at the same time.

There are several scientific aspects of gene therapy that will not be addressed here because they are becoming more complex. However, it is important to note that the challenges are daunting, and it is also unclear how effective this modern method of medicine can be in the long run or how many neurological disorders will be amenable to gene therapy.

Parkinson's disease, malignant brain tumours, motor neuron disease, genetic disorders exacerbated by single gene mutations, demyelinating diseases, cerebrovascular disease, [9] and acute CNS injuries are among the human neurological diseases that may benefit from gene therapy using viral vectors [10]. Parkinson's disease and malignant gliomas are two cases where gene therapy is expected to be effective.

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