



## CYTOMEGALOVIRUS

Cytomegalovirus (CMV) is a lytic, double stranded DNA virus belonging to the Betaherpesvirinae subgroup of the Herpesviridae family. It is widespread and thought to infect approximately 40% of adults worldwide. In common with other Herpesviridae viruses, CMV persists for life in a latent state following primary infection. However, it is possible for latent CMV to become reactivated, allowing shedding of infectious virus in bodily secretions such as urine and saliva. The presence of CMV in bodily secretions allows it to spread from person to person through close physical contact. It can additionally be transmitted through sexual activity and organ transplants, as well as through blood transfusions, although this is rare. CMV can also be spread from mother to baby through placental infection, maternal genital secretions during delivery and via breast milk.

### Symptoms

In immunocompetent young children and adults, both primary and recurrent CMV infections are typically asymptomatic. In individuals who do develop symptoms, they tend to resemble those of mild flu and normally last for no longer than two weeks. In contrast, CMV infection can be problematic in immunocompromised patients and unborn or prematurely born babies whose immune system is not yet fully developed (congenital CMV). In extreme cases, CMV infection of the unborn baby can result in a stillbirth. In babies born with congenital CMV, symptoms can include jaundice, pneumonia, enlarged liver and spleen, low birth weight and seizures. They may also develop long-term problems including hearing loss, visual impairment, learning difficulties and epilepsy.

In immunocompromised individuals, symptoms are widespread and can vary across patient groups. Disease manifestations that may be evident include fever, pneumonia, hepatitis, gastrointestinal problems, retinitis and neurological symptoms. Bone marrow transplant patients with CMV often develop pneumonitis, whilst hepatitis is commonly observed in those with liver transplants. In contrast, retinitis is a frequent manifestation in CMV infected individuals with AIDS, although this has become less prevalent since the introduction of highly active antiretroviral therapy (HAART).

## **Diagnostic tests and their interpretation**

### **Serological testing**

A variety of tests can be used in the diagnosis of CMV. These typically involve either detecting an immune response to the virus (serological tests), or isolation and detection of the virus itself. Serological testing can allow identification of either past or recent CMV infection. A number of tests are available for detecting both CMV IgG and CMV IgM antibodies. The CMV IgG antibody is produced in the early stages of primary infection and persists for life. It is therefore a useful test for determining an individual's CMV immune status, for example in organ donors and patients with immunodeficiency. Additionally, rising IgG antibody levels can indicate recurrent infection. CMV IgM antibodies are also produced in the early stages of primary infection. However, in contrast to the IgG antibody, it is only detectable in the first 3 – 4 months of infection and is not necessarily present in cases of viral reactivation. Detection of IgM antibody is therefore useful in cases of recent symptomatic primary infection.

### **Isolation of virus in cell culture**

Isolation and detection of the virus itself is a more preferable method of diagnosing CMV. Methods of virus detection include isolation of virus in cell culture, visualisation by electron microscopy and detection of specific viral components including antigen and DNA. Isolation of the virus involves inoculating cell cultures, which are commonly fibroblasts, with the patient sample. However, the time taken before a viral cytopathic effect is observed can be up to four weeks limiting the diagnostic usefulness of this technique. A more rapid method is the detection of early antigen fluorescent foci (DEAFF), whereby cell cultures inoculated with CMV virus can be examined using immunofluorescence. To stain the cultures, monoclonal antibodies directed towards  $\alpha$  and  $\beta$  proteins produced by CMV are used, allowing examination 24 hours following inoculation.

### **CMV pp65 antigenaemia assay**

This is based on the detection of pp65, a lower matrix viral protein expressed on the surface of infected polymorphonuclear leucocytes. It is a rapid test and the number of infected leucocytes has been reported to correlate with severity of infection, allowing semi-quantitative results to be obtained. However, the relatively complex and labour intensive nature of this technique means it has now been largely replaced by assays based on genome detection and quantitation.

### **CMV DNA detection**

The use of molecular amplification processes provides a rapid and sensitive method for detecting CMV DNA. A number of commercially produced kits exist which can be performed on a variety of real-time PCR platforms. In house assays have also been developed, which are largely based on real-time PCR. Micropathology Ltd performs both qualitative and quantitative CMV DNA detection using an 'in house' nested molecular amplification assay. This assay is included in external quality assurance schemes.

## **CMV drug resistance testing**

Ganciclovir (GCV) is the most widely used antiviral therapy for CMV and has proved to be effective in reducing the CMV viral load in organ transplant recipients and patients with AIDS. As a result this has led to the development of GCV-resistant CMV strains. Factors increasing the risk of a patient developing GCV resistant strains include donor-positive, recipient-negative organ transplant recipients, prolonged antiviral therapy (over 3 months), increased immunosuppression, severe CMV, high viral loads and lung transplantation. The majority (90%) of GCV resistant CMV strains possess *UL97* gene mutations. Less commonly strains may possess mutations in the *UL54* gene, and in these circumstances the virus may also be cross-resistant to alternative therapies such as cidofovir and in a minority of cases to foscarnet.

The sequencing of genes allows resistant mutations to be identified and is therefore useful for determining the appropriate treatment. This can include increasing the dose of GCV or switching to an alternative antiviral such as foscarnet. Micropathology Ltd performs CMV ganciclovir resistance testing for *UL97* encoded resistance mutations.