Capture-CMV®

Solid Phase System for the Detection of IgG and IgM Antibodies to Cytomegalovirus (CMV)

Intended Use:
The Immucor Capture-CMV is an in vitro qualitative solid phase red cell adherence test system for the detection of antibodies (IgG plus IgM) to cytomegalovirus (CMV) in human serum or plasma. Capture-CMV is intended to be used in screening of donors or patients for serological evidence of previous infection by CMV.

Summary of the Test:
Cytomegalovirus (CMV) is a common human viral pathogen which belongs to the family of herpes viruses. The presence of CMV antibodies in an individual indicates prior infection by the virus. The possibility exists that viral reactivation can occur in such individuals. CMV infection is usually asymptomatic, and can persist as a latent or chronic infection. Viral transmission may occur through transfusion of blood or transplantation of organs from seropositive donors.

Immunocompromised patients, such as premature neonates, organ transplant patients, and oncology patients, are at greater risk of developing more severe manifestations of CMV infections which can be a major direct or indirect cause of mortality in such patients. Congenitally infected newborns are especially prone to developing severe cytomegalic inclusion disease (CID). The severe form of CID may be fatal or may cause permanent neurological sequelae, such as mental retardation, deafness, microcephaly, and motor dysfunction. A CMV mononucleosis-type syndrome can result from the transfusion of CMV-infected blood products or the transplantation of CMV-infected donor organs in a seronegative immunocompromised patient. Low birth weight neonates are also at high risk to CMV mononucleosis through transfusion of CMV-infected blood products.

One method of preventing or reducing CMV infection in seronegative immunocompromised patients is to select CMV seronegative blood donors or organ donors that have been tested by serological screening test for antibodies to CMV. Capture-CMV is a solid phase red cell adherence antibody detection system based on procedures of Papp et al. This procedure is a modification of the mixed agglutination test for antigen and antibody detection of Coombs et al and Hogman employing anti-IgG and anti-IgM-coated red cells as the indicator. The positive test is indicated by a blue color change of the indicator red cells. The negative test is indicated by a pink color change of the indicator red cells.

Principle of the Test:
The CMV antigen utilized in this test is obtained from the cytomegalovirus strain AD 169 grown in human foreskin (HF) fibroblast cells. The inactivated virus is coated onto microtitration wells. The wells are dried and supplied to users along with necessary reagents and controls.

The assay procedure is a two step solid phase red cell adherence test carried out in microtitration wells coated with inactivated CMV virus. Serum or plasma samples are added to the viral-coated wells. The samples are incubated for five minutes, during which antibodies specific for CMV proteins bind to immobilized viral proteins. Unbound immunoglobulins are washed from the wells and replaced with a suspension of anti-IgG and anti-IgM indicator red cells. Centrifugation brings the indicator red cells in contact with antibodies bound to the immobilized viral proteins. In the case of a positive test, the migration of the indicator red cells to the bottom of the well is impeded as the anti-IgG and anti-IgM bridges are formed between the indicator red cells and the viral-bound antibodies. As a consequence, the indicator red cells adhere over the surface of the microtitration well. In contrast, in the absence of viral antigen-antibody interactions (ie, a negative test) the indicator red cells are not impeded during their migration, and pellet to the bottom of the well as a packed, well-defined cell button.

Reagents:
Capture-CMV Microtitration Wells: Rigid U-bottom microtitration well coated with glycine-extracted and purified CMV antigen obtained from cytomegalovirus strain AD 169 grown in human foreskin (HF) fibroblast cells. The wells are enclosed in foil pouches to which a desiccant and moisture indicator have been added. Each microtitration well is ready to be used as supplied. Store the wells between 1-30 C. If the humidity indicator enclosed within each pouch shows the presence of moisture (by the humidity indicator turning from blue to pink), the wells should not be used. Unused microtitration wells, desiccant and humidity indicator should be immediately resealed within the foil pouch to prevent the uptake of moisture. Carefully reseal pouch to minimize leakage of moisture into pouch during storage. Microtitration wells resealed in a pouch should be used within two weeks (but not beyond the expiration date) provided the humidity indicator does not show the presence of moisture. Microtitration wells removed from pouches should be used within one (1) hour.

Adjunct Reagents to Capture Test Wells:
(Purchased separately)
Capture-CMV Indicator Red Cells: A suspension of human red blood cells coated with rabbit anti-human IgG plus goat anti-human IgM molecules. The red blood cells are suspended in a buffered solution to which chloramphenicol (0.25 mg/mL), neomycin sulfate (0.1 mg/mL) and gentamycin sulfate (0.05 mg/mL) have been added as preservatives. Store at 1-10 C.

Capture-CMV Positive Control Serum (strong): OPTIONAL USE: Human serum containing IgG antibodies to CMV viral proteins. Sodium azide (0.1%) has been added as a preservative*. Store at 1-10 C. Slight turbidity may occur with age.

Capture-CMV Positive Control Serum (weak): Human serum containing IgG antibodies to CMV viral proteins. Capture-CMV Positive Control Serum (weak) is manufactured to represent the reactivity obtained by weak CMV antibody positive donors. Weak CMV antibody positive donors have a titration endpoint of 1:2 or less. Weak CMV antibody positive reactions are found in less than 2% of the donor population. Sodium azide (0.1%) has been added as a preservative*. Store at 1-10 C. Slight turbidity may occur with age.

Capture-CMV Negative Control Serum: Human serum containing no antibodies to CMV. Sodium azide (0.1%) has been added as a preservative*. Store at 1-10 C. Slight turbidity may occur with age.

Capture LISS: a low ionic strength solution containing glycine, bromocresol purple dye and the preservative sodium azide (0.1%)*. Store at 1-10 C.

On receipt, Capture-CMV adjunct reagents should be stored at 1-10 C.

The in-date components (Capture-CMV test wells, Capture LISS, Capture-CMV Controls, Capture-CMV Indicator Red Cells) used to perform Capture-CMV assays can be used interchangeably with other components, irrespective of their lot numbers, providing the components are within their expiration dates.

Precautions:
For in vitro diagnostic use.
**CAUTION**: ALL BLOOD PRODUCTS SHOULD BE TREATED AS POTENTIALLY INFECTIOUS. SOURCE MATERIAL FROM WHICH THIS PRODUCT WAS DERIVED WAS FOUND NEGATIVE WHEN TESTED IN ACCORDANCE WITH CURRENT FDA REQUIRED TESTS. NO KNOWN TEST METHODS CAN OFFER ASSURANCE THAT PRODUCTS DERIVED FROM HUMAN BLOOD WILL NOT TRANSMIT INFECTIOUS AGENTS.

1. Draw a blood specimen using an acceptable phlebotomy technique. *Serum or plasma (EDTA, CPD, CP2D, CPDA-1, ACD) may be used in this assay. Testing should be performed as soon as possible to minimize the chance that falsely positive or falsely negative reactions will occur due to improper storage or contamination of the specimen. Should delays in testing occur, serum or EDTA, CPD, and ACD anticoagulated whole blood specimens should be stored at 1-10 C for up to one week. Specimens collected in CP2D and CPDA-1 anticoagulants and stored as whole blood specimens at 1-10 C may be tested up to one week. Specimens at 1-10 C may be tested up to one week. Testing of CPDA-1 and ACD anticoagulated specimens stored at 18-25 C for five days is acceptable. Alternatively, serum or plasma may be separated from red cells and stored frozen at –20 C in a nondefrosting refrigerator. Samples should not be repeatedly frozen and thawed. Weakly reactive antibodies may deteriorate and become undetectable in samples stored beyond five days at room temperature or in serum or anticoagulated samples stored at 1-10 C beyond the recommended storage time.*

2. Add 2 drops (100 μL) of Capture LISS to all test wells.

3. Add 1 drop (50 + μL) of Capture-CMV Indicator Red Cells in dropper vials or hand-held multi-channel refilling syringe. *This reagent contains 0.1% sodium azide and is classified as Harmful (Xn). R22 Harmful if swallowed. Sodium azide may react with lead and copper plumbing to form explosive compounds. If discarded into the sink, flush with a large volume of water to prevent azide build-up.

4. Decant or aspirate the serum-LISS mixture from the wells and wash wells using a manual or automated wash technique. i. Fill the wells with a minimum of 250 μL of saline dispensed from a pipette or pipet tip. ii. Put the incubator or plate washer on its side and incubate 20 C in a nondefrosting refrigerator.

5. Stop watch or interval timer.

6. Add 1 drop (50 + μL) of Capture-CMV Positive Control Serum (strong) in dropper vials (optional).

7. Add 1 drop (50 + μL) of Capture-CMV Negative Control Serum in dropper vials.

8. Draw a blood specimen using an acceptable phlebotomy technique. *Serum or plasma (EDTA, CPD, CP2D, CPDA-1, ACD) may be used in this assay. Testing should be performed as soon as possible to minimize the chance that falsely positive or falsely negative reactions will occur due to improper storage or contamination of the specimen. Should delays in testing occur, serum or EDTA, CPD, and ACD anticoagulated whole blood specimens should be stored at 1-10 C for up to one week. Specimens collected in CP2D and CPDA-1 anticoagulants and stored as whole blood specimens at 1-10 C may be tested up to 42 days postdonation. Testing of CPDA-1 and ACD anticoagulated specimens stored at 18-25 C for five days is acceptable. Alternatively, serum or plasma can be separated from red cells and stored frozen at –20 C in a nondefrosting refrigerator. Samples should not be repeatedly frozen and thawed. Weakly reactive antibodies may deteriorate and become undetectable in samples stored beyond five days at room temperature or in serum or anticoagulated samples stored at 1-10 C beyond the recommended storage time.*

9. Proceed in this manner until all test sera or plasma samples have been added. A clean pipette tip or new pipette must be used for each test sample to prevent cross-contamination. One (1) drop (50 + μL) of Capture-CMV Positive Control Serum (strong) can be added as an OPTIONAL positive control to a designated well.

10. Incubate the Capture-CMV wells at 18-30 C for a minimum of 5 minutes, but no more than 30 minutes.

11. Decant or aspirate the serum-LISS mixture from the wells and wash wells using a manual or automated wash technique.

   a. Manual Washing Technique
      i. Fill the wells with a minimum of 250 μL of saline dispensed from a multichannel dispenser or manifold designed for microtiter plates. Alternatively, a saline wash bottle can be used to dispense the saline.

   b. Automated Instrument Users: For testing with automated instrumentation, refer to instructions provided in the instrument operator manual.

**Materials Provided:**
1. Capture-CMV Microtitration Wells in sealed pouches
2. Capture-CMV Indicator Red Cells in dropper vials
3. Capture-CMV Positive Control Serum (strong) in dropper vials (optional)
4. Capture-CMV Negative Control Serum in dropper vials
5. Capture LISS in dropper vials

**Additional Reagents:**
1. Automatic or manual microtitration plate washer, vacuum source, and trap; or hand-held multi-channel refilling syringe. *Note: The Capture-CMV system has been designed so that automated microtiter plate washers may be incorporated in washing steps to reduce the risks associated with handling patient samples.
2. Micropipettors and tips capable of delivering 50 μL and 100 μL, or disposable Pasteur pipets capable of delivering a 50 ± 5 μL drop. Alternatively, an automatic pipettor-dilutor may be used.
3. Glass or plastic test tubes.
4. Stop watch or interval timer.
5. Illuminated white translucent surface.
6. Isotonic saline (0.9% sodium chloride in reagent grade water), commercially prepared isotonic saline without preservative, or phosphate buffered saline; saline pH range should be 6.5 - 7.5.

**Validation results should be maintained as part of the laboratory's records for review by regulatory agencies.**

**Automated Instrument Users:** For testing with automated instrumentation, refer to instructions provided in the instrument operator manual.

**Key:**
- Underline = Addition or significant change; ▲ = Deletion of text
i. Decant the wells thoroughly by manually inverting the strip wells over a sink or waste container and with several rapid, sharp motions, dump the saline from the wells.

ii. Wash the wells six to eight (6-8) times with saline using steps i and ii above. Inspect wells to ensure all fluid has been decanted.

b. Automated Washing Technique
i. Prime the instrument and intake lines with isotonic saline according to the instrument manufacturer's directions.
ii. Wash each well six to eight (6-8) times by filling each well with at least 250 μL of saline and then aspirating the well contents with a vacuum device. Consult the instrument manufacturer's operating manual for a description of the proper use of the microtitration plate washing device. It is recommended, when using an automated microtitration plate washer, to use two 3-cycle or 4-cycle washes. Following the first wash cycle turn the plate 180 degrees. If, in the event that one of the dispensing or aspirating probes of the washer has become clogged, this increases the likelihood that the test wells will be washed. Alternatively, washers capable of performing simultaneous dispense and aspiration of saline in the microtitration wells may be used. It is recommended that a minimum of 1.5 mL of saline be used to wash each test well in this simultaneous wash/aspirate mode.

NOTE: Automated washing devices must be adjusted such that approximately 4-6 μL of saline remains in each well after aspiration. Wells should not be aspirated until they are dry.

12. Resuspend Capture-CMV Indicator Red Cells by gently inverting the vial. Immediately add 1 drop (50 μL + 5 μL) of Capture-CMV Indicator Red Cells to each test well.

13. Centrifuge the wells at 450-600 X g for 1 minute. Allow the centrifuge rotor to come to a complete stop. Centrifuge wells again at 1000-1400 X g for an additional minute. (The g force is an approximation of the speed required to produced the required degree of adherence. The appropriate g force (or rpms) and centrifugation time must be determined individually for each centrifuge used.)

NOTE: Overcentrifugation of the tests, following addition of the Capture-CMV Indicator Red Cells, may result in falsely negative or doubtful positive reactions due to the collapse of the adherent indicator layer. Failure to obtain fully adherent reactions with the Positive Control Serum (strong) and/or partially adherent reactions with the Positive Control Serum (weak) may indicate that the microtitration wells have been overcentrifuged. The acceleration or deceleration characteristics of the centrifuge in use may affect the type of reactions obtained at the end of the assay. Failure to apply the braking mechanism in units with long deceleration times may result in falsely negative reactions. Conversely, braking of centrifuges with short deceleration times may also cause erroneous test results. Acceleration and deceleration parameters must be determined for each centrifuge type. In most cases, acceleration times of 5-30 seconds will permit satisfactory results. Excessive vibration of test wells during deceleration will lead to weak false-positive results. In such cases, results with the negative control will not be valid. Do not re-centrifuge test wells. Repeat tests using new test wells and centrifuge using an alternative centrifuge.

14. Place the microtitration wells on an illuminated surface and examine for adherence or the absence of Indicator Cell adherence. For test results to be considered valid, the following reactions must be obtained with the Capture-CMV Control Sera:
Positive Control (Strong): OPTIONAL USE = adherence of Indicator Red Cells over the entire reaction surface forming an even thin red cell layer. Positive Control (Weak) = adherence of Indicator Red Cells over part or all of the reaction surface.
Negative Control Serum = a button of Indicator Red Cells at the bottom of the test wells with no area of adherence.

15. Compare each antibody detection test result with those obtained with the positive and negative control sera. A test should be repeated if a doubtful reaction (irregular, nonconcentric adherence) is obtained or if the control sera do not perform properly.

Stability of the reaction:
Following centrifugation, tests can be read immediately. Since positive reactions are permanent, wells can be covered following centrifugation to prevent evaporation, stored at 1-10°C, and read or reread up to 2 days following testing.

Quality Control:
The reactivity of the Capture-CMV assay is evaluated at each centrifugation run by inclusion of the negative, strong positive (optional use), and weak positive controls. If, in any test run, any of the Positive Control Sera do not produce positive results and/or the Negative Control Serum does not produce negative results, the test run is invalid and all the tests performed in the run must be repeated. Continued failure of the control sera to perform properly may indicate that either one or more of the test reagents has deteriorated, or that the tests are not being performed correctly.

Interpretation of Results:
Negative test: A button of the Capture-CMV Indicator Red Cells at the bottom of the test well with no area of adherence indicates the test sample has no detectable CMV antibody and the person has not yet been infected with CMV and is presumed to be susceptible to primary infection.

Positive test: Adherence of Capture-CMV Indicator Red Cells to part or all of the reaction surface indicates a person with previous or current infection and who is presumed to be at risk of transmitting CMV infection but who is not necessarily currently contagious.

Limitations:
Erroneous test results can occur from bacterial or chemical contamination of test materials, inadequate incubation periods, improper centrifugation, inadequate washing of test wells, or omission of test reagents or steps. Addition of Capture-CMV Indicator Red Cells in excess of amounts described in this insert may result in falsely negative or doubtful test reactions. The Capture-CMV assay is designed to detect IgG plus IgM antibodies. The assay is neither designed to detect antibodies of the IgA or IgE class nor differentiate between IgM and IgG antibodies to CMV.

Care should be taken in interpreting test results of neonatal samples. A positive test usually indicates the presence of antibodies passively transferred from mother to fetus. A negative test may be helpful in excluding possible infection, but a diagnosis of active CMV infection may require viral culture.9,10 The presence of IgG or total complement-fixing antibody does not assure protection from infection.11

The titer of a single specimen should not be used to aid in the diagnosis of recent infection. Paired samples (acute and convalescent) should be collected and tested concurrently to look for seroconversion which is indicative of primary infection.12 Positive test results may not be valid in persons who have received blood transfusions or other blood products within the past several months.

Samples obtained too early during primary infection may not contain detectable antibodies. If CMV infection is suspected, a second sample should be obtained 2-7 weeks later and tested in parallel with the first specimen to look for seroconversion which is indicative of primary infection.

Positive test results in symptomatic patients require careful interpretation since false-positive reactions or heterotypic IgM responses may occur with sera from patients with heterophile-positive mononucleosis13 or varicella zoster infection.14 Heterotypic IgM antibody responses to CMV have been reported in as many as 30% of patients with infectious mononucleosis15 and polyclonal stimulation of B lymphocytes by EBV seems the most likely mechanism. However, reactivation of latent CMV is also a possibility. The reverse, that is heterotypic IgM antibody responses to EBV in CMV infections, is less frequently seen, but has been reported.16 Reactivation of latent EBV would seem to be a possible mechanism.13 Overcentrifugation of the tests, following addition of the Capture-CMV Indicator Red Cells, may result in falsely negative or doubtful positive reactions due to the collapse of the adherent indicator layer. Undercentrifugation will lead to falsely positive results.

Expected Values:
The incidence of CMV infection is dependent upon geographical, socioeconomic, and age factors. Serological studies indicate that the incidence of antibodies to CMV is between 15% and 70% in adult populations.17 The geographic location and anti-CMV prevalence of each donor test site evaluating the Capture-CMV assay are provided in the following table:

<table>
<thead>
<tr>
<th>Test Site</th>
<th>Geographic Location</th>
<th>Anti-CMV Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site #2</td>
<td>Southern United States</td>
<td>59%</td>
</tr>
<tr>
<td>Site #3</td>
<td>Western United States</td>
<td>27%</td>
</tr>
<tr>
<td>Site #5</td>
<td>Southern United States</td>
<td>34%</td>
</tr>
<tr>
<td>Site #6</td>
<td>Midwestern United States</td>
<td>49%</td>
</tr>
<tr>
<td>Site #7</td>
<td>Northeastern United States</td>
<td>31%</td>
</tr>
</tbody>
</table>

Specific Performance Characteristics:
The performance of this product is dependent upon adhering to the insert’s recommended methodology. The expiration for Capture-CMV Indicator Red Cells is 60 days from the date of the manufacturer which is the earliest date blood used in this product is withdrawn from any donor.
The performance of the Capture-CMV assay was evaluated at seven (7) separate test sites on 6,506 specimens. The specimens comprised a mixture of blood bank donors and hospital patients in which CMV antibody status was routinely requested.

Performance in Patient Populations:
The performance of the Capture-CMV assay was compared to commercially available latex agglutination test at two (2) separate test sites on 308 patient specimens. Specimens giving discrepant results between the Capture-CMV assay and the latex agglutination test were evaluated at an independent test site using commercially available enzyme immunoassay (EIA) for total antibody and an in-house direct immunofluorescence assay (IFA) for CMV IgM antibody. A consensus result of positive or negative antibodies to CMV was assigned to each discrepant specimen based on the EIA and IFA results. The results are summarized in the following table:

<table>
<thead>
<tr>
<th>Test Site</th>
<th>Relative Sensitivity</th>
<th>Relative Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site #2</td>
<td>100%</td>
<td>96.7-100</td>
</tr>
<tr>
<td>Site #3</td>
<td>100%</td>
<td>98.7-100</td>
</tr>
<tr>
<td>Site #5</td>
<td>100%</td>
<td>99.9-100</td>
</tr>
<tr>
<td>Site #6</td>
<td>99.5%</td>
<td>99.0-100</td>
</tr>
<tr>
<td>Site #7</td>
<td>99.2%</td>
<td>99.1-99.7</td>
</tr>
</tbody>
</table>

+95% CI= 95% Confidence Interval

The latex agglutination test exhibited a relative sensitivity of 99.5% (211-212) and a relative specificity of 99.3% (204/206) at test sites 2 and 3. The automated passive hemagglutination assay demonstrated a relative sensitivity of 96.0% (1313/1368) and a relative specificity of 99.2% (2573/2619) at test sites 5-7. The performance of Capture-CMV when tested on the Galileo automated analyzer with additional information or for technical support, contact Technical Service at 800-492-6800.

Relative Sensitivity = 100% (138/138)
Relative Specificity = 99.4% (169/170)

The commercially available latex agglutination test exhibited a relative sensitivity of 100% (138/138) and a relative specificity of 99.4% (169/170) at these test sites.

Performance in Donor Populations:
The performance of the Capture-CMV assay was compared to a commercially available latex agglutination test at two (2) separate test sites on 508 donor specimens and to a commercially available automated passive hemagglutination assay at three (3) separate test sites on 4,367 specimens. The donor populations tested consisted of serum and plasma (EDTA) samples. Specimens giving discrepant results between the Capture-CMV assay and the latex agglutination tests were evaluated at an independent test site using commercially available enzyme immunoassay (EIA) for total antibody and an in-house indirect immunofluorescence assay (IFA) for CMV antibody. A consensus result of positive or negative antibodies to CMV was assigned to each discrepant specimen based on the EIA and IFA results. The relative sensitivity and relative specificity of the Capture-CMV assay with the calculated 95% confidence intervals at each donor test site are summarized in the following table:

<table>
<thead>
<tr>
<th>Site #5</th>
<th>Site #6</th>
<th>Site #7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>Potency</td>
<td><em>Frequency</em></td>
</tr>
<tr>
<td>Negative</td>
<td>63.5%</td>
<td>100%</td>
</tr>
<tr>
<td>Weak Positive</td>
<td>1.5%</td>
<td>91.7%</td>
</tr>
<tr>
<td>Moderately Positive</td>
<td>3.1%</td>
<td>100%</td>
</tr>
</tbody>
</table>

* Frequency = Expected frequency at the donor site population

To demonstrate the absence of nonspecific reactivity of sera from patients with other IgG antibodies, samples from positive for herpes simplex I&II (10 ea), Epstein-Barr (10 ea), varicella zoster (8 ea), rubella (8 ea), rheumatoid factor (5 ea), toxoplasma gondii (4 ea), and anti-nuclear antibodies were tested by the Capture-CMV assay. Two samples containing herpes simplex IgM antibodies were also tested. In all cases the sera were found nonreactive for CMV antibody by the Capture-CMV assay suggesting no nonspecific reactivity or interference.

Relative Seronegativity = 99.4% (169/170)
Relative Reactivity = 99.6% (204/206)

The reproducibility of the Capture-CMV assay was determined using two separate panels of coded samples provided to the trial sites. The reproducibility of Capture-CMV was evaluated on twenty-five (25) coded samples at five (5) test sites comparing the performance of Capture-CMV to a latex agglutination test. The Capture-CMV assay demonstrated a 94.8% agreement (121 of 125 samples) of reproducibility panel test results between test sites. For three (3) donor test sites comparing Capture-CMV to a passive hemagglutination assay, reproducibility was evaluated on identical panels of sixty (60) samples consisting of ten (10) samples of each of six serum pools. The Capture-CMV assay demonstrated a 94.4% agreement (170/180) of reproducibility panel test results between three test sites. The test sites collectively demonstrated 94.2% (113/120) within-day and a 94.4% (170/180) day-to-day reproducibility. A summary of the reproducibility of the Capture-CMV assay at each donor site on the samples with negative, weakly positive, and moderately positive potencies and the expected frequencies of such potencies in the donor populations are provided in the following table:

Key:
Underline = Addition or significant change; ▲ = Deletion of text

Bibliography: