Rising Levels of Human Cytomegalovirus (HCMV) Antigenemia during Initial Antiviral Treatment of Solid-Organ Transplant Recipients with Primary HCMV Infection

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In 7 of 18 solid-organ transplant recipients with primary human cytomegalovirus (HCMV) infection, HCMV antigenemia levels were unexpectedly found to rise significantly \( (P = 0.018) \) during a mean time of 7.3 ± 3.2 days after initiation of specific antiviral treatment, whereas corresponding levels of viremia dropped significantly \( (P = 0.043) \). Thus, shifting to an alternative antiviral drug based solely on increasing antigenemia levels is not justified in this group of patients.

Several methods have been developed to detect and quantify virus or viral components in blood of immunocompromised patients with human cytomegalovirus (HCMV) infection, such as viremia (7), antigenemia (6, 13, 17), leukocyte DNAemia (L-DNAemia), and plasma DNAemia (2–4). According to a preemptive therapy approach (14), treatment of primary HCMV infections is currently started in several transplant centers upon the first detection of antigenemia (1, 9, 10). This strategy led us to observe a paradoxical phenomenon in some transplant patients, in whom antigenemia levels were unexpectedly found to rise during the first week of antiviral treatment (9).

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In the period 1990 to 1995, 249 patients underwent heart transplantation (HT), 22 underwent heart-lung transplantation, and 17 underwent double-lung and 21 underwent single-lung transplantation (SLT) at the Cardiac Surgery Department of IRCCS Policlinico San Matteo, Pavia, Italy. Of these, 20 patients (16 HT, 2 heart-lung transplantation, and 2 SLT patients) developed a primary HCMV infection (17 males and 3 females; median age, 38.5; range, 13 to 65 years), and 18 of them received antiviral treatment. Clinical and virological follow-up lasted a median time of 138 (47 to 347) days. All patients were virologically monitored by prospective quantitation of pp65 antigenemia and viremia and retrospective quantitation of L-DNAemia in PBL. PBL were obtained from buffy coat samples, which were processed within 4 h after bleeding. The level of viremia was measured according to the shell vial technique (7).

All patients were prospectively monitored for clinical evidence of HCMV-related symptoms or signs. Disseminated HCMV disease followed recommendations made by participants in a workshop on HCMV disease (11).

Ganciclovir was administered intravenously at a standard dosage of 10 mg/kg of body weight/day for at least 14 days or until antigenemia clearance. Alternatively, foscarnet was administered intravenously at a dosage of 180 mg/kg/day for 21 days. In the 18 treated patients with primary HCMV infection, indications for initiation of antiviral therapy changed with time, i.e., appearance of HCMV-related clinical symptoms in 13 patients, HCMV antigenemia of >100 in 2 patients, and an antigenemia level of 48 in one patient, whereas in 2 patients treatment was started upon the first observation of antigenemia.

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Differences in means of nonparametric data were tested by the Wilcoxon signed-rank test for paired data and the Kolmogorov-Smirnov test for unpaired data. In addition, Fisher’s exact test was used to test differences in proportions when the total sample size was less than 30. All tests were two-tailed.

During follow-up of 18 solid organ transplant recipients with primary HCMV infection, the mean time to a ≧90% reduction of viral load in the blood, following initiation of antiviral treatment, was 3.5 (0 to 8) days when viral load was measured by viremia, 6.9 (2 to 22) days when it was measured by L-DNAemia, and 14.6 (3 to 34) days when it was quantified by antigenemia. More detailed analysis of these data unexpectedly showed that, while viremia and most L-DNAemia levels rap-
idly decreased after onset of antiviral therapy, antigenemia levels increased in 7 of 18 (38.9%) patients. As shown in Fig. 1, the 18 patients belonged to two groups on the basis of antigenemia response to treatment during the first week of therapy: the group of “normal” responders (n = 11), in whom viremia, L-DNAemia, and antigenemia levels decreased, and the group of “delayed” responders in whom decreasing levels of viremia and (mostly) L-DNAemia were associated with increasing levels of antigenemia. Subsequently, a progressive decrease in antigenemia levels was observed also among delayed responders. Thus, the group of normal responders presented significant (P < 0.01) decreases in median levels of viremia (from 110 [1 to 1,000] to 0 [0 to 4]), antigenemia (from 350 [60 to 2,000] to 25 [0 to 4]), and L-DNAemia (from >10,000 [794 to >10,000] to 159 [5 to 1,412] GE). On the other hand, in the group of delayed responders, while the median level of viremia dropped significantly (P = 0.05) from 11.0 (0 to 280) to 0 and level of L-DNAemia did not change significantly (316, range 10 to >10,000 versus 141, range 12 to 742 GE), the level of antigenemia rose significantly (P = 0.046) from 48 (5 to 600) to 390 (28 to 900). The mean time of antiviral treatment during this observation was 5.5 ± 1.8 days for normal responders and 7.3 ± 3.2 days for delayed responders.

Major differences between the two groups were the following: (i) the mean time of antigenemia positivity prior to antiviral therapy was found to be significantly shorter in the group of delayed responders (5.7 ± 6.4 versus 9.7 ± 5.2 days) (P = 0.046); (ii) mean pretreatment levels of viremia, antigenemia, and L-DNAemia were lower in the group of delayed responders, even though only L-DNAemia reached the level of significance (P = 0.046); and (iii) all four patients in whom treatment was started with antigenemia levels of >50 had increasing antigenemia levels, whereas only 3 of 14 (21%) patients starting treatment with a higher antigenemia level showed the same type of response (P < 0.05). There was no correlation between time elapsed after transplantation and clinical symptoms or type of antiviral drug.

Clinical and virological consequences of the delayed antigenemia response to antiviral treatment were as follows: (i) the proportion of patients with secondary episodes of HCMV infection (reactivations) following the primary episode was higher (although not significantly) in the group of delayed (5 of 7; 71%) compared to normal (4 of 11; 36%) responders; in addition, the overall incidence of secondary episodes during follow-up was higher among delayed responders (12 versus 6 episodes); (ii) the mean times to ≥90% antigenemia level reduction after onset of antiviral treatment were 20.8 ± 7.7 days for delayed and 9.9 ± 6.7 days for normal responders (P = 0.18).

Table 1 reports the follow-up of three normal responders (patients 5, 10, and 12) and three delayed responders (patients...
<table>
<thead>
<tr>
<th>Patient</th>
<th>Type of transplant</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>Days after transplant</th>
<th>HCMV quantitation in blood</th>
<th>Antiviral drug (days of administration)</th>
<th>Onset of treatment after 1st positive antigenemia (day)</th>
<th>HCMV-related clinical symptoms^c</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Viremia</td>
<td>Antigenemia</td>
<td>L-DNAemia</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5H</td>
<td>M</td>
<td>37</td>
<td>3</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10T</td>
<td>M</td>
<td>18</td>
<td>2</td>
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<tr>
<td>12</td>
<td>12H</td>
<td>M</td>
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</tr>
<tr>
<td>16</td>
<td>16SLT</td>
<td>M</td>
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<tr>
<td>22</td>
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<td>M</td>
<td>30</td>
<td>21</td>
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### Notes:
- M, male; F, female.
- G, ganciclovir; F, foscarnet.
- 1, presence of clinical symptoms; 2, absence of clinical symptoms.
- ND, not determined.
16, 22, and 26). In patient 16 the increasing antigenemia level prompted clinicians to shift from ganciclovir to foscarnet following the first 8 days of antiviral treatment.

Results of the present study indicated that, in solid-organ transplant recipients with primary HCMV infection, early initiation of treatment may be followed by a significant rise in antigenemia level during the first week of treatment, delayed antigenemia clearance, or a higher incidence of HCMV reactivation episodes after discontinuation of treatment. The significantly earlier initiation of treatment based on first antigenemia positivity along with the significantly lower absolute antigenemia level in the group of delayed responders represented the major factors associated with the rise in antigenemia level after onset of therapy. These conclusions are in keeping with two recent studies reporting an increase in quantitative antigenemia in liver (9) and allogeneic bone marrow (1) transplant recipients.

The reported increase in antigenemia level is often the critical factor prompting the clinician to shift to an alternative drug (patient 16 [Table 1]) due to the suspicion that a drug-resistant strain is emerging (15). To avoid such an erroneous therapeutic approach, other assays should be performed in parallel, e.g., measurement of viremia, which in the presence of a sensitive HCMV strain, drops sharply within 24 to 48 h.

Although early replicative events have been shown to occur in both mononuclear (16) and polymorphonuclear leukocytes (8), it should be noted that virus or viral material detected in blood by different assays has been assumed to be mostly taken up by PBL by phagocytosis (5). Thus, it appears reasonable to hypothesize that while antiviral treatment quickly blocks virus replication by PBL by phagocytosis (5). Thus, it appears reasonable to hypothesize that while antiviral treatment quickly blocks virus replication, previously synthetized pp65 may still be phagocytized by PBL for several days after discontinuation of treatment.

In conclusion, antigenemia-guided antiviral treatment in solid-organ transplant recipients with primary HCMV infection could be reasonably started with antigenemia levels of >50. This could avoid erroneous treatment modifications as well as partially prevent secondary episodes of HCMV reactivation and result in a faster virus clearance from blood.

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REFERENCES