CD4⁺CD7⁻CD57⁺ T Cells: A New T-Lymphocyte Subset Expanded During Human Immunodeficiency Virus Infection

By Eric Legac, Brigitte Autran, Hélène Merle-Beral, Christine Katlama, and Patrice Debre

CD7 and CD57 are two cell surface molecules related to the differentiation or functional stages of CD4⁺ T cells. The CD4⁺CD7⁻ T cells represent a minor subset of CD4⁺ cells in normal individuals and are considered to contain the normal counterpart of Sézary T cells; the CD4⁺CD57⁺ peripheral blood lymphocytes (PBL) are detectable in long-term renal allograft recipients. We compared the cell surface expression of these CD7 and CD57 markers on CD4⁺ T lymphocytes in peripheral blood and lymphoid organs from normal individuals and human immunodeficiency virus (HIV)-infected patients. Our results indicate that CD4⁺CD7⁻ T cells in normal PBL do not express CD57 and were poorly responsive to anti-CD3 monoclonal antibody (MoAb), the activation being restored by addition of anti-CD28 MoAb. This CD4⁺CD7⁻ cell subset is increased in peripheral blood during HIV infection, and its progressive expansion mirrors both the absolute and relative decrease of CD4⁺ T cells. The lack of CD7 expression is correlated with CD57 acquisition on CD4⁺ T cells because CD4⁺CD7⁻CD57⁺ T cells represent a major component of the CD4⁺CD7⁻ subset in HIV-infected patients. Our results suggest that the presence and the expansion of CD4⁺CD7⁻CD57⁺ T lymphocytes, which do not behave as previously defined helper subsets, may participate to the immune dysfunction observed during HIV infection.

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Materials and Methods

Patients. We studied 78 seropositive HIV-infected patients observed in the Department of Infectious Diseases of the Pitié-Salpêtrière Hospital. The seropositivity was assessed by enzyme-linked immunosorbent assay (ELISA) and Western blotting (ELA-VIA and New LAV Blot I; Diagnostics Pasteur, Marnes-La-Coquette, France). Data from HIV patients were compared with 43 seronegative controls: normal blood samples from 32 healthy volunteers, bone marrow samples from three normal donors for allogeneic bone marrow transplantation, thymus samples from two children undergoing cardiac surgery, three tonsil samples from laryngologic surgery, and three spleen samples from posttraumatic abdominal surgery.

Monoclonal antibodies (MoAbs). A panel of 28 murine MoAbs was used in this study: Anti-CD4 (IOT4), anti-CD7 (IOT7), anti-CD11a (IOT16), anti-CD16 (ION16), anti-CD18 (IOT18), anti-CD23 (JOB8), anti-CD45RA (IOL2), and anti-CD54 (IOM54) were purchased from Immunotech (Marseille-Luminy, France). Anti-CD34 (MY10), anti-CD38 (Leu17), anti-CD57 (Leu7), and anti-TCR α/β were obtained from Becton-Dickinson (Grenoble, France). We purchased from Coultronics (Margency, France).
anti-CD1a (T6), anti-CD2 (T11), anti-CD3 (T3), anti-CD5 (T1),
anti-CD7 (3A1), anti-CD8 (T8), anti-CD10 (J5), anti-CD14 (MY4),
antii-CD19 (B4), anti-CD25 (IL2R1), anti-CD26 (Tal), anti-
CDw29 (4B4), anti-CD56 (NKH1), anti-CD71 (T9), anti-HLA-
DR, TQ1 (LAM1, not clustered).

Cells. Peripheral mononuclear cells were isolated using Ficoll
Hypaque gradient (Pharmacia, Uppsala, Sweden). Normal lym-
phoid organs were teased out immediately after ablation and
mononuclear cells separated as described above.

Separation procedure. Purified lymphocyte subsets were sorted
using panning techniques completed by immunomagnetic separa-
tion. Before purification, monocytes were removed by incubating
cells in RPMI 1640 medium in culture flasks at 37°C and 5% CO2
for 1 hour. Nonadherent cells were collected, washed, and sus-
pended in RPMI 1640. CD7+ T cells were removed using panning
techniques. Culture flasks were coated with anti-CD7 I21 (a kind
gift of A. Bernard, Institut Gustave-Roussy, Villejuif, France) for
16 hours at 4°C in RPMI 1640. After washing, nonadherent mononuclear cells were incubated in these culture flasks for 90
minutes in RPMI 1640 at 4°C. The supernatant was collected and
washed, and cells were counted. In a third step, a cocktail of I21
(CD7) and T8 (CD8) MoAbs was added to residual cells and
magnetic microbeads coated with antimonouse IgG (Dynal, Oslo,
Norway) was used (as directed by manufacturer) to remove labeled
cells. To further purify CD4+CD7+ T lymphocytes, cells were then
incubated with a cocktail of MY4 (CD14), ION16 (CD16), and B4
(CD19) MoAbs and labeled cells removed by the same magnetic
beads. Cell purity was controlled by two distinct epitopes of CD7
(3A1-phycocerythrin [3A1-PE], IOT7-fluorescein isothiocyanate
[3A1-phycoerythrin [3A1-PE]. This lack of CD7 cell surface
expression could be related to a downmodulation. How-
results although higher fluorescence intensity could be
erved at day 2 and day 5 by liquid scintillation counting (LS1701
counter; Beckman, Gagny, France).

Statistical tests. Statistical analysis used correlation tests and
r-tests.

RESULTS

Phenotypic characterization of CD4+CD7+ T lymphocytes in normal individuals. To compare the CD7 expression on
CD4+ T cells from HIV-infected patients and control
subjects, we first studied the CD4+CD7-TL population in
peripheral blood and in lymphoid organ samples from 43
seronegative individuals. The CD4+ T lymphocytes that do
not express CD7 cell surface antigen were detectable as
shown in Table 1. They represented a minor subset of the
CD4+ T cells. The same distribution was ob-
erved in lymphoid organs: spleen (9% ± 3%), thymus (9% ± 2%), bone marrow (13% ± 1%).

Cell surface expression of CD7 was controlled with two
anti-CD7 MoAbs (3A1, IOT7). Both MoAbs gave similar
results although higher fluorescence intensity could be
obtained with 3A1-PE. This lack of CD7 cell surface
expression could be related to a downmodulation. How-

Table 1. CD7 and CD67 Expression of CD4 Lymphocytes of Seronegative Controls

<table>
<thead>
<tr>
<th>CD4+CD7−</th>
<th>PBL</th>
<th>Spleen</th>
<th>Bone Marrow</th>
<th>Thymus</th>
<th>Tonsil</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD4+CD7+TL</td>
<td>N*</td>
<td>32</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CD4+CD67+TL</td>
<td>%</td>
<td>10 ± 4</td>
<td>9 ± 3</td>
<td>13 ± 3</td>
<td>9 ± 2</td>
</tr>
<tr>
<td>CD4+CD67+CD7+</td>
<td>%</td>
<td>2</td>
<td>2 ± 1</td>
<td>3 ± 1</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>CD4+CD67+CD7−</td>
<td>%</td>
<td>1 ± 1</td>
<td>2 ± 1</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>CD4+CD67−</td>
<td>%</td>
<td>0.3 ± 0.3</td>
<td>1 ± 1</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

*Number of samples studied.
†Percentage of positive cells (mean ± SD).
‡Subsets identified by three-color staining.
§Not done.

For intracytoplasmic staining, the cells were permeabilized with the saponin technique.

Samples were analyzed on a FACSCan flow cytometer (Becton-Dickinson, Sunnyvale, CA). Peripheral blood mononuclear cells were characterized by two- or three-color fluorescence staining. The lymphoid cells were first gated by their physical properties (forward and right angle scattering). Then, only CD4+ lymphocytes were gated by fluorescence emission and analyzed for at least 5,000
cells.

Proliferation assays. Proliferation assays used various combina-
tions of stimulating agents: immobilized anti-CD3 MoAb UCHT1, 1/200 (P.J.C. Beverley, Cancer Research Institute, London, UK); anti-CD28 MoAb 248-23, 1/100 (D. Olive, Marseille-Luminy, France); mitogenic combination of anti-CD2-MoAbs X11 and D66, 1/100, (A. Bernard, Institut Gustave-Roussy, Villejuif, France); phytohemagglutinin (PHA-M), 10 µg/mL and phorbol myristate acetate (PMA), 1 ng/mL. Controls consisted of supplemented medium alone. Purified T cells (0.5.106 cells) were incubated in
triplate in 96-well flat-bottom plates in a total volume of 0.2 mL
RPMI 1640 supplemented with 10% (vol/vol) fetal calf serum, 1%
glutamine, 1% pyruvate, 1% nonessential amino acids (MEM).
Cultures were pulsed overnight with 1 µCi (H)-thymidine and were harvested subsequently. Incorporated radioactivity was mea-
ured at day 2 and day 5 by liquid scintillation counting (LS1701
counter; Beckman, Gagny, France).

Statistical tests. Statistical analysis used correlation tests and
r-tests.
ever, we failed to detect any intra-cyttoplasmic CD7 expression in the CD4+CD7-TL (data not shown). In addition, several modulation experiments were performed. Normal PBL were incubated in RPMI 1640 medium at 4°C, 20°C, and 37°C and the CD7 reactivity controlled after 1, 2, 6, and 18 hours. Results showed that the lack of CD7 cell surface expression was not related to CD7 modulation (data not shown). Three-color staining on peripheral blood cells and double-labeling experiments on purified cells were performed. The CD4+CD7- cells did not display monocytic double-labeling experiments on purified cells were performed. Normal PBL were incubated in RPMI 1640 medium at 4°C, 20°C, and 37°C and the CD7 reactivity controlled after 1, 2, 6, and 18 hours. Results showed that the lack of CD7 cell surface expression was not related to CD7 modulation (data not shown). Three-color staining on peripheral blood cells and double-labeling experiments on purified cells were performed. The CD4+CD7- cells did not display monocytic markers (CD14+, HLA-DR+) but rather were T lymphocytes expressing: CD2, CD5, CD3, TCR α/β. This T-cell subset expressed high levels of CDw29, LAM1 molecule and did not express CD45RA, as previously described. The CD4+CD7-TL were neither activated T cells, as shown by the lack of expression of the CD25, CD26, CD38, CD71, HLA-DR antigens, nor natural killer (NK) cells (CD16+, CD56+, CD57-). In addition, these cells expressed CD11a/CD18 complex and were negative for CD10, CD23, CD34, and CD54. The results are listed in Table 2. Altogether, these data indicate that CD4+CD7- lymphocytes are mature T cells in normal individuals.

Functional analysis of CD4+CD7-TL in normal individuals. The proliferative responses of purified CD4+CD7-TL were compared with purified CD4+CD7-TL responses. These cells were obtained by panning methods resulting in depletion of accessory cells. We used a panel of seven stimulating reagents including: mitogenic combination of anti-CD2 MoAbs, immobilized anti-CD3 MoAb, anti-CD28 MoAb, anti-CD3 + PMA, anti-CD3 + anti-CD2 MoAbs, anti-CD3 + anti-CD28, PMA + PHA. The results of one typical experiment out of five are detailed in Table 3. The overall absolute CD4+CD7-TL proliferative responses obtained at day 2 were consistently lower than CD4+CD7-TL ones, although the stimulation indexes were comparable. Results differed at day 5: CD4+CD7-TL had normal proliferative responses when stimulated via CD2, contrasting with weak responses obtained with anti-CD3 MoAb even if associated with PMA. Similarly, the PHA + PMA responses remained low. In contrast, the addition of anti-CD28 MoAb restored the CD3-induced proliferation.

Altogether these data point out the presence of a normal minor CD4+ T-cell subset particular by its lack of CD7 expression and by its dissociated responses when stimulated via CD3 or CD2.

Analysis of the CD4+CD57+ T lymphocytes in normal individuals. In addition to CD7, we investigated the CD57 expression on the CD4+ T lymphocytes. Figure 1 shows typical results obtained with anti-CD4, anti-CD7, and anti-CD57 MoAbs on purified normal CD4+CD7-TL and normal CD4+ peripheral lymphocytes. We studied normal peripheral blood and the same panel of normal lymphoid organs. When analyzing the CD57 fluorescence on gated CD4+ T lymphocytes, we individualized CD4+CD57+ cells.

### Table 2. Phenotypic Characterization of Normal Purified CD4+CD7-T Cells

<table>
<thead>
<tr>
<th>CD*</th>
<th>% Cells†</th>
<th>CD</th>
<th>% Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>97 ± 2</td>
<td>25</td>
<td>5 ± 3</td>
</tr>
<tr>
<td>3</td>
<td>98 ± 2</td>
<td>26</td>
<td>4 ± 2</td>
</tr>
<tr>
<td>4</td>
<td>99 ± 1</td>
<td>29</td>
<td>87 ± 10</td>
</tr>
<tr>
<td>5</td>
<td>96 ± 5</td>
<td>34</td>
<td>3 ± 2</td>
</tr>
<tr>
<td>7</td>
<td>&lt; 1</td>
<td>38</td>
<td>2 ± 2</td>
</tr>
<tr>
<td>8</td>
<td>&lt; 1</td>
<td>45RA</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>10</td>
<td>3 ± 2</td>
<td>56</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>11a</td>
<td>95 ± 2</td>
<td>57</td>
<td>5 ± 4</td>
</tr>
<tr>
<td>14</td>
<td>1 ± 1</td>
<td>21</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>16a</td>
<td>2 ± 1</td>
<td>TCR α/β</td>
<td>93 ± 4</td>
</tr>
<tr>
<td>18</td>
<td>96 ± 2</td>
<td>HLA-DR</td>
<td>7 ± 4</td>
</tr>
<tr>
<td>23a</td>
<td>4 ± 3</td>
<td>TQ1</td>
<td>41 ± 10</td>
</tr>
</tbody>
</table>

*Cluster of differentiation or antigen if not clustered.
†Percentage of labeled cells by the MoAb expressed as mean percentage ± standard deviation in four experiments.

### Table 3. Proliferative Responses of Purified CD4+CD7- and CD4+CD7+ T Lymphocytes

<table>
<thead>
<tr>
<th>Cell Treatment</th>
<th>CD4+/CD7- TL</th>
<th>Day 5</th>
<th>CD4+/CD7+ T L</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 2</td>
<td>Day 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>140 ± 50*</td>
<td>266 ± 69</td>
<td>1,024 ± 181</td>
<td>2,700 ± 800</td>
</tr>
<tr>
<td>Anti-CD3†</td>
<td>616 ± 115</td>
<td>1,100 ± 360</td>
<td>2,900 ± 1,000</td>
<td>85,798 ± 6,287</td>
</tr>
<tr>
<td>4,4</td>
<td>4,1</td>
<td>2,8</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Anti-CD25</td>
<td>6,513 ± 400</td>
<td>24,745 ± 5,180</td>
<td>13,780 ± 2,230</td>
<td>76,215 ± 3,633</td>
</tr>
<tr>
<td>47</td>
<td>93</td>
<td>14</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Anti-CD28</td>
<td>1,190 ± 294</td>
<td>346 ± 14</td>
<td>2,000 ± 783</td>
<td>2,700 ± 1,000</td>
</tr>
<tr>
<td>8.5</td>
<td>1.3</td>
<td>1.9</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Anti-CD3 + CD28</td>
<td>5,079 ± 656</td>
<td>91,823 ± 15,120</td>
<td>18,260 ± 3,900</td>
<td>242,387 ± 26,244</td>
</tr>
<tr>
<td>36</td>
<td>345</td>
<td>18</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Anti-CD3 + CD2</td>
<td>4,748 ± 502</td>
<td>93,310 ± 15,030</td>
<td>30,344 ± 1,447</td>
<td>66,000 ± 8,376</td>
</tr>
<tr>
<td>34</td>
<td>350</td>
<td>30</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Anti-CD3 + PMA</td>
<td>1,178 ± 149</td>
<td>2,006 ± 270</td>
<td>14,232 ± 2,010</td>
<td>162,798 ± 28,391</td>
</tr>
<tr>
<td>8.4</td>
<td>7.6</td>
<td>14</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>PHA + PMA</td>
<td>1,762 ± 360</td>
<td>8,992 ± 1,160</td>
<td>16,620 ± 1,928</td>
<td>28,956 ± 7,690</td>
</tr>
<tr>
<td>13</td>
<td>34</td>
<td>16</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

*cpm expressed as mean ± SD.
†Immobilized anti-CD3 MoAb.
‡Stimulation index = experimental cpm/spontaneous cpm.
$Comitogenic combination of X11 and D66 MoAbs.
These cells were a minor subset of CD4+ T cells in peripheral blood (2% ± 1%), thymus (2% ± 1%), spleen (2% ± 1%), and bone marrow (3% ± 1%). As already reported, only tonsil CD4 lymphocytes expressed significant levels of CD57 (13% ± 6%, P < .001 v other organs). A three-color immunofluorescence analysis was performed on the same controls. Results (Table 1) showed that CD57 was mainly expressed on CD4+CD7- lymphocytes. No CD4+CD7-CD57-TL could be detected in peripheral blood (0.3% ± 0.31%), as mentioned above, but only in tonsils where a very low percentage of CD4+CD7-CD57-TL was detectable. They represented 3% ± 1% of tonsil CD4+ T cells (P < .001 v PBL and other lymphoid organs).

Characterization of the CD4+CD7-CD57+ T-lymphocyte subset in HIV-infected patients. We investigated the CD7 expression on CD4+ T lymphocytes in 78 HIV-infected patients. The results differed markedly from normal seronegative controls (Table 4) because the mean percentage of CD4+CD7- was expanded in HIV-infected patients (33% ± 21%, P < .001). A hydrophobic sequence in the transmembrane region of CD7 shares similarities with fusion sequences in the transmembrane region of HIV-1 gp41. Thus, we studied a possible CD7 modulation induced by anti-HIV antibodies. Normal peripheral CD4+ lymphocytes were incubated for 1, 2, 6, 16, and 24 hours with serial dilutions of HIV-infected sera. Then, the mean fluorescence channel of anti-CD7 MoAb and the percentage of CD4+CD7-TL were analyzed. No induction of CD7-negative cells could be observed (data not shown).

Table 4. Characterization of CD4+/CD7- T Lymphocytes in HIV-Infected Patients

<table>
<thead>
<tr>
<th>No. of Patients</th>
<th>All HIV Patients</th>
<th>CD4 &gt; 400*</th>
<th>CD4 200-400</th>
<th>CD4 &lt; 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>17</td>
<td>23</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>33 ± 21</td>
<td>28 ± 17</td>
<td>23 ± 12</td>
<td>43 ± 22</td>
</tr>
<tr>
<td>P</td>
<td>&lt; .001 v NC</td>
<td>&gt; .05</td>
<td>&gt; .01</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Absolute no. (/mm³)</td>
<td>67 ± 49</td>
<td>142 ± 87</td>
<td>72 ± 51</td>
<td>31 ± 22</td>
</tr>
<tr>
<td>P</td>
<td>&lt; .001 v NC</td>
<td>&lt; .01</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

*Absolute number of CD4 lymphocytes/mm³.

†P observed v normal seronegative controls.

We also observed an expansion of peripheral blood CD4+ lymphocytes positive for the CD57 marker (Table 5). These cells represented 14% ± 15% of the CD4+ population (P < .001 v seronegative controls). The CD4+CD7- and CD4+CD57+ subsets were significantly linked as observed in 46 HIV-infected patients (Fig 2a, r = .90, P < .001). To test whether the CD4+CD7- cells could be the CD4+CD57+ cells, we performed a three-color staining in 18 HIV-infected patients and compared it with data obtained from seronegative normal PBL. Figure 3 shows typical results obtained in one HIV-infected patient after staining with anti-CD4, anti-CD7, and anti-CD57 MoAbs. When gating on CD4+ T cells, 60% are CD7- (Fig 3d) and 50% are CD57+ (Fig 3e). Moreover, 45% of the CD4+ cells are both CD7- and CD57+ (Fig 3f). Similar data were obtained in the 18 tested patients.

Therefore, in the overall 18 patients, we could subdivide the CD4+ lymphocyte population in HIV-infected patients in four subsets. The mean percentages in each subset for the 18 patients were: CD4+CD7-CD57+ cells (68% ± 22%), CD4+CD7-CD57- cells (3% ± 2%), CD4+CD7-CD57+ cells (19% ± 12%), CD4+CD7-CD57+ cells (9% ± 9%). Linear regression analysis (Fig 2b) showed that CD4+CD7-CD57- strongly correlated with CD4+CD7-CD57+ cells (r = .97, P < .001). These data demonstrate: (1) the expansion of the CD4+CD7- subset in the peripheral blood of HIV-infected patients and (2) the expression of the CD57 molecule on CD4+CD7- T PBL. Therefore, we can individualize, in
Results of the CD4\textsuperscript{+}CD7\textsuperscript{-}CD57\textsuperscript{+}TL evaluation are listed in Table 4. We subdivided HIV patients (n = 78) into three groups: (1) CD4\textsuperscript{+} cells > 400/mm\textsuperscript{3}, (2) 200 < CD4\textsuperscript{+} cells < 400/mm\textsuperscript{3}, (3) CD4\textsuperscript{+} cells < 200/mm\textsuperscript{3}. The mean percentages of CD4\textsuperscript{+}CD7\textsuperscript{-}TL were 43% ± 22%, 23% ± 12%, and 28% ± 17% in groups 3, 2, and 1, respectively. The results from each group differed from those observed in normal PBL (P < .001). Among HIV-infected patients, the percentages of CD4\textsuperscript{+}CD7\textsuperscript{-}TL were significantly increased in patients with CD4 < 200/mm\textsuperscript{3} if compared with data observed in the other two groups (P < .001). Furthermore, regression curve analysis (Fig 4) showed that, in 78 HIV-infected patients, the percentages of CD4\textsuperscript{+}CD7\textsuperscript{-}CD57\textsuperscript{+}TL correlated with the percentages (r = −.47, P < .001) and the absolute values of CD4\textsuperscript{+} T cells (r = −.49, P < .001).

In addition, we studied the absolute values of CD4\textsuperscript{+}CD7\textsuperscript{-}TL in each of the three groups (Table 3). Of note, CD4\textsuperscript{+}CD7\textsuperscript{-} TL were expanded when CD4 > 400/mm\textsuperscript{3} (142 ± 87/mm\textsuperscript{3} v 73 ± 25 in normal controls, P < .001). These data suggest that the expansion of the CD4\textsuperscript{+}CD7\textsuperscript{-} subset occurs at early stages of HIV infection but is proportionally increasing along with the depletion of the total CD4\textsuperscript{+} subset.

The correlation between the CD57 expression on CD4\textsuperscript{+} cells and the CD4\textsuperscript{+} cells number was also analyzed in two groups of HIV-infected patients (CD4 < 200, CD4 > 200/ mm\textsuperscript{3}). Results showed that the mean percentages observed when CD4 < 200 (20% ± 21%) significantly differed from results in patients with CD4 > 200 (8% ± 9%) and from normal controls (Table 4). However, the regression analysis showed no correlation between the CD4\textsuperscript{+}CD57\textsuperscript{+}TL and the decrease of CD4\textsuperscript{+} T cells (r = −.19, P > .10, data not shown), suggesting different kinetics between the nonexpression of CD7 and the detection of CD57 on CD4\textsuperscript{+} T cells. Finally, eight HIV-infected patients were evaluated to determine whether AZT therapy could influence the levels of CD4\textsuperscript{+}CD7\textsuperscript{-}CD57\textsuperscript{+} T cells. Chronicologic samples were tested: (1) before azidothymidine (AZT) therapy, (2) 2 or 4 months, (3) 6 or 8 months, and (4) 12 or 16 months after AZT introduction. No characteristic variation could be observed for these two cell subsets as well as for the CD8\textsuperscript{+}CD57\textsuperscript{+} T lymphocytes subset (data not shown).

Together, the study of the CD7 and CD57 expression on CD4\textsuperscript{+} lymphocytes from HIV-infected patients gave us two important results: (1) the levels of CD4\textsuperscript{+}CD7\textsuperscript{-}CD57\textsuperscript{+} T cells correlate with the depletion of the total CD4\textsuperscript{+} subset and (2) the CD4\textsuperscript{+}CD7\textsuperscript{-} subset is expanded at early stages of the HIV disease.

### DISCUSSION

The CD4\textsuperscript{+} T lymphocyte population remains one of the most important criteria to assess cellular immune deficiency in HIV-infected patients. This subset of T cells was already well documented for its expression of CDw29 and CD45 antigens.\textsuperscript{22} Previous studies suggested that the CD45RO\textsuperscript{+}CDw29\textsuperscript{+}CD4\textsuperscript{+} subset corresponded to memory CD4\textsuperscript{+} lymphocytes that could be preferentially infected by HIV and, consequently, the first CD4\textsuperscript{+} subset that decreases in peripheral blood.\textsuperscript{17} The major goals of our study were to point out the existence of two cell surface markers that could better characterize CD4\textsuperscript{+} lymphocytes during HIV infection, define a new subset abnormally present in such occasions, and provide new prognostic tools.

The CD7 antigen is the first specific marker of T-cell lineage and is expressed during all stages of T-cell differentiation.\textsuperscript{1} However, defective expression of CD7 on CD4\textsuperscript{+} T lymphocytes has already been reported. Indeed, normal CD4\textsuperscript{+} lymphocytes,\textsuperscript{13,21} various leukemic T cells\textsuperscript{13,21} (such as Sézary cells), and synovial CD4\textsuperscript{+} lymphocytes in rheumatoid arthritis\textsuperscript{22} lacking the CD7 molecule were described. Furthermore, a case of severe combined immunodeficiency with absence of CD7 on T cells has been reported.\textsuperscript{21} In Sézary cells, as in our experience on normal T cells, CD4\textsuperscript{+}CD7\textsuperscript{-}TL exclusively expressed CDw29 and lacked
CD4+CD7-CD57+ T CELLS IN HIV INFECTION

The CD7 modulation capacity has been reported. Mainly induced by anti-CD7 MoAbs, this phenomenon is reversible and results in an inhibition of T-cell proliferation. In our technical procedure, CD7 molecule did not modulate and the results of intracytoplasmic staining suggest that there was no CD7 internalization.

The functional role of CD7 remains unclear even if this molecule is supposed to be the T-lymphocyte receptor for IgM. In HIV infection, various antilymphocyte antibodies on CD4+ T cells have been reported. In such occasions, antilymphocyte IgM could bind to CD7 molecule and induce an epitope masking. To eliminate such a hypothesis, the lack of CD7 expression on CD4+ T lymphocytes was controlled by two distinct epitopes of CD7 and no modulation of CD7 antigen was induced by sera from HIV-infected patients.

Previous reports demonstrated that CD7 may function as an accessory activation molecule and that CD7 is a calcium-inducible gene transcribed in immediate stages of activation. Heinrich et al reported that inhibition of T-cell activation by anti-CD7 MoAb could be helpful in preventing transplant rejection episodes. In our experience, CD4+CD7-TL do not behave like helper T cells. The absence of proliferative responses at day 2 cannot be explained by cell death because significant responses are observed at day 5. Contrasting with a normal CD2 pathway, CD4+CD7-TL weakly respond to anti-CD3 MoAb even if associated with PMA. Interestingly, anti-CD28 MoAb, which delivers a costimulatory signal to T cells, restores the stimulation via CD3 as reported for naive T cells. Altogether, these data suggest that the lack of CD7 cell surface expression observed in normal individuals is not a manifestation of T-cell activation and emphasized the uncommon nature of CD4+CD7-TL that might correspond to memory cells with an abnormal CD3-TCR stimulation pathway.

Initially described as a marker of neurectodermal cells, the CD57 molecule may be related to neural cell adhesion molecule (NCAM) and myelin associated glycoprotein. Besides NK cells, CD57 is expressed on a subset of CD8 T lymphocytes, which are supposed to be CD8 suppressor T cells. CD8+CD57+ cells are expanded in various diseases including HIV disease and after allogeneic bone marrow transplantation. Interestingly, these CD8+CD57+ cells do express the CD7 antigen. More recently, Legendre et al characterized a subset of CD4+CD57+ large granular lymphocytes in renal allograft recipients. However, the CD7 expression was not studied. If compared with CD4+CD57-TL, these cells do not proliferate when stimulated with either lectins or allogeneic cells. Thus, CD57 identifies, in transplant recipients, a subset of CD4 cells that do not behave as previously defined helper cells.

In HIV-infected patients, both the CD4+CD7- and CD4+CD57+ T cells are increased. Our data clearly demon-
strated that the lack of CD7 is strongly correlated with CD57 acquisition on CD4 T cells.

To our knowledge, this is the first description of such a T-cell subset expanded as a function of time in HIV-infected patients. Moreover, the CD4+CD7- T cells acquire a prognostic value since correlating with absolute numbers of CD4+ lymphocytes. In contrast, because CD57 is detected only on a subset of the CD4+CD7-TL, its prognostic value remains lower. The low T-cell responsiveness to activation via CD3 observed even at early stages of HIV infection might be related to the expansion of CD4+CD7-TL.18-20 Our results emphasize that, besides quantitative defects, immune deficiency could also be explained by qualitative alterations of CD4+ lymphocytes. As previously suggested,10 the defective function of the CD4+ T cells may, in part, account for the imperfect correlation between cellular immunodeficiency and CD4+ T-cell depletion.

The appearance of CD4+CD7-CD57-TL that do not behave as previously defined helper cells raise three important questions: (1) are these cells the result of either a differentiation or activation disorder in T-cell lineage? (2) Are they the result of a selective process related to HIV infection? (3) Are the expression of an unexpected marker (CD57) and the lack of another (CD7) the consequences of an imbalance in cytokines production? These questions are currently under investigation.

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