Hematopoietic Stem Cell Transplantation
A Global Perspective

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Hematopoietic stem cell transplantation (HSCT) has become the standard of care for many patients with defined congenital or acquired disorders of the hematopoietic system or with chemosensitive, radiosensitive, or immunosensitive malignancies.1,2 Over the last 2 decades, HSCT has seen rapid expansion in use and a constant evolution in its technology. Novel indications are currently under evaluation.3,4 Bone marrow is supplemented as a stem cell source by peripheral blood or cord blood. More than 14 million typed volunteer donors or cord blood units from the many registries worldwide provide stem cells for patients without family donors. Novel conditioning regimens with lower intensity have expanded the use of HSCT to older patients and to those with comorbidities.5,6

Context  Hematopoietic stem cell transplantation (HSCT) requires significant infrastructure. Little is known about HSCT use and the factors associated with it on a global level.

Objectives  To determine current use of HSCT to assess differences in its application and to explore associations of macroeconomic factors with transplant rates on a global level.

Design, Setting, and Patients  Retrospective survey study of patients receiving allogeneic and autologous HSCTs for 2006 collected by 1327 centers in 71 participating countries of the Worldwide Network for Blood and Marrow Transplantation. The regional areas used herein are (1) the Americas (the corresponding World Health Organization regions are North and South America); (2) Asia (Southeast Asia and the Western Pacific Region, which includes Australia and New Zealand); (3) Europe (includes Turkey and Israel); and (4) the Eastern Mediterranean and Africa.

Main Outcome Measures  Transplant rates (number of HSCTs per 10 million inhabitants) by indication, donor type, and country; description of main differences in HSCT use; and macroeconomic factors of reporting countries associated with HSCT rates.

Results  There were 50 417 first HSCTs; 21 516 allogeneic (43%) and 28 901 autologous (57%). The median HSCT rates varied between regions and countries from 48.5 (range, 2.5-505.4) in the Americas, 184 (range, 0.6-488.5) in Asia, 268.9 (range, 5.7-792.1) in Europe, and 47.7 (range, 2.8-95.3) in the Eastern Mediterranean and Africa. No HSCTs were performed in countries with less than 300 000 inhabitants, smaller than 960 km², or having less than US $680 gross national income per capita. Use of allogeneic or autologous HSCT, unrelated or family donors for allogeneic HSCT, and proportions of disease indications varied significantly between countries and regions. In linear regression analyses, government health care expenditures (r² = 76.28), human development index (r² = 74.36), and gross national income per capita (r² = 74.04) showed the highest associations with HSCT rates.

Conclusion  Hematopoietic stem cell transplantation is used for a broad spectrum of indications worldwide, but most frequently in countries with higher gross national incomes, higher governmental health care expenditures, and higher team densities.
Still, HSCT remains associated with significant morbidity and mortality and represents one example of high-cost, highly specialized medicine. It requires significant infrastructure and a network of specialists from all fields of medicine. Hence, information on indications, use of specific technologies, and trends in the application of HSCT is essential for correct patient counseling and for health care agencies to prepare the necessary infrastructure and to avoid planning errors. In addition, HSCT is no longer limited to countries with abundant resources. For selected indications, HSCT might represent the most cost-effective therapy in some countries. An assessment of global HSCT activity is warranted.

In view of the increasing numbers of transplant teams and HSCTs worldwide and the increasing awareness of the need for a global perspective for all cell, tissue, and organ transplants by the World Health Organization, the recently founded Worldwide Network for Blood and Marrow Transplantation decided to collect standardized HSCT activity data on a global level. Results of the first worldwide HSCT survey are presented herein.

### METHODS

#### Study Design

This is a retrospective survey among all HSCT teams known to the investigators, which was organized by the Worldwide Network for Blood and Marrow Transplantation through established international and regional organizations. The study was approved by the ethics committee of the University of Basel; and the need for informed consent of patients was waived because no individualized data was transferred to the investigators.

The main outcome measures were the determination of transplant rates (number of HSCTs per 10 million inhabitants) by indication, donor type, and country on a global level. Secondary outcomes were the description of the main differences in HSCT use and the key macroeconomic factors of the reporting countries and regions associated with their transplant rates.

#### Participating Groups, Continents, Countries, and Teams

There were 1327 teams in 71 reporting countries over 5 continents (see eTable at http://www.jama.com) that provided information on numbers of HSCT for 2006 by indication and donor type (Table 1). They were subdivided into 4 regions: (1) the Americas (the corresponding World Health Organization regions are North and South America), (2) Asia (Southeast Asia and the Western Pacific Region, which includes Australia and New Zealand), (3) Europe (which includes Tur-
key and Israel), and (4) the Eastern Mediterranean and Africa.

Data were provided by the Asian Pacific Blood and Marrow Transplant Group, the Australian Bone Marrow Transplant Recipient Registry, the Canadian Blood and Marrow Transplant Group, the Center for International Blood and Marrow Transplantation, the Sociedade Brasileira de Transplante de Medula Ossea, the Eastern Mediterranean Blood and Marrow Transplant Group, and the European Group for Blood and Marrow Transplantation (see eTable at http://www.jama.com).17-20

Collection System and Data Validation
Data were obtained from mandatory reporting systems of initial transplant data (Australian Bone Marrow Transplant Recipient Registry, Canadian Blood and Marrow Transplant Group, and Center for International Blood and Marrow Transplantation) or collected on separate survey data forms from individual centers or national registries (Asian Pacific Blood and Marrow Transplant Group, European Group for Blood and Marrow Transplantation, Eastern Mediterranean Blood and Marrow Transplant Group, and Sociedade Brasileira de Transplante de Medula Ossea).

Data were validated by several independent methods. The data were first confirmed by the reporting team, which received a computer printout of the entered data. Selective comparison also was used with Med-A data sets in the European Group for Blood and Marrow Transplantation Promise data system or by cross-checking with national registries. Onsite visits of selected teams were part of the quality-control program within the Center for International Blood and Marrow Transplantation and the European Group for Blood and Marrow Transplantation.

Based on quality controls and contacts with regulatory agencies or national offices, response rates of allogeneic HSCT was greater than 95% in Australia, Brazil, Canada, Europe, Japan, Korea, Malaysia, New Zealand, Taiwan, and the United States. No formal response rate can be evaluated for the other participating countries; there is no formal regulatory framework for cross-confirmation. Concerning autologous HSCT, the response rate in Europe was greater than 90% and it can be estimated to be between 80% and 90% for Australia, Brazil, Canada, Europe, Japan, Korea, Malaysia, New Zealand, Taiwan, and the United States. For autologous HSCT, no formal framework exists to capture nonreporting teams and to validate response rates with accuracy.

Definitions
This Worldwide Network for Blood and Marrow Transplantation survey focused on the numbers of patients treated for the first time with HSCT in 2006. Information on additional transplants (eg, retransplants or multiple HSCTs) was not included.

Transplant rates were computed as the number of HSCTs per 10 million inhabitants.21 Transplant rates refer to the number of transplants in a given country compared with its own population, without adjustments for patients who cross borders and receive a HSCT in a foreign country. Population data were obtained from the US Census office.

Team density refers to the number of transplant teams per 1 million inhabitants.22 The definition of a team followed the principles of the Foundation for the Accreditation of Cellular Therapy and the Joint Accreditation Committee of the International Society for Cellular Therapy and the European Group for Blood and Marrow Transplantation.

Transplant rates within the reporting participating countries were compared with a range of macroeconomic health care indicators: gross national income per capita; total health care expenditures; governmental health care expenditures; adult, infant and maternal mortality rate; number of hospital beds per capita; cesarean delivery rates; human developmental index, which is a composite index reflecting the developmental status of all countries in the world in a scale from 0 to 1.0; and team density, which indicates the number of transplant teams per 1 million inhabitants. Data were obtained from the World Bank, the World Health Organization, and the United Nations. Data from 2006 were used for all comparisons whenever possible.

Statistical Analysis
The association of the macroeconomic factors with HSCT rates was estimated by single linear and multiple linear regression analysis, using the least squares method. The linear relationship, positive or negative, between the macroeconomic factors and HSCT rates after transformation was measured using the t statistic; a level of 5% was considered significant. The goodness of fit was measured using the coefficient of determination (r²). For the single and multiple linear regression analyses, the dependent variables were transformed to point out the linear associations. In the multiple regression analyses, all factors were assessed for their multicollinearity. Taiwan and Hong Kong were excluded from the multiple economic comparisons because of missing information on governmental health care expenditures. Cesarean delivery rates were included in the single linear analyses but not the multiple regression analyses, because data from too many countries were missing.

The t test was used to evaluate if the 4 world regions had a significant difference in the relative proportion of main indications and donor type (allogeneic vs autologous, unrelated vs family donors); P = .05 was considered significant. All statistical analyses were performed with EViews version 5.1 (Quantitative Micro Software, Irvine, California).

RESULTS
A total 50 417 first HSCTs were reported for 2006; 21 516 allogeneic (43%) and 28 901 autologous (57%) (Table 1). The main indications were lymphoproliferative disorders (27 492
patients [54.5%]; 3502 allogeneic [13%] and 23,990 autologous [87%]); leuke-
mias (17,049 patients [33.8%]; 15,210 allogeneic [89%] and 1839 autolo-
gous [11%]); solid tumors (2925 pa-
tients [5.8%]; 153 allogeneic [5%] and 2772 autologous [95%]); nonmalign-
ant disorders (2593 patients [5.1%]; 2396 allogeneic [92%] and 197 autolo-\ngous [8%]), and other nonspecified dis-
orders (358 patients; 1%).

The most frequent malignant dis-
ease for an allogeneic HSCT was acute
myeloid leukemia (n = 7026; 33%), the
most frequent nonmalignant disease
was bone marrow failure syndrome
(n = 1336; 6%), and the most frequent
indication for an autologous HSCT was
a plasma cell disorder (n = 11,877; 41%).

Most of the 50,417 HSCTs were per-
formed in Europe with 24,216 (48%) (median [range], 255 [6-4619] per
country) followed by the Americas with
17,875 (36%) (median [range], 61 [8-15
082] per country), Asia with 7096
(14%) (median [range], 139 [5-3823]
per country), and the Eastern Mediterr-
anean and Africa with 1230 (2%) (me-
dian [range], 63 [10-360] per coun-
try). The absolute numbers of HSCTs
in the participating countries ranged
from 15,082 in the United States to 5
in Vietnam.

**Transplant Rates in 2006**
The median HSCT rates varied be-
tween the continental regions and be-
tween participating countries from 48.5
(range, 2.5-505.4) in the Americas, 184
(range, 0.6-488.5) in Asia, 268.9 (range,
5.7-792.1) in Europe, and 47.7 (range,
2.8-95.3) in the Eastern Mediterranean
and Africa (Figure 1). Transplant rates
for allogeneic HSCT ranged from 434.9
in Israel to 0.2 in Vietnam. Transplant
rates for autologous HSCT ranged from
500 in Iceland to 0.3 in Mexico.

**Regional Differences in Donor Type
and Main Indications**
Overall, there were more autologous
HSCTs (n = 28,901; 57%) than alloge-
neic HSCTs (n = 21,516; 43%)
(TABLE 2). Most of the autologous
HSCTs occurred in the Americas and
Europe. In other regions, allogeneic
HSCTs were more common (Asia:
57.2%; the Eastern Mediterranean and Africa: 65.3%). The differences in the prevalences of allogeneic HSCTs and the proportions of unrelated donor HSCTs are presented in Table 3. The proportion of unrelated donor HSCT was highest in Asia (52%), but it was negligible in the Eastern Mediterranean and Africa (1%).

Leukemia was the main indication for allogeneic HSCT globally (71% overall; the Americas, 68%; Asia, 77%; Europe, 71%; Eastern Mediterranean and Africa, 61%). Nonmalignant diseases comprised about 11% in the Americas, Asia, and Europe and 34% in the Eastern Mediterranean and Africa (see Table 2). Lymphoma was the most common indication for autologous HSCT (79%) in the Eastern Mediterranean and Africa. Plasma cell disorders were the most common indications for autologous HSCT in the Americas and Europe. Compared with Asia, among individuals in the Eastern Mediterranean and Africa there were more allogeneic HSCTs for chronic myelogenous leukemia (28% vs 7%), respectively and hemoglobinopathies (26% vs 11%).

**Transplant Rates and Macroeconomic Factors**

No HSCTs were performed in countries with less than 300,000 inhabitants, smaller than 960 km², or having less than US $680 gross national income per capita. All macroeconomic factors had a significant positive or negative association with transplant rates in single regression analyses with a widely variable explanatory content: gross national income per capita ($r^2 = 74.04$); total health care expenditures ($r^2 = 73.41$); governmental health care expenditures ($r^2 = 77.33$) (Figure 2A and interactive graphs at http://www.jama.com); adult ($r^2 = 49.03$), infant ($r^2 = 66.31$), and maternal ($r^2 = 63.21$) mortality rates; hospital beds ($r^2 = 32.04$); cesarean section rates ($r^2 = 30.56$); and team density ($r^2 = 76.28$) (Figure 2B); and human developmental index ($r^2 = 74.36$) (Figure 2C).

The first factor in the multiple linear regression analysis, government health care expenditure (GOV), explained 77.33% of the variance of the

### Table 2. Allogeneic and Autologous Hematopoietic Stem Cell Transplants by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Allogeneic Donor</th>
<th>Autologous Donor</th>
<th>Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americas (n = 17,875)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asia (n = 7,096)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe (n = 24,216)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Mediterranean and Africa (n = 1,230)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (N = 50,417)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indication</th>
<th>Americas</th>
<th>Asia</th>
<th>Europe</th>
<th>Eastern Mediterranean and Africa</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukemia</td>
<td>7527 (42.1)</td>
<td>4058 (57.2)</td>
<td>9128 (37.7)</td>
<td>803 (65.3)</td>
<td>21,516 (42.7)</td>
</tr>
<tr>
<td>Lymphoproliferative disorders</td>
<td>1466 (19.0)</td>
<td>429 (10.6)</td>
<td>1579 (17.3)</td>
<td>28 (3.5)</td>
<td>3,502 (16.3)</td>
</tr>
<tr>
<td>Solid tumors</td>
<td>32 (&lt;1.0)</td>
<td>37 (1.0)</td>
<td>83 (1.0)</td>
<td>1 (&lt;1.0)</td>
<td>153 (&lt;1.0)</td>
</tr>
<tr>
<td>Nonmalignant disorders</td>
<td>755 (10.0)</td>
<td>418 (10.3)</td>
<td>946 (10.4)</td>
<td>277 (34.5)</td>
<td>2,396 (11.1)</td>
</tr>
<tr>
<td>Other</td>
<td>118 (2.0)</td>
<td>55 (1.4)</td>
<td>77 (1.0)</td>
<td>5 (&lt;1.0)</td>
<td>255 (1.2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indication</th>
<th>Americas</th>
<th>Asia</th>
<th>Europe</th>
<th>Eastern Mediterranean and Africa</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukemia</td>
<td>10,348 (57.9)</td>
<td>3,038 (42.8)</td>
<td>15,088 (62.3)</td>
<td>427 (34.7)</td>
<td>28,901 (57.3)</td>
</tr>
<tr>
<td>Lymphoproliferative disorders</td>
<td>8,936 (86.4)</td>
<td>2,380 (78.3)</td>
<td>12,336 (81.8)</td>
<td>338 (79.2)</td>
<td>23,990 (83.0)</td>
</tr>
<tr>
<td>Solid tumors</td>
<td>895 (8.6)</td>
<td>389 (12.8)</td>
<td>1,459 (9.7)</td>
<td>29 (6.8)</td>
<td>2,772 (9.6)</td>
</tr>
<tr>
<td>Nonmalignant disorders</td>
<td>49 (&lt;1.0)</td>
<td>23 (1.0)</td>
<td>123 (1.0)</td>
<td>2 (&lt;1.0)</td>
<td>197 (1.0)</td>
</tr>
<tr>
<td>Other</td>
<td>25 (&lt;1.0)</td>
<td>44 (1.4)</td>
<td>34 (&lt;1.0)</td>
<td>0</td>
<td>103 (&lt;1.0)</td>
</tr>
</tbody>
</table>

### Table 3. Allogeneic and Unrelated Donor Hematopoietic Stem Cell Transplantations (HSCTs)

<table>
<thead>
<tr>
<th>Region</th>
<th>Comparison</th>
<th>Allogeneic HSCT, %</th>
<th>Test Statistic</th>
<th>Critical Value at 5% Level</th>
<th>Degrees of Freedom</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>vs Americas</td>
<td>42</td>
<td>3.34</td>
<td>2.16</td>
<td>13</td>
<td>.005</td>
</tr>
<tr>
<td>vs Europe</td>
<td>38</td>
<td>4.24</td>
<td>2.20</td>
<td>12</td>
<td>12</td>
<td>.001</td>
</tr>
<tr>
<td>Americas</td>
<td>vs Eastern Mediterranean and Africa</td>
<td>65</td>
<td>-4.21</td>
<td>2.23</td>
<td>11</td>
<td>.002</td>
</tr>
<tr>
<td>vs Europe</td>
<td>38</td>
<td>1.66</td>
<td>2.10</td>
<td>18</td>
<td>12</td>
<td>.11</td>
</tr>
<tr>
<td>Europe</td>
<td>vs Eastern Mediterranean and Africa</td>
<td>65</td>
<td>-4.96</td>
<td>2.23</td>
<td>10</td>
<td>.001</td>
</tr>
<tr>
<td>Eastern Mediterranean and Africa</td>
<td>vs Family vs Unrelated Donor</td>
<td>99</td>
<td>-10.00</td>
<td>2.23</td>
<td>11</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>vs Asia</td>
<td>57</td>
<td>-8.40</td>
<td>2.20</td>
<td>12</td>
<td>12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>vs Europe</td>
<td>54</td>
<td>-13.31</td>
<td>2.02</td>
<td>17</td>
<td>12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Americas</td>
<td>vs Asia</td>
<td>57</td>
<td>-8.40</td>
<td>2.20</td>
<td>12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>vs Europe</td>
<td>54</td>
<td>0.15</td>
<td>2.11</td>
<td>17</td>
<td>17</td>
<td>.88</td>
</tr>
<tr>
<td>Asia</td>
<td>vs Europe</td>
<td>48</td>
<td>-0.885</td>
<td>2.13</td>
<td>15</td>
<td>.39</td>
</tr>
</tbody>
</table>

Values are expressed as number (column percentage of total and within subgroup). Percentages may not equal 100% due to rounding.

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(Reprinted) JAMA, April 28, 2010—Vol 303, No. 16 1621

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HSCT rates. The second factor, team density (TD), increased $R^2$ to 79.83%, and the third factor, gross national income (GNI) per capita, added another 4.41% of explanation. All other factors, including the human development index, became insignificant, mainly due to multicollinearity with gross national income per capita, meaning that several factors did correlate highly with each other. Therefore, the equation of the multiple regressions was

$$\sqrt{\text{TR}} = c_1 \sqrt{\text{GOV}} + c_2 \ln(\text{TD}) + c_3 \ln(\text{GNI}) + \epsilon$$

Hence, the combined explanatory content was $R^2 = 84.24$.

**COMMENT**

This first report by the Worldwide Network for Blood and Marrow Transplantation documents the current state of HSCT on a global level. It describes the achievements, illustrates the major differences, and points to the key needs. Transplant activity is concentrated in countries with higher governmental health care expenditures, higher gross national income per capita, and higher team density. Hence, availability of resources, governmental support, and access to a transplant center are the key factors related to regional HSCT activity. However, disease prevalence can differ between regions and could contribute to differences in HSCT rates; those data were not included in this report.

The close link of HSCT rates with gross national income per capita was recognized many years ago; HSCT is an expensive procedure with a substantial investment for a single patient. No HSCTs were performed in countries with less than US $700 gross national income per capita. However, gross national income per capita explained only parts of the variations. Therefore, we were specifically interested in other macroeconomic factors associated with HSCT rates. These factors were chosen with intention. They were either directly linked to availability of resources (gross national income per capita, health care expenditures), to governmental support (governmental health care expenditures), or to the overall infrastructure in a country (human development index). Others reflect quality measures of the health care system (mortality rates) or indicate potential overuse of the health care system (hospital beds, cesarean delivery). Of all macroeconomic factors, this study identified governmental health care expenditures as the most closely associated factor with HSCT rates.

Our study could not assess the role of the health care system in the participating countries because there is no globally accepted definition available. Definitive explanations cannot be given, but some assumptions can be made. The cost-effectiveness of HSCT compared with conventional treatment has at least recently been discussed for patients with chronic myeloid leukemia in middle-income countries. Transplant rates were strongly associated with team density. There was no indication for saturation in this association. Hence, a minimum number of transplant teams per inhabitants must be available so that patients have sufficient access. It does not appear that transplant teams overuse their infrastructure.

None of the other traditional health care indicators or the composite human development index provided a higher explanatory content or added information in the multiple regression analyses. There were significant differences between the regions concerning indications and donor type, with fewer autologous HSCTs in Asia and the Eastern Mediterranean and Africa than in the Americas and Europe. There were more unrelated donors for HSCTs in the Americas, Asia, and Europe than in the Eastern Mediterranean and Africa; the highest proportion of unrelated donors for HSCTs was in Japan. There also were more HLA identical sibling donors for congenital disorders or...
for aplastic anemia in countries with limited resources. A matched sibling don-
nor HSCT might represent the most ef-
cient way of therapy for a patient with
aplastic anemia, thalassemia, or se-
vere combined immunodeficiency in
a country with some but still limited re-
sources. No induction, consolidation
chemotherapy is needed as would be
the case for patients with acute leukemi-
a.23

There are some limitations of this
study that warrant caution in inter-
pretation. The organizations collecting
the data had neither legal enforcement to
obtain nor the possibility to control all
data locally for accuracy and complete-
ness. Cross-checks with national orga-
nizations indicate that the report cov-
ered nearly 100% of all HSCTs within
their country. A few countries choose
to not report any data. Most missing in-
formation relates to numbers of autolo-
gous HSCTs because they are per-
formed in some countries outside of the
realm of national transplant organiza-
tions and in nonuniversity institu-
tions. Despite these limitations, the
main observations of this study regard-
ing the main indications, donor type,
transplant rates, and associations with
macroeconomic factors should re-
main valid. Finally, we had neither
information on outcome of the trans-
plant procedures nor on correctness of
the indication; this is beyond the scope
of this study and would require a much
longer follow-up time.24

This study was in part triggered by
the increasing awareness by scientific
and health care organizations, includ-
ing the World Health Organization, to
address key aspects of cell, tissue, and
organ transplantation on a global level.
In contrast to solid organ transplanta-
tion, HSCT faces limitations other than
donor organ shortage.25 Patients are in
need of a closely matched donor, fam-
ily or unrelated donor, but there are
many unrelated donor registries and
public cord blood banks throughout the
world. In 2008, there were, for the first
time, more unrelated donor HSCTs than
family donor HSCTs reported to the Eu-
ropean survey and more unrelated
HSCTs across than within borders. In
addition to traditional HSCT, novel
transplant procedures with hematopoietic
stem cells for nonhematopoietic use or
transplantation of nonhematopoietic
stem cells for organ and tissue repair
are under investigation.26–29 The chal-
enges with these new forms of therapy
have recently been addressed; stem cell
tourism has become a topic of con-
cern.30 Information on the current sta-
tus of HSCT use has become a neces-
sity for correct patient counseling and
health care planning.

In conclusion, this global overview
on HSCT activity demonstrates that it
is an accepted therapy worldwide, with
different needs and priorities in differ-
ent regions. Transplant activity is con-
centrated in countries with higher
health care expenditures, higher gross
national income per capita, and higher
team density; hence, the availability
of resources, governmental support, and
access to a transplant center deter-
mine regional HSCT activity.

Author Contributions: Dr. A. Gratwohl had full ac-
cess to all of the data in the study and takes respon-
sibility for the integrity of the data and the accuracy
of the data analysis.

Study concept and design: A. Gratwohl, Bouzas,
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Analysis and interpretation of data: A. Gratwohl,
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M. Gratwohl, Frauendorfer, Niederwieser, Horowitz,
Kodera.

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Critical revision of the manuscript for important in-
tellectual content: Baldomero, Aljurf, Bouzas, Yoshimi,
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Statistical analysis: Pasquini, Bouzas, Yoshimi,
Schwendener, M. Gratwohl, Frauendorfer, Kodera.

Omitted funding: A. Gratwohl, Pasquini, Bouzas,
Yoshimi, Horowitz, Kodera.

Administrative, technical, or material support: Baldomero,
Aljurf, Pasquini, Bouzas, Yoshimi, Niederwieser,
Kodera.

Study supervision: A. Gratwohl, Pasquini, Bouzas,
Yoshimi, Lipton, Kodera.

Financial Disclosures: None reported.

Funding/Support: This work was supported in part by
grant LSH-2002-2.2.0-3 from the European Leukae-
mia Net, by grant 320908-118176 from the Swiss Na-
tional Research Foundation, the Swiss Cancer League,
the Regional Cancer League, and the Horton Foun-
dation. The Center for International Blood and Mar-
row Transplantation is supported by public health ser-
vice grant/cooperative agreement U24-CA76518 from the
National Cancer Institute, the National Heart, Lung,
and Blood Institute, and the National Institute of Al-
lengy and Infectious Diseases. The Center for Interna-
tional Blood and Marrow Transplantation has received
cooperative agreement 5U01HL069294 from the National
Heart, Lung, and Blood Institute and the National Cancer In-
stitute; by contract HHS124200637015C with the Health-
care Resources and Services Administration; and by
grants N00014-06-1-0704 and N00014-08-1-0058 from the
Office of Naval Research; and by grants from AABB,
Aetna, the American Society for Blood and Marrow
Transplantation, Amgen Inc, the Match Founda-
tion to the Medical College of Wisconsin, Astellas
Pharma US Inc, Baxter International Inc, Bayer Health-
Care Pharmaceuticals, Be the Match Foundation, Bio-
gene iDEC, BioMarin Pharmaceutical Inc, Biovitrum AB,
Blood Center of Wisconsin, Blue Cross and Blue Shield
Association, Bone Marrow Foundation, Canadian Blood
and Marrow Transplant Group, CardiainBCT, Cel-
gene Corporation, CellGenics Gmbh, Centers for Dis-
ease Control and Prevention, Children’s Leukemia Re-
search Association, ClinImmune Labs, CTI Clinical Trial
and Consulting Services, Cubist Pharmaceuticals, Cy-
lex Inc, CytoTher, DOR BioPharma Inc, Dynal Bio-
tech (an Invitrogen company), Eisai Inc, Enzon Phar-
maceuticals Inc, the European Group for Blood and
Marrow Transplantation, Gamida Cell Ltd, GE Health-
care, Genentech Inc, Genzyme Corporation, Histo-
geneics Inc, HKS Medical Information Systems, Hospira
Inc, Infectious Diseases Society of America, Kiadis
Pharma, Kirin Brewery Co Ltd, the Leukemia & Lym-
phoma Society, Merck & Company, the Medical Col-
lege of Wisconsin, MGI Pharmaceuticals Inc, Millen-
ium Blood Centers, Millennium Pharmaceuticals Inc,
Müller Pharmacal Group, Milliman USA Inc, Miltenyi
Biotec Inc, National Marrow Donor Program, Nature
Publishing Group, New York Blood Center, Novartis
Oncology, Oncology Nursing Society, Osiris Thera-
peutics Inc, Osaka America Pharmaceutical Inc, Pall
Life Sciences, Pfizer Inc, Salidax Biomedical Inc,
Scherger Corporation, Society for Healthcare Epide-
miology of America, StemCyte Inc, StemSoft Soft-
ware Inc, Symyx America Inc, Teva Pharmaceutical
Industries, THERAKOS Inc, Thermogenesis Corpora-
tion, Vidacare Corporation, Vitexus Inc, ViraCor Laborato-
ries, Viropharma Inc, and Wellpoint Inc. The European
Group for Blood and Marrow Transplantation is sup-
ported by grants from the corporate members Amgen Europe, Viropharma Europe, G1-
leads Sciences UK, Miltenyi Biotec GmbH, Schering-
Plough, Celegene International SARL, Genzyme, Fre-
senius Biotech GmbH, Therakos, Bristol-Myers Squibb,
Cephalon, F. Hoffmann-La Roche Ltd, Pierre Fabre Mé-
dicament, Alexion Europe, Pfizer, Merck Sharp and
Dohme, Chugai Sanofi-Aventis, and Novartis.

Role of the Sponsor: The funding organizations and
sponsors of the organizations had no role in the design
and conduct of the study; collection, management,
analysis, and interpretation of the data; and prepara-
tion, review, or approval of the manuscript. Funding sup-
port from corporate members was solely for keeping the
infrastructure of the organizations and no pay-
ment was made to any of the persons involved in the
study by the sponsors or organizations.

Disclaimer: The views expressed in this article do not
reflect the official policy or position of the National
Institute of Health, the Department of the Navy, the
Department of Defense, or any other agency of the
US government.

Online-Only Material: ETable and interactive graphs
are available at http://www.jama.com.

Additional Contributions: We greatly appreciate
the cooperation of all participating teams, countries,
and organizations and their staff (see ETable); specifi-
cally, the following: the Australian Bone Marrow Trans-
plant Recipient Registry; the Asian Pacific Blood and
Marrow Transplant Group (Minako Iida, MD, PhD);
Aichi Medical School; the Canadian Blood and Mar-
row Transplant Group; the Center for International
Blood and Marrow Transplantation (Kathy Sobocin-
ski, MS, and Wensheng He, MS); the Medical Col-
lege of Wisconsin; European Group for Blood and
Marrow Transplantation coordination offices in Barcelona,
Spain, Paris, France, and London, England; the Aus-

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(Reprinted) JAMA, April 28, 2010—Vol 303, No. 16 1623
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3. Ljungman P, Urbano-Ispizua A, Cavazzana-Calvo M, et al; European Group for Blood and Marrow Transplantation Registry; the Swiss Registry; the Turkish Bone Marrow Transplantation Registry; and the British Registry. We also thank Susanna Stöckli (University Hospital Basel) for excellent secretarial assistance.

17. Kedera Y. The Japan Marrow Donor Program, the Japanese Registry; and the British Registry. We also thank Susanna Stöckli (University Hospital Basel) for excellent secretarial assistance.

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