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REVIEW ARTICLE

Efforts of the United States' National Marrow Donor Program and Registry to improve utilization and representation of minority donors

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SUMMARY. Haematopoietic stem cell transplantation is often used as a therapy for patients with certain blood, metabolic or immune system disorders. The United States' National Marrow Donor Program (NMDP) works to facilitate such life-saving transplants by coordinating the donor search and match process. However, concern exists that the NMDP Registry is underutilized and under-representative of racial and ethnic minorities. African-Americans and Hispanics are somewhat under-represented within the total number of donors, and it is estimated that the Registry is used by only approximately one-third of patients needing transplants. The NMDP has instituted programmes that address such concerns, resulting in an increase in both the total number of donors and the minority representation on the Registry. It has also increased efforts to recruit donors of umbilical cord blood, often a viable alternative source of haematopoietic stem cells. Over the past 8 years, the Registry has grown by more than 30% to contain over seven million donors, and the proportional distribution of racial and ethnic groups on the Registry has steadily approached their proportional distribution in the US population. Continued efforts on the part of the NMDP to maintain a Registry that is large in number and ethnically diverse should help ensure access to haematopoietic stem cell transplants for all patients who need them. The procedures and experience of the NMDP and its Registry may have implications for registries elsewhere in the world as they confront similar issues of number and diversity.

Key words: National Marrow Donor Program, Registry, transplant, underutilization, under-representation.

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Haematopoietic stem cell transplantation

Since the first bone marrow transplant in 1968, survival of patients who undergo haematopoietic stem cell transplantation has improved dramatically (NMDP, 2006a). Transplants of bone marrow, peripheral blood stem cell (PBSC) and umbilical cord blood (UCB), all sources of haematopoietic stem cells, can be life-saving therapies for patients diagnosed with leukaemia or other blood, metabolic or immune system disorders that are aggressively treated with chemotherapy and/or radiation (Kumar, 2007). A large majority of patients requiring haematopoietic stem cell transplants are not candidates for autologous transplants and do not have a genetically identical individual donor from whom to receive the cells

(NMDP, 2004). They therefore receive cells from genetically similar (related or non-related) individuals, referred to as an allogeneic transplant.

Allogeneic donation and transplantation procedures vary depending on the source of the haematopoietic stem cells. Bone marrow is harvested from a matching donor by drawing the marrow out of the pelvic bone or sternum; PBSCs are collected by apheresis following stimulated production of the cells in the donor and UCB is collected from the umbilical cord and placenta of a newborn after delivery is complete. Prior to receiving donated haematopoietic stem cells, recipients undergo myeloablative regimens to destroy all cancer cells and abnormal marrow (Aschan, 2006; NMDP, 2006b). Non-myeloablative and reduced-intensity regimens are sometimes effective as well and have increased the number of patients who can receive transplants because those who could not tolerate a myeloablative regimen may be better able to tolerate the lower toxicity associated with a non-myeloablative regimen (Aschan, 2006; NMDP, 2006c). Donor stem cells are infused into the recipient and engraftment occurs 2 to 4 weeks later, depending on the source of the stem cells (National Cancer Institute, 2004). The transplanted stem cells often cause a graft-vs-tumour effect in which the new stem cells recognize any remaining cancer cells as foreign and attack them (National Cancer Institute, 2004; Holler, 2007).

HLA matching

A specific donor is chosen for each transplant recipient based on the degree of human leukocyte antigen (HLA) matching. It is recommended that DNA-based testing be used to type the patient at high resolution at four HLA sites, HLA-A, HLA-B, HLA-C and HLA-DRB1 (Hurley *et al.*, 2003; NMDP, 2006d; Petersdorf, 2007). Both related and unrelated donors should match at no less than five of six HLA antigens at HLA-A, HLA-B and HLA-DRB1 for bone marrow and PBSC transplants, and at no less than four of six HLA antigens for UCB transplants (Hurley *et al.*, 2003; NMDP, 2006d, e). Clinical data suggest that additional matches may improve outcome (Hurley *et al.*, 2003). In all transplants, the recipient is at risk of developing graft-versus-host disease (GVHD), a potentially fatal complication in which donor T cells attack tissues of the recipient (National Cancer Institute, 2004; Holler, 2007). The risk of GVHD increases as the number of HLA mismatches increase (Petersdorf, 2007).

Sources of haematopoietic stem cells

The selection of a stem cell source is based on both patient-specific and disease-specific factors (NMDP, 2006f; Kumar, 2007; Urbano-Ispizua, 2007). Bone marrow is the most common stem cell source for patients under 20 years of age (NMDP, 2006f; Kumar, 2007). Time to engraftment is somewhat slower in bone marrow transplants than in PBSC transplants, but the risk of GVHD is lower. PBSC transplants have better outcomes in adults than in children and are now the most common stem cell choice for patients over 20 years of age (Kumar, 2007). The donor collection procedure is easier, but the risk of GVHD is higher with PBSC transplants than with bone marrow (NMDP, 2006f; Kumar, 2007). UCB transplants are becoming common in patients under 20 years of age. Matching requirements are less restrictive in UCB transplants (Goldstein *et al.*, 2007), and because cryopreserved UCB units are readily available in cord blood banks, UCB transplants can be performed more quickly. UCB transplants are associated with reduced GVHD risk; however, time to engraftment is slower, and the small volume of blood yields fewer cells for transplantation (Urbano-Ispizua, 2007). Therefore, UCB transplants are most commonly used in paediatric patients (NMDP 2006g; Kumar, 2007).

In the United States, the National Marrow Donor Program (NMDP) Registry, officially named the C.W. Bill Young Cell Transplantation Program, exists to help patients and physicians find an appropriate donor when no related donor is available. However, concerns exist that the Registry is underutilized, in part because it fails to proportionally represent ethnic minorities in its donor population. Much of the public is uninformed about the benefits of transplantation and therefore is not aware of the need for donors. There are also misconceptions that donation is risky and painful, decreasing the pool of available donors. This report reviews the NMDP and its efforts to recruit potential donors of bone marrow, PBSCs and UCB. It also addresses barriers to donation and strategies to increase the minority donor pool.

METHODS

Literature searches were conducted in the PubMed database for English-language articles published between 1997 and 2008 using the search terms 'haematopoietic stem cell transplantation', 'marrow donor', 'National Marrow Donor Program' and 'cord blood donation', in combination with the terms 'minority' and 'under-representation'. Additionally, substantial information was collected from two comprehensive reviews. The first is the 2004 Biennial Report of the National Bone Marrow Donor Registry and the second is a review of the NMDP by the U.S. General Accounting Office (GAO). Web sites of the

NMDP and other private donor registries were consulted, and personal communication with NMDP representatives provided updated statistics and programme information.

RESULTS

The National Marrow Donor Program and Registry

The NMDP, a non-profit organization established in 1986 (NMDP, 2004), operates the NMDP Registry (Registry), the world's largest unrelated donor haematopoietic stem cell registry, under a contract with the U.S. Department of Health and Human Services (HHS) and the Health Resources and Services Administration, with additional support from the U.S. Navy (U.S. General Accounting Office, 2002; NMDP, 2004). The operating costs of the NMDP are greater than $160 million (U.S.) per year. The HHS and the Navy provide approximately 22% of the NMDP budget each year, with programme revenue and private sources providing the rest (U.S. General Accounting Office, 2002; NMDP, 2004). Since its establishment through 2007, the NMDP has facilitated more than 30 000 transplants (NMDP, 2007a). The NMDP coordinates transplants by managing a network of more than 450 affiliated organizations that include donor, apheresis, collection and transplant centres, recruitment groups, cord blood banks, DNA typing and phenotyping laboratories, and sample repositories (U.S. General Accounting Office, 2002; NMDP, 2004, 2006g). As of 2004, more than 70 of these affiliated organizations were located internationally (NMDP, 2004, 2006g). The Registry currently contains more than seven million potential donors, the majority of whom (i.e. those who joined after 2001) are fully typed for HLA-A, HLA-B and HLA-DRB1, whereas a small percentage (i.e. those who joined in 2001 or before) are typed for HLA-A and HLA-B (NMDP, 2004; T. Walker, NMDP, personal communication).

The total number of donors on the Registry has grown by more than 30% during the past 8 years, and in the first 5 years of UCB collection, more than 40 000 units were obtained (NMDP, 2006a). Donor centres and recruitment groups work locally with civic, community, faith-based, and corporate organizations to raise awareness and recruit donors, and often conduct a total of more than 800 drives each month in the United States (NMDP, 2004). Additionally, with the help of a donor centre, families and communities can organize recruitment drives, typically intended to find a donor for a specific patient. Those recruited donors become part of the Registry (NMDP, 2004). Volunteer donors are eligible to join the Registry at age 18 years and can remain on it until age 61 years, although they may request to be removed before that age. Donors will also be removed before 61 years of age if they develop a health condition that confers an unacceptable risk to a potential recipient or to themselves (were they to donate) (U.S. General Accounting Office, 2002; NMDP, 2004). The NMDP charges donors a fee of $52 (U.S.) to cover initial tissue typing (NMDP, 2006h). In most cases, this fee is paid by matching funds raised by the NMDP, private sources, or the federal government. There is no tissue typing charge assessed to racial and ethnic minority donors. If a donor matches a patient in need of a transplant, there is no cost to the donor for the additional testing and donation procedures (U.S. General Accounting Office, 2002). Donation of UCB is generally an option given to pregnant women over age 18 years and in good health. There is no cost to donate UCB (NMDP, 2007b).

The donor pool is made up of volunteers from several racial and ethnic groups, including Caucasian, Hispanic, African-American, Asian/Pacific Islander, American Indian/Alaska Native and people of mixed race (U.S. General Accounting Office, 2002; NMDP, 2004). Historically, the NMDP has focused on increasing the number of volunteer donors from the general public, with the goal of replacing donors lost through attrition and increasing the diversity of HLA types represented on the Registry (NMDP, 2004). Now that the Registry exceeds seven million donors and continues to grow, it is less likely that newly recruited donors will have an HLA tissue type that differs from existing donors. For this reason, the NMDP has increased its efforts to retain existing donors and to recruit donors from minority groups that are underrepresented on the Registry (U.S. General Accounting Office, 2002).

Donor retention

Donor retention projects aim to increase the probability of donors on the Registry remaining interested, locatable and available for donations over the extensive period that they may be a part of the Registry (NMDP, 2004). Past research by the NMDP has shown that regular communication with donors increases retention, and for that reason is a key part of the retention strategy. Donors are annually mailed *The Marrow Messenger*, a newsletter containing updates on the activities of the NMDP; a reminder that the donor is registered; a change of address card to report donor relocation; a reminder list of donor eligibility requirements; and a request to notify the donor centre if the donor believes he or she may be

ineligible to donate (NMDP, 2004). In fiscal year 2006, more than 290 000 donor addresses were updated by this method. Regular communication is also initiated by individual donor centres, which also may mail publications to donors (NMDP, 2004). Other retention strategies include communication by e-mail and the mailing of greeting cards thanking donors for their commitment (NMDP, 2004). In fiscal year 2006, the NMDP processed more than 4000 donor updates through phone contact and more than 41 000 change of address updates through the NMDP Web site (T. Walker, NMDP, personal communication).

Characteristics that are related to retention were investigated in a study of approximately 750 volunteer donors (Switzer *et al.*, 1999). A donor's volunteer history was found to significantly affect retention. Specifically, blood donors are less likely to drop-out of the Registry, whereas those who have been on the Registry for more than 4 years were more likely to drop-out (Switzer *et al.*, 1999). Recruitment-related issues were also associated with retention. Those who delayed the decision to join the Registry or who were discouraged from joining by others were more likely to drop-out, whereas those who consulted a professional or a relative were less likely (Switzer *et al.*, 1999). Those who joined with others or joined at a community or family drive for a specific patient were more likely to drop-out (Switzer *et al.*, 1999). Concerns about the actual donation process affect retention as well. Not surprisingly, those who feared pain, needles, side effects and damage to their own health were more likely to drop-out of the Registry (Switzer *et al.*, 1999). Based on these findings, Switzer *et al.* (1999) suggest that to increase retention, recruitment settings should strive to reduce ambivalence about joining, shield potential donors from social pressures to join, foster intrinsic commitment to donating and allay medical concerns.

Donor search process

Because only approximately 30% of patients have a related individual who is an appropriate donor, approximately 70% of patients seeking an allogeneic transplant will need to search for an unrelated donor (U.S. General Accounting Office, 2002). Several steps are required when a physician and patient search the Registry for a potential donor. When a patient becomes a candidate for a haematopoietic stem cell transplant, the patient's physician submits patient information and HLA type to the Registry (U.S. General Accounting Office, 2002; NMDP, 2004). The NMDP carries out a preliminary search of the Registry for donors and cord blood units whose HLA type matches the patient's, and a resulting list of potential matching donors is reported back to the physician by the next business day (U.S. General Accounting Office, 2002; NMDP, 2004).

If the physician and patient elect to continue, a more formal search is initiated. Although any physician can initiate a preliminary search, only a physician affiliated with an NMDP transplant centre may initiate a formal search. If the physician is not affiliated, the NMDP Office of Patient Advocacy handles the search request (U.S. General Accounting Office, 2002; NMDP, 2004). In the formal search stage, confirmatory HLA typing of both potential donor (or UCB unit) and patient is carried out. The donor sample is also tested for possible infectious diseases that could be transmitted to the patient (U.S. General Accounting Office, 2002; NMDP, 2004). If UCB is the donor source, it is then shipped to the transplant centre. If bone marrow or PBSCs are required, the donor is further counselled on the process, and a thorough physical examination is carried out to ensure that the donor is healthy enough to withstand the donation procedure (U.S. General Accounting Office, 2002; NMDP, 2004). The donor is then asked to sign an Intent to Donate form, after which the collection of the stem cells is scheduled. The donor has the option of declining to proceed at any point prior to signing the Intent to Donate form (U.S. General Accounting Office, 2002; NMDP, 2004). Whereas the donor may also decline to proceed after this point, he or she is counselled that such a decision may cause irreparable harm to the proposed recipient (NMDP, 2007c).

For a marrow or PBSC donor, the median time from initiation of the formal search to the request for a donor is 51 days. For a cord blood unit, the average time from initiation of the formal search to the request for a cord blood unit is less than 2 weeks (I. Terrio, NMDP, personal communication). Often, the timeframe for the search process is dependent on the condition of the patient and the success of other treatments occurring at the same time the search is being conducted (Health Resources and Services Administration, 2002). Time to procurement of bone marrow or PBSC is dependent on the location of patient and donor and on the urgency of the transplant. Time to procurement of UCB is usually shorter because the stem cells have already been collected and need only to be shipped (I. Terrio, NMDP, personal communication). For donations that cross international borders, the NMDP is required by the U.S. Food and Drug Administration to file extra paperwork that can increase procurement time (T. Walker, NMDP, personal communication). On average, NMDP search initiation to transplantation time

ranges between 3 and 4 months (U.S. General Accounting Office, 2002).

For each formal search, the Registry bills the transplant centre a one-time fee of approximately $700 (U.S.), plus the cost of each further test component, each of which can be more than $200 (T. Walker, NMDP, personal communication). The transplant centre may pay thousands of dollars for a single patient's search because multiple donors may need to be tested before an appropriate donor is chosen. The patient may ultimately pay even more once the charges from the transplant centre are passed on (U.S. General Accounting Office, 2002). Few insurance companies pay for a patient's search, although most pay for the collection of the stem cells and the actual transplant (U.S. General Accounting Office, 2002).

Other registries

Several registries besides the NMDPs exist, both within the United States and internationally (Bone Marrow Donors Worldwide, 2006). These include the national registries of other countries and also private registries that are focused on recruiting donors from particular racial or ethnic groups. For example, Gift of Life Bone Marrow Foundation recruits donors of Eastern-European Jewish descent (Gift of Life Bone Marrow Registry, 2007), and the MatchMaker programme recruits mixed race donors (Mavin Foundation, 2007). Registry sizes are variable from country to country, the smallest being the United Arab Emirates Bone Marrow Registry at just 45 donors (as of December 2007) and the largest being the NMDP Registry (Bone Marrow Donors Worldwide, 2007). Other large registries include those of Germany (>3 million donors), the UK (>750 000 donors), Israel (>380 000 donors), Italy (>320 000 donors), Taiwan (>270 000 donors) and Canada (>220 000 donors) (Bone Marrow Donors Worldwide, 2007).

Almost all registries, including the NMDPs, are part of Bone Marrow Donors Worldwide (BMDW), an international network of 58 stem cell donor registries and 38 cord blood banks (Bone Marrow Donors Worldwide, 2006). BMDW provides centralized information on HLA phenotypes of donors who are part of each registry in the BMDW network. When a search is initiated by any of the BMDW network registries, all other registries are also searched. Together, the BMDW registries contain over 11 million donors, dramatically increasing the chances that a matching donor will be identified (Bone Marrow Donors Worldwide, 2006). Many of the BMDW registries have cooperative relationships with the NMDP, and if a matching donor is identified in one, then the NMDP can facilitate the transplant. If the NMDP identifies a donor on a BMDW registry with which it does not have a cooperative relationship, then the NMDP cannot facilitate the transplant and instead the patient's physician must contact the other registry to begin the procurement procedure (I. Terrio, NMDP personal communication).

In general, search and donation procedures of other registries are similar to those of the NMDP Registry, the exception being that most registries besides the NMDPs do not charge the donor an initial HLA-typing fee (Hawkins & Liang, 2002; The Anthony Nolan Trust, 2007; The Caitlin Raymond International Registry, 2007). The time from search initiation to transplantation is similar worldwide, averaging approximately 2 months (Bone Marrow Donors Worldwide, 2006). The German National Bone Marrow Donor Registry has the shortest search-to-transplantation time at just under 2 months (German National Bone Marrow Registry, 2007). This is due in part to a German law that requires citizens to notify the government anytime their address changes, allowing potential donors to be located more rapidly (T. Walker, NMDP, personal communication).

Underutilization of the Registry and NMDP efforts to increase utilization

It is not known exactly how many patients need transplants from unrelated donors each year, but it is estimated that the number of patients who utilize the Registry is about one-third of those requiring a transplant (U.S. General Accounting Office, 2002). It is also estimated that only approximately one-tenth of patients requiring unrelated transplants actually obtain a transplant facilitated by the NMDP (U.S. General Accounting Office, 2002). The HHS Office of the Inspector General and GAO have raised concerns about the low utilization of the NMDP, and in 2002, the GAO released a report entitled 'Bone Marrow Transplants: Despite Recruitment Successes, National Program May Be Underutilized' (U.S. General Accounting Office, 2002). In the report, the extent to which the Registry is searched and utilized for transplants, the efforts of the NMDP to provide equal opportunity for all racial and ethnic groups to find compatible donors and the management of donor centres are addressed.

The GAO report cites several factors contributing to the underutilization of the Registry for searches and transplants, some of which are outside of the NMDPs control. The most common reason why a preliminary search is initiated but not continued is a change in medical condition of the recipient that renders him or

her an inappropriate candidate for transplantation (U.S. General Accounting Office, 2002). A timely transplant referral depends on the transfer of all patient records and effective communication between treating physicians (NMDP, 2006i). Any delay in the referral process increases the likelihood that the recipient's medical condition has changed (T. Walker, NMDP, personal communication). Another factor thought to contribute to underutilization is that stem cells may be obtained from a source other than the NMDP, such as a related donor or a different registry (U.S. General Accounting Office, 2002). Frequently, physicians have more experience initiating a search with a different registry and will choose to continue using that registry for their other patients (U.S. General Accounting Office, 2002). Search and collection costs may contribute to underutilization. The NMDP is one of only a few registries worldwide that charge a fee for a formal search, and the cost of stem cell procurement at NMDP tends to be higher (U.S. General Accounting Office, 2002). There is also some thought among transplant centre administrators that the NMDP takes longer to provide the stem cells than other programmes (U.S. General Accounting Office, 2002). Importantly, inability to find a matching donor was not found to significantly contribute to underutilization (U.S. General Accounting Office, 2002).

The NMDP has attempted to increase utilization by addressing the concern of many physicians that it is slow in providing stem cells. In 2004, it instituted an ultra-urgent search pilot project to explore methods of accelerating the search process for patients in critical need of a transplant (NMDP, 2004). The project uses a donor selection team at the NMDP national office experienced in HLA matching that manages all aspects of the donor search. The NMDP identifies and tissue types 10–12 potential donors for each patient simultaneously, saving time in finding a suitable match (NMDP, 2004). This project has also used volunteers' frozen blood samples for confirmatory testing whenever possible instead of drawing fresh samples (NMDP, 2004). Using these strategies, the NMDP was able to shorten its time from formal search initiation to transplantation from 4·8 months in 1993 to 3·7 months in 2000 (U.S. General Accounting Office, 2002). The project was intended to facilitate transplants for patients in urgent need, but the success of the pilot project led the NMDP to incorporate many of the ultra-urgent search project practices into its ongoing, everyday searches (NMDP, 2004). The shortened search time has translated into a 14% increase in the number of preliminary searches that proceed to transplantation (NMDP, 2004). Because efficiently locating a potential donor can speed the search-to-transplantation time, thereby addressing the concern that underutilization is a result of slow stem cell procurement, the NMDP has continued successful projects aimed at maintaining up-to-date donor information (NMDP, 2004).

Minority representation on the Registry and Recruitment Programmes

Since 1998, the proportional distribution of racial and ethnic groups on the Registry has steadily approached their proportional distribution in the U.S. population (U.S. General Accounting Office, 2002; NMDP, 2004). Between 1998 and 2001, the number of minority donors increased by between 30% and 53% (NMDP, 2004). However, African-Americans and Hispanics are still under-represented within the total number of donors on the Registry by 17% and 15%, respectively (U.S. General Accounting Office, 2002). In 2001, Caucasians with transplantable disorders had an approximately 80% chance of finding a donor by searching the Registry, whereas African-Americans had a less than 30% chance (Laver *et al.*, 2001). Whereas most national registries aim to maintain racial and ethnic representation similar to that of the general population they serve, many do not have the same ethnic and racial diversity issues that the NMDP faces (T. Walker, NMDP, personal communication). Because the NMDP serves one of the most racially and ethnically diverse populations in the world, its emphasis on efforts to maintain minority representation has been intense.

A survey of nearly 600 African-Americans showed that one of the most common barriers to bone marrow donation is a lack of awareness, both of the existence of the NMDP, and that transplantation can save lives (Laver *et al.*, 2001). Those individuals who knew that transplantation can save lives were more than twice as likely to donate (Laver *et al.*, 2001). Lack of opportunity to donate and the cost associated with donation were also cited as barriers (Laver *et al.*, 2001). Fear of pain and inconvenience were cited although much less frequently than the previously mentioned factors (Laver *et al.*, 2001). Another study found a similar lack of awareness of the existence of the NMDP, but that willingness to donate was not lower among African-Americans (Onitilo *et al.*, 2004). In contrast to Laver *et al.* (2001), Onitilo *et al.* (2004) found that for those who were not willing to donate, fear of pain was the most commonly cited reason. In general, and more so in African-Americans, many who indicated they were willing to donate were unwilling to be contacted to sign up for the Registry (Onitilo *et al.*, 2004).

Commonly cited barriers to donation in African-Americans identified by both Laver *et al.* (2001) and

Onitilo *et al.* (2004) can be largely addressed by educational strategies such as group sessions conducted at churches and community centres and aimed at increasing knowledge of the existence of the NMDP, that bone marrow can save lives and that matches are more likely within the same ethnic group. In addition to a description of the donation procedure, educational materials should include a description of the type and severity of pain that is likely to be encountered, and the risk of an adverse outcome during the donation process because it is a common misconception that donation is painful and risky (Laver *et al.*, 2001; Onitilo *et al.*, 2004). The NMDP pays the typing costs for minority donors (see below) (NMDP, 2004), so an effort should be made to address the misconception that donation is costly. Not surprisingly, a similar disparity in minority willingness to donate solid organs has been observed and was reviewed in a 2002 report of the American Medical Association's Council on Scientific Affairs, entitled 'Increasing Organ Donation' (Council on Scientific Affairs, 2002). Awareness and educational strategies similar to those aimed at increasing minority representation on the Registry were suggested for increasing the willingness of minorities to donate solid organs (Council on Scientific Affairs, 2002). The NMDP has recognized that under-representation of racial and ethnic groups on the Registry may lead to unequal opportunity for all patients in need of transplants to find matches and has instituted several programmes, many of which address the suggestions by Laver *et al.* (2001) and Onitilo *et al.* (2004), aimed at increasing minority representation on the Registry (NMDP, 2004).

Between 1993 and 1997, the NMDP instituted four minority recruitment initiatives aimed at African-Americans (African-Americans United for Life), Asian/Pacific Islanders (Asian-Pacific Islander Donors Can Save Lives), Hispanics (Hispanics Giving Hope/Hispanos Dando Esperanza) and American Indian/Alaska Natives (Keep the Circle Strong) (NMDP, 2004). Each initiative included public education materials such as public service announcements, recruitment brochures and promotional materials that were distributed to donation centres at either free or reduced costs (NMDP, 2004). The materials were translated into five languages and focused on educating minorities about the importance to people of their own race or ethnic background of becoming a donor (NMDP, 2004). These materials are continually updated and distributed throughout the NMDP network (NMDP, 2004).

In 2003, the NMDP intensified its efforts to recruit African-American donors with a programme aimed at increasing awareness of the NMDP, increasing understanding of the need for minority donors and increasing motivation of African-Americans to join the Registry (NMDP, 2004). Market research was conducted to determine the most effective ways to target the African-American community. Results of the research showed that 48% of African-Americans were open to learning about the NMDP and that the initiative should focus on the themes of unity, strength and 'helping fellow man, woman, and child' (NMDP, 2004). Based on the results, new print, Web and public service announcements were developed. The NMDP also established partnerships with the African-American fraternity Phi Beta Sigma, XM Satellite Radio and Essence Magazine (NMDP, 2004).

The minority recruitment initiatives were successful. Between 1994 and 2004, minority representation on the Registry increased from approximately 22% to approximately 32%, an increase of over 1 million minority donors (NMDP, 2004). The increase in minority representation on the Registry has translated into more transplants for minorities. Since 2002, there has been an average increase of 17% per year in transplants to African-American patients (T. Walker, NMDP, personal communication).

In response to concerns that minorities are still somewhat under-represented on the Registry, the NMDP has continued specialized recruitment efforts. Currently, the NMDP pays the full costs of tissue typing for donors from minority groups with funds provided by the U.S. Health Resources and Services Administration and the U.S. Navy (NMDP, 2004). Also, the NMDP and each donor centre negotiate minority recruitment goals based on the population demographics of the location of the donor centre. Donor centres are reimbursed by the NMDP $28 (U.S.) for each recruited minority donor and $10 for each recruited Caucasian donor up to the number specified in its recruitment goal (U.S. General Accounting Office, 2002; NMDP, 2004). Financial penalties are levied when donor centres fail to meet their recruitment goal (U.S. General Accounting Office, 2002).

The Health Resources and Services Administration challenges the notion that minorities continue to be under-represented on the Registry and reports that NMDP efforts to increase minority representation have been successful (Health Resources and Services Administration, 2002). Among the group of donors who joined the Registry after 2001 and are fully typed for HLA-A, HLA-B and HLA-DRB1, each racial and ethnic group with the exception of Caucasians comprises a larger proportion of the Registry than it does of the general population (Health Resources and Services Administration, 2002). Over 98% of donors are chosen from the fully typed group (Health Resources and Services Administration, 2002).

It is important to note that it may never be possible to increase the likelihood of an African-American finding a donor to that of a Caucasian-American (Laver *et al.*, 2001; U.S. General Accounting Office, 2002; Onitilo *et al.*, 2004). Some minority groups, including African-Americans, have more rare and varied HLA combinations than do Caucasians. Finding a match from an ethnically defined group of donors with rarer and more varied HLA types is more difficult than finding a match among Caucasian donors, even if the donor groups are the same size (Laver *et al.*, 2001; U.S. General Accounting Office, 2002; Onitilo *et al.*, 2004). Although equal access to transplants for all groups is a goal of the NMDP, the recruitment of a large number of minority donors in an effort to add rare HLA types to the donor pool is expensive and may deplete resources required to recruit donors with common HLA types that might more readily increase the number of matches (U.S. General Accounting Office, 2002). The GAO did not find that inability to find a donor contributed to underutilization (U.S. General Accounting Office, 2002). Minority recruitment efforts have increased minority representation on the Registry and have increased donor-recipient matches, although they may not have significantly increased the Registry's utilization.

UCB as an alternative source of stem cells

The NMDP Cord Blood Registry was established in 1998 to increase the options for patients in need of haematopoietic stem cell transplants (NMDP, 2004). The Registry now contains over 71 000 UCB units (T. Walker, NMDP, personal communication). Because HLA-matching requirements for UCB are more lenient (NMDP, 2006a), minorities with rarer and more varied HLA types may have an increased chance of finding a UCB match (NMDP, 2004). Physicians can search simultaneously for marrow donors and for cord blood units stored at NMDP-affiliated cord blood banks (NMDP, 2004). Because the cord blood is stored, a matched unit can take as little as 2 weeks to obtain, making cord blood a preferred source of haematopoietic stem cells for patients requiring urgent transplantations (NMDP, 2004).

A minority recruitment project was initiated by the NMDP in 2001 with the goal of increasing the number of cord blood units donated by minorities (NMDP, 2004). The number of unique UCB HLA phenotypes on the Registry increased by approximately 7%, and substantial increases in matching rates were observed for African-Americans, Hispanics, Asian/Pacific Islanders and Native Americans (NMDP, 2004). However, a 2002 study found that in general, minority donation of cord blood is less common than donation of marrow (Ballen *et al.*, 2002). It is hypothesized that because recruitment efforts for UCB donation usually occur in doctors' offices and pre-natal classes, those women who receive less pre-natal care are less likely to learn about UCB donation (Ballen *et al.*, 2002). African-American women are less likely to receive pre-natal care and more likely to report barriers to pre-natal care (Tossounian *et al.*, 1997) and, therefore, may not be aware of UCB donation opportunities. Cord blood donor centres that approach women after admission to the labour floor appear to be more successful at recruiting donors than those who focus recruitment efforts on pre-natal settings (Ballen *et al.*, 2002). General mistrust of the medical system by African-Americans is blamed in part for their lesser willingness to donate organs (Siminoff and Arnold, 1999; Council on Scientific Affairs, 2002; Hartwig *et al.*, 1993). The same mistrust may contribute to an unwillingness to donate UCB.

Ballen *et al.* (2002) suggest that recruitment strategies for minority UCB donation include hiring more minority employees for the cord blood programme, recruiting donors on the labour floor and establishing outreach programmes in local churches and community organizations. Cord blood banks in the NMDP network have employed some of the strategies suggested by Ballen *et al.* (2002); however, ethical concerns exist about the strategy of aggressively recruiting expectant mothers on the labour floor because thorough explanation of the risks and benefits of UCB donation and written consent of the parents is required (American Medical Association Code of Medical Ethics, E-2.165). Once an expectant mother is admitted to the labour floor, there may not be sufficient time for the risks and benefits to be explained, and the parents may be under such stress that they do not give full attention to the explanation before making a decision about donation.

In 2005, the U.S. Stem Cell Therapeutic and Research Act was signed into law, providing $70 million (U.S.) in additional federal funding to increase the number and genetic diversity of UCB units available for matches (NMDP, 2005; Stem Cell Research and Therapeutic Act, 2005). In carrying out the provisions of the legislation, the NMDP has specific recruitment goals for collecting cord blood from minorities and has established several programmes towards that end. In 2006, the NMDP partnered with Mocha Moms, a support group for stay-at-home mothers of colour, to educate women about the importance of diversity in UCB donations (NMDP, 2006j). NMDP has provided grants to public cord blood banks in major metropolitan areas to help

establish relationships with predominantly African-American churches to educate expectant parents about donation. Grants have also been provided by the NMDP to public cord blood banks to hire bilingual translators to educate Hispanic/Latina expectant mothers in medical clinics and to gain consent for UCB collection in advance of their delivery date (T. Walker, NMDP, personal communication). Educational materials are being provided in several languages to educate those whose first language is not English about cord blood donation. As a result of these programmes, 39% of UCB units on the NMDP Cord Blood Registry are from racial and ethnic minorities, an increase of 24% since 2001 (T. Walker, NMDP, personal communication).

CONCLUSIONS

Haematopoietic stem cell transplantation is a life-saving therapy for those patients who have access to a matching donor. The NMDP Registry strives to facilitate transplants for all patients who need them. However, it is estimated that the programme is only used by approximately one-third of patients needing transplants, and this underutilization, coupled with an apparent under-representation of minorities on the Registry, has caused concern. The NMDP has instituted programmes addressing underutilization and under-representation, which have substantially increased the total number of donors and minority representation on the Registry. Some of these initiatives may have applicability elsewhere as donor registries throughout the world increasingly confront under-representation because of increased ethnically and racially diverse populations.

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