

# Constituting a public umbilical cord blood bank in South Africa

J Mellet, M Alessandrini, HC Steel and MS Pepper

Department of Immunology, Faculty of Health Sciences and Institute for Cellular and Molecular Medicine (ICMM), University of Pretoria, Pretoria, South Africa  
E-mail: michael.pepper@up.ac.za

The South African population is known as 'the rainbow nation' which is appropriate for a country with a cultural diversity that is illustrated by its 11 official languages, mostly indigenous to South Africa. This diversity translates into an extensive genetic diversity in the populations residing in the country. As the South African Bone Marrow Registry (SABMR) is constituted of potential donors who are predominantly Caucasian, it is not a representative of the demographics of the country, in which nearly 80% of inhabitants are of Black African origin. The HLA complex that comprises the most polymorphic genes in humans, has a pivotal role in determining the successful outcome of hematopoietic SCT (HSCT).<sup>1</sup> The high degree of diversity and the small number of Black African individuals registered with the SABMR decreases the likelihood of finding HLA-compatible donors for these individuals.<sup>2</sup> Table 1 indicates the number of matched-unrelated HSCTs performed on South African patients as reported by the SABMR since its inception in 1991.<sup>3</sup>

A regional public cord blood bank is therefore likely to provide individuals of African origin, both locally and abroad, with a higher probability of obtaining an HLA-compatible donor. In addition, umbilical cord blood-derived hematopoietic stem cell (HSCs) require a minimum 4/6 HLA-match between donors and recipients at three HLA loci, namely HLA-A, -B (antigen-level) and -DRB1 (allele-level),<sup>4</sup> which is less than is required for bone marrow-derived HSCs for transplantation. Our objective is to determine the basis on which a public cord blood bank would need to be constituted to accommodate the diversity of local and regional populations. The diversity of the South African population can be considered at three levels: racial groups, ethnic/linguistic groups and HLA diversity.

The South African population officially comprises four racial groups: Black, Caucasian, Mixed Ancestry and Indian/Asian. The Black South African population is characterized by great linguistic diversity which encompasses four broad groupings: Nguni (Zulu, Xhosa, Ndebele and Swazi), Sotho-Tswana (Southern, Northern and Western Sotho populations), Tsonga and Venda. Studies have indicated the linguistic relatedness of the Nguni languages as well as the relatedness between individuals belonging to the Nguni group. Another cluster is formed by Sotho-speaking individuals, whereas close similarity exists between the Venda and Tsonga groups.<sup>5</sup>

The South African Caucasian population is mainly of European descent (Dutch, British, German and French) and primarily speaks Afrikaans and English.<sup>6</sup> Mixed-Ancestry South Africans predominantly speak Afrikaans and comprise individuals with a genetic contribution from populations related to Indonesians, Europeans, southern Asians and Xhosas. Indian and Asian South Africans mainly speak English.

The different ethnic/language groups are distributed, with varying frequencies, across the nine provinces of South Africa. Populations belonging to the same ethnic/language group generally tend to cluster together. Ethnicity reflects cultural groupings and cross-cultural marriages, and is often indicated by the language spoken. Even though there are distinct ethnic and cultural groups in South Africa, there is a high degree of intermixing between the ethnic groups, in particular between Black South Africans.<sup>7</sup> Gauteng is home to varying proportions of all the ethnic/language groups in South Africa, which makes it the most diverse and hence most suitable province for establishing the country's first public cord blood bank. However, to take advantage of the distinct population distributions, additional collection sites will need to be strategically positioned across the country.

Numerous studies have investigated the distribution and diversity of HLA in African populations. However, very few studies have determined HLA diversity in the South African population. Increased diversity and decreased homozygosity are observed at multiple loci.<sup>8</sup> Black South Africans possess numerous alleles at each HLA locus that contribute to this diversity. The Mixed-Ancestry population shares allele groups with Black and Caucasian South Africans, and some alleles present in the Mixed-Ancestry population are prevalent in the Khoisan and East Asian populations, suggesting previous admixture.

Black South Africans share several alleles with other African populations.<sup>8</sup> However, several alleles are population specific and may subsequently decrease the likelihood of finding HLA-compatible donors. A public cord blood bank in South Africa, constituted almost exclusively of units from Black African individuals, is likely to improve the chances of finding an HLA-compatible donor.

There is therefore an urgent need to establish a public cord blood bank to cater for the genetically diverse population in South Africa. The feasibility and public acceptance of establishing such a public cord blood bank have been investigated and initial results are favorable.<sup>9</sup> In addition, the ethical and regulatory issues surrounding cord blood banking in South Africa have recently been addressed.<sup>10</sup>

The genetic diversity of the HLA complex across populations of African origin appears to be too vast to serve as the principal guide for constituting a public bank. Therefore, constituting a bank based either on social race or broad ethnic groupings would appear to be a more reasonable approach, with the intention of ultimately incorporating all ethnic groups present in the country. The future plans for the implementation of the National Health Insurance scheme in South Africa and its goal of achieving equity and access to health-care services to all South African citizens further underscores the importance of establishing a public bank in the country.<sup>10</sup>

Challenges to this approach include the lengthy support required as a result of prolonged neutropenia and the need for

**Table 1.** Matched-unrelated HSCTs reported by the SABMR

HSC source	Number	Percentage
Peripheral blood (international donor)	188	58
BM (international donor)	29	9
Cord blood (international donor)	26	8
Peripheral blood (South African donor)	81	25
Total	324	100

Abbreviations: HSC = hematopoietic stem cell; HSCT = hematopoietic SCT; SABMR = South African Bone Marrow Registry.

blood products following cord blood transplantation, particularly in a setting in which health-care resources are primarily dedicated to the management of high-priority diseases, such as HIV/AIDS and tuberculosis. Haploidentical HSCT appears to be a promising alternative for the future, particularly in view of the great genetic diversity which is found in the region. Nonetheless, the availability of an additional source of HSCs from a public cord blood bank would not only serve the South African population, but also individuals living in Africa and the rest of the world.

#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

#### ACKNOWLEDGEMENTS

This research and the publication thereof is the result of funding provided by the South African Medical Research Council of in terms of the MRC's Flagships Awards Project SAMRC-RFA-UFSP-01-2013/STEM CELLS, the Institute for Cellular and Molecular Medicine of the University of Pretoria, and the National Research Foundation of South Africa.

#### REFERENCES

- 1 Loiseau P, Busson M, Balere ML, Dormoy A, Bignon JD, Gagne K *et al.* HLA Association with hematopoietic stem cell transplantation outcome: the number of mismatches at HLA-A, -B, -C, -DRB1, or -DQB1 is strongly associated with overall survival. *Biol Blood Marrow Transplant: J Am Soc Blood Marrow Transplant* 2007; **13**: 965–974.
- 2 South African Bone Marrow Registry. *Chairman's Report*, 2008.
- 3 Du Toit E. *The South African Bone Marrow Registry*. [PowerPoint Presentation]. Presented at the WBMT Workshop in Cape Town, South Africa, 15 November 2014.
- 4 Scaradavou A. Unrelated umbilical cord blood unit selection. *Semin Hematol* 2010; **47**: 13–21.
- 5 Lane AB, Soodyall H, Arndt S, Ratsikhophpha E, Jonker C, Freeman L *et al.* Genetic substructure in South African Bantu-speakers: evidence from autosomal DNA and Y-chromosome studies. *Am J Phys Anthropol* 2002; **119**: 175–185.
- 6 Statistics South Africa. Census 2011. Release version 1.1.
- 7 Coetzee V, Greeff JM, Barrett L. Facial-based ethnic recognition: insights from two closely related but ethnically distinct groups. *S Afr J Sci* 2009; **6**: 464–466.
- 8 Peterson TA, Bielawny T, Lacap P, Hardie R, Daniuk C, Mendoza L *et al.* Diversity and frequencies of HLA class I and class II genes of an East African population. *Open J Genet* 2014; **4**: 99–124.
- 9 Meissner-Roloff M, Pepper MS. Establishing a public umbilical cord blood stem cell bank for South Africa: an enquiry into public acceptability. *Stem Cell Rev* 2013; **9**: 752–763.
- 10 Chima SC, Mamdoo F. Ethical and regulatory issues surrounding umbilical cord blood banking in South Africa. *South African J Bioeth Law* 2011; **4**: 79–84.