Umbilical cord blood banking: Beyond the public-private divide

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Umbilical cord blood is a source of haematopoietic progenitor cells, which are used to treat a range of malignant, genetic, metabolic and immune disorders. Until recently, cord blood was either collected through donations to publicly funded cord blood banks for use in allogeneic transplantation, or stored in commercial cord blood banks for use in autologous transplantation. The line between public and private cord blood banking is being blurred by the emergence of "hybrid" models that combine aspects of both the public and private systems. The authors describe these hybrid models and argue that their emergence is explained by both market forces and public sector policy. They propose that the future of the sector will depend heavily on several key developments that will differentially affect public, private and hybrid banking models.

INTRODUCTION

Umbilical cord blood is a rich source of haematopoietic progenitor cells which can be used to treat a range of malignant, genetic, metabolic and immune disorders. For the purpose of transplantation, haematopoietic progenitor cells sourced from cord blood have several advantages over those sourced from bone marrow or peripheral blood. Cord blood is widely available and easily accessible; collection is relatively non-invasive, safe and painless; and because haematopoietic progenitor cells derived from cord blood are immunologically naïve, they can be safely infused even when they are an incomplete match for the recipient.[1] Furthermore, in recent years the high rates of infection and graft failure evident in early studies of cord blood transplantation, which related to the low numbers of haematopoietic progenitors in single cord blood units, have been largely overcome by the practice of "double cord" transplantation, where two cord blood units are transplanted into the recipient.[2]

Cord blood was first used successfully for allogeneic transplantation in 1988[3] and the first publicly funded cord blood bank was established in New York in 1993. Worldwide to date, over 15,000 allogeneic cord blood transplants have been performed and there are more than 53 public cord blood banks which store donated cord blood for public access. These banks are listed on national and international registries and networks that can be searched by clinicians who are looking for a donor for a child or adult requiring a transplant. For example, Bone Marrow Donors Worldwide (BMDW) currently lists 44 cord blood banks from 26 different countries and contains 446,817 units of cord

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[1] Gluckman E and Rocha V, "History of the Clinical Use of Umbilical Cord Blood Hematopoietic Cells" (2005) 7 *Cytotherapy* 219.

[2] Stanevsky A, Shimoni A, Yerushalmi R and Nagler A, "Double Umbilical Cord Blood Transplant: More Than a Cell Dose?" (2010) 51 *Leukemia Lymphoma* 975.

[3] Gluckman E, Broxmeyer HA, Auerbach AD et al, "Hematopoietic Reconstitution in a Patient with Fanconi's Anemia by Means of Umbilical-Cord Blood from an HLA-identical Sibling" (1989) 321 NEJM 1174.

blood.[4] Currently in the United States, more than 50% of haematopoietic progenitor cell transplants from unrelated donors to children are sourced from cord blood.[5]

Donation of cord blood is based on communitarian values such as altruism and social solidarity.[6] The act of donation, the public banks that enable it and the international networks and registries that connect them are thus widely regarded as social goods, along with other systems of tissue and organ donation and volunteering. In most developed countries, therefore, donors are protected by ethical guidelines and there is a high level of cooperation between government agencies and scientific and medical bodies to protect the supply of cord blood for allogeneic transplantation, and to develop and promote the public system of donation.

Soon after public cord blood banks were established, a parallel commercial industry emerged as private banks began offering to store a child's cord blood on a fee-for-service basis for personal (autologous) or family use. There are currently approximately 225 private cord blood banks worldwide.[7] Approximately 800,000 cord blood units are stored in private banks, which far exceeds the number stored by international stem cell registries for public use.[8]

Private cord blood banks differ from public banks in terms of both their medical rationale and the values on which they are based. Currently, there are few clinical indications for autologous transplants using stored cords.[9] Cord blood is stored privately largely on the assumption that it will eventually prove to be an important source of haematopoietic progenitor cells for regenerative medicine. Regenerative medicine remains little more than a promising possibility, however, and although some clinical trials are currently underway, the value of cord blood in this wider enterprise also remains uncertain. The medical utility of private cord blood banks is thus more potential than actual, and as a consequence, their emergence has been attended by controversy on the grounds, eg, that they threaten the supply of cords to the public system; that they displace proven therapeutic uses of cord blood with uses whose benefits are largely speculative; that misleading claims are made about the magnitude of those benefits; and that commercialisation displaces relationships of solidarity in a global community with contractual relationships in a commercial market.[10] Notwithstanding this, private banks have evidently enjoyed a measure of commercial success. They market their services by tapping into parents' sense of obligation towards their own children, and parents' anxiety that they may in future regret having missed the opportunity to protect their children and feel guilty for doing so.[11] Private storage of cord blood is thus marketed and consumed as a form of "biological insurance" taken out by

[4] *Bone Marrow Donors Worldwide*, http://www.bmdw.org viewed 9 November 2010.

[5] New York Blood Centre, *National Cord Blood Program* (2010), http://www.nationalcordbloodprogram.org viewed 9 November 2010.

[6] Waldby C. "Umbilical Cord Blood: From Social Gift to Venture Capital" (2006) 1 *Biosocieties* 55.

[7] Parents' Guide to Cord Blood Foundation, *Find a Family Bank*, http://www.parentsguidecordblood.org/findabank viewed 7 February 2012.

[8] Manegold G, Meyer-Monard S, Tichelli A, Granado C, Hösli I and Troeger C, "Controversies in Hybrid Banking: Attitudes of Swiss Public Umbilical Cord Blood Donors Toward Private and Public Banking" (2010) 1 Arch Gynecol Obstet 6.

[9] Fruchtman SM, Hurlet A, Dracker R et al, "The Successful Treatment of Severe Aplastic Anemia with Autologous Cord Blood Transplantation" (2004) 10 Biol Blood Marrow Transplant 741; Imura K, Kawahara H, Kitayama Y, Yoneda A, Yagi M and Suehara N, "Usefulness of Cord-blood Harvesting for Autologous Transfusion in Surgical Newborns with Antenatal Diagnosis of Congenital Anomalies" (2001) 36 J Pediatr Surg 851.

[10] Samuel GN and Kerridge IH, "Equity, Utility, and the Marketplace: Emerging Ethical Issues of Umbilical Cord Blood Banking in Australia" (2007) 4 J Bioeth Inq 57; Waldby n 6 at 55-70.

[11] Fernandez CV, Gordon K, Van den Hof M, Taweel S and Baylis F, "Knowledge and Attitudes of Pregnant Women with Regard to Collection, Testing and Banking of Cord Blood Stem Cells" (2003) 168 Can Med Assoc J 695; Sugarman J, Kaplan L, Cogswell B and Olson J, "Pregnant Women's Perspectives on Umbilical Cord Blood Banking" (1998) 7 J Womens Health 57; Dinç H and Sahin NH, "Pregnant Women's Knowledge and Attitudes about Stem Cells and Cord Blood Banking" (2009) 56(2) Int Nurs Rev 250.

"good parents" to safeguard their children's future, and is therefore based on the neo-liberal principles of private insurance, which offers personalised risk-management services as a hedge against future uncertainties.[12]

Until recently, only one alternative has stood intermediate between public donation and private storage, that being the option of "directed donation" of cord blood donated to public banks to siblings who have an existing condition that may in future require an allogeneic transplant. The line between public and private cord blood banking is being increasingly blurred by the emergence of "hybrid models" that combine aspects of both the public and private systems. The remainder of this article describes these hybrid models, offers an explanation for their emergence, and describes three factors that are likely to play a major role in determining how they are likely to evolve.

HYBRID MODELS OF CORD BLOOD BANKING

Hybrid models of cord blood banking fall into two broad categories (Table 1). First, instead of offering parents either public donation or private storage, some banks are now offering both options. Many private cord blood banks have adopted this strategy, including Lifeforce Cryobanks in the United States and Cryosave in Belgium. To date, the only public bank in the world to offer both options is the Alberta Cord Blood Bank in Canada.

TABLE 1 Hybrid models of umbilical cord blood banking

Type of hybrid	Model	Description
Cord blood banks that offer both public donation and private storage options	Private banks that offer a public donation option	Several private banks now offer to store donated cord blood for use in allogeneic transplants, eg Lifeforce Cryobanks in the United States, Eticur in Germany, Eurocord in Slovakia and Cryosave in Belgium (which provides the not-for-profit health foundation Osidea with storage facilities for donated cord blood).
	Public banks that offer a private storage option	Since 2005 the Alberta Cord Blood Bank in Canada has offered a private storage option to generate funding.
Innovations that make privately stored blood available to the public system	Turkish model	According to government legislation, 25% of all privately stored cord blood is donated to the public system.
	Spanish model	Cord blood stored in a private bank is recorded on the Official Spanish Register of Bone Marrow Donors. Should a patient in need of a transplant find a correct human leukocyte antigen match, parents are obliged to donate the cord blood and the storage fee is reimbursed.
	Virgin model	80%of the cord blood is donated to the public sector and 20% is stored for private use. Profits are used to fund stem cell research.
	Private banks that provide an option to release stored cord blood for public use	Several German banks offer parents the option of privately storing cord blood which can be released for use if it is matched to a patient who needs an allogeneic transplant. Parents are under no obligation to release the blood if a match is found. VITA34 bank offers this as an option called *VitaplusSpende* and Eticur offer this as an option called *Eticur:Kombi*. Both banks also offer parents the option of storing cord blood privately for autologous use only.

Secondly, other banks make privately stored cord blood available to the public system of donation. This is has been achieved in Turkey and Spain by legislative means. The Virgin model in the United Kingdom achieves the same outcome by splitting each individual unit of cord blood so that 80% is donated to the public system for allogeneic transplantation and 20% is stored privately for

[12] Manegold et al, n 8 at 99-104.

future autologous use, with the profits used to fund stem cell research. Other private banks such as VITA34 and Eticur in Germany offer parents the option of releasing privately stored cord blood if it is matched to a patient who needs it for an allogeneic transplant.

INFLUENCES DRIVING THE EMERGENCE OF HYBRID MODELS

The emergence of hybrid models of cord blood banking reflects the influence of both market forces and public sector policy. It also reflects public support for organ and tissue donation and transplantation programs, and private storage.[13] Hybrid models such as those developed by Virgin, VITA34 and Eticur are, therefore, likely to appeal to a wider market because they cater to both communitarian and neo-liberal values rather than forcing parents to choose between them.

Hybrid models of cord blood banking can also be understood as a response to the threat of state intervention. Some governments, including those of Italy, France, Belgium and Luxembourg, have sought to protect the public system and the communitarian values underpinning it by prohibiting private cord blood banks altogether. Measures introduced by the governments of Turkey and Spain are clearly designed to achieve the same ends by less restrictive means. In Turkey, cord blood can be privately stored but the government has legislated that 25% of the banks' cord blood units must be offered to the public system[14] to ensure a sufficient supply of haematopoietic progenitor cells for allogeneic transplantation. Spain also allows private storage of cord blood, but stored cords must be recorded on the official Spanish Registry of Bone Marrow Donors and made available to any patient who requires them for an allogeneic transplant.

The hybrid models introduced by private banks can therefore be explained as both prudential measures as well as marketing strategies. By making privately stored blood available to the public system on their own accord, private banks weaken the warrant for legislation or regulatory controls that would force this to happen on terms that are not of their own choosing, or that would curtail their business entirely.

The hybrid model introduced by the public cord blood bank in Alberta, Canada, is also a response to public policy in the sense that it is an attempt to compensate for lack of public funding. Other public banks with the same problem might be expected to follow suit.

FACTORS THAT WILL SHAPE THE FUTURE OF HYBRID MODELS

Future directions in cord blood banking will depend heavily on several factors that will impact differentially on public and private banks and their hybrid offspring. One factor is the degree to which the promises of regenerative medicine are realised. A related factor is the importance that haematopoietic progenitor cells derived from cord blood turn out to have in this emerging field. If the promises of regenerative medicine are realised, and if cord blood proves to be a useful resource for regenerative therapies, then the demand for private storage of cord blood is likely to increase. This may reduce the supply of cords to the public system and increase the profitability of banks that offer a private storage option. Clinical trials of autologous cord blood transplants for cerebral palsy and juvenile diabetes are already underway,[15] but ongoing uncertainty about the promise of regenerative medicine and the place that cord blood has in it has led to private storage being characterised as a practice grounded more in hope than in evidence.[16]

Another factor that will impact on the future of cord blood banking is the emergent possibility of in vitro expansion of haematopoietic progenitor cells derived from cord blood – recently reported by a

[13] Manegold et al, n 8 at 99-104; Fernandez et al, n 11 at 695; Sugarman et al, n 11 at 747-757; Dinç and Sahin, n 11 at 250-256.

[14] Brand A, Rebulla P, Engelfriet CP et al, "Cord Blood Banking" (2008) 95 *Vox sang* 335.

[15] Cord Blood Registry, Centre for Regenerative Medicine, *Cord Blood Clinical Trials Overview*, http://www.cordblood.com/regenerative-medicine/clinical_trials_overview.asp viewed 9 November 2010.

[16] Martin P, Brown N and Turner A, "Capitalizing Hope: The Commercial Development of Umbilical Cord Blood Stem Cell Banking" (2008) 27 New Genet Soc 127.

team led by John Rasko in Australia.[17] This development may have considerable implications for hybrid models that divide cord blood units. While dividing single cords between public donation and private storage may currently decrease their clinical utility, making them unsuitable for either allogeneic or autologous transplantation, should in vitro expansion of haematopoietic progenitor cells derived from cord blood becomes widely available, it will be possible, at least in principle, for parents to both donate to public banks and store cord blood privately without compromising its clinical utility. This would clearly favour hybrid models of cord blood banking such as the Virgin model.

Yet another factor that will impact on cord blood banking is the emergence of clinical alternatives to cord blood transplantation – most notably the use of bone marrow or peripheral blood haematopoietic progenitor cells from haploidentical donors. Haploidentical donors are already being used more frequently for the purpose of allogeneic transplantation, and indications are that they may increasingly be used in preference to cord blood.[18] Currently, the main disadvantages with this type of transplant are high rates of graft-versus-host disease, graft failure, disease relapse and infection due to delayed immune reconstitution.[19] If the outcomes of haploidentical transplants continue to improve, however, this form of transplantation may make public cord blood donation relatively less important, and the costs associated with maintaining public cord blood banks less easy to justify. Such a development would, in turn, favour banks that offer a private storage option by removing competition from public banks altogether.

CONCLUDING COMMENTS

The public-private divide that has, until recently, characterised umbilical cord blood banking reflects the more fundamental division of many modern societies into public and private sectors that are each underpinned by different values. The emergence of public banks is an expression of social values such as cooperation, altruism, social solidarity, collective social responsibility and ethical citizenship. The emergence of private banks is an expression of commercial values such as competition, speculation, innovation and profit. Hybrid models of cord blood banking have recently emerged which combine aspects of both public donation and private banking. These can be understood as the outcome of both market forces and measures undertaken to defend public banking against competition from commercial markets. The future of these hybrid models depends heavily on a number of recent developments in biomedical research and clinical medicine, including regenerative medicine, in vitro expansion of haematopoietic progenitor cells and the use of bone marrow from haploidentical donors. Each of these developments will favour or disfavour commercial storage of cord blood, the public system of donation, and emerging hybrid models in the different ways outlined above.

[17] Holst J, Watson S, Lord MS et al, "Substrate Elasticity Provides Mechanical Signals for the Expansion of Hemopoietic Stem and Progenitor Cells" (2010) 28 Nat Biotech 123.

[18] King ME and Rowe JM, "Recent Developments in Acute Myelogenous Leukemia Therapy" (2007) 12 *Oncologist* 14; Kanda J, Chao N and Rizzieri D, "Haploidentical Transplantation for Leukemia" (2010) 12 Curr Oncol Rep 292.

[19] Huang X, "Current Status of Haploidentical Stem Cell Transplantation for Leukemia" (2008) 1 J Hematol Oncol 27; Guinan E, Luzmik L, Handgretinger R and Woolfrey A, "Preservation of Immune Repertoire by Selective Depletion of Haploidentical Grafts" (2010) 16 Biol Blood Marrow Transplant S68.