

The sky is the limit: Potential clinical uses of umbilical cord blood stem cells and Wharton's jelly mesenchymal stem cells

Omar Aljitalawi, MD  
Blood and Marrow Transplant Program  
Pathology and Laboratory Medicine  
University of Kansas Medical Center, Kansas City, KS

---

---

---

---

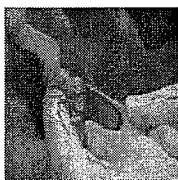
---

---

---

---

First successful cord blood transplant (1988)



Umbilical cord blood extraction

- A major collaborative effort across the Atlantic:
- A patient of Dr. Joanne Kurtzberg
- The cord blood was banked by Dr. Hal Broxmeyer
- Dr. Elaine Gluckman performed cord blood transplant in Paris

\*Since the first successful UCB has been used as a graft source for over 25 000 patients with both malignant and non-malignant diseases ( Cutler et al, 2012).

---

---

---

---

---

---

---

---

Umbilical cord blood transplantation at KUMC

- KUMC has been involved in umbilical cord blood transplant clinical trials, including Clinical trial network (CTN) trials #0604 and CTN #1101
- KUMC has been involved in pre-clinical experiments expanding umbilical cord blood stem cells

---

---

---

---

---

---

---

---

## Ex vivo expansion of umbilical cord blood stem cells

**A Wharton's Jelly Mesenchymal Stromal Cell Derived 3D Osteogenic Niche (Bone) Allows for Cord Blood Stem Cell Expansion**

---

---

---

---

---

---

---

---

Components of the 3D structure used to expand UCB stem cells

- Occupying cells: mesenchymal stromal cells isolated from umbilical cord Wharton's jelly matrix (A and B)
- Synthetic scaffolds(PLLA) to provide the 3D frame (C and D)



Cells positive for CD 90, CD105, CD 73 and negative for CD 34, CD 45, and (isotype consistent with MSC phenotype)

---

---

---

---

---

---

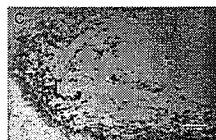
---

---

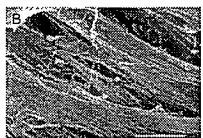
## Verification of Osteogenic (bone) differentiation



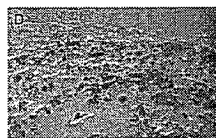
Scanning electron microscopy picture



Alizarin red staining



Bone producing cells and matrix



Bone mineralization

---

---

---

---

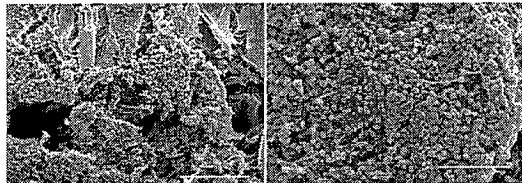
---

---

---

---

### Expansion of umbilical cord blood stem cells



Umbilical cord blood stem cells attached to bone producing cells

---

---

---

---

---

---

---

---

### Indications for umbilical cord blood transplantation

Table 1  
Indications of hematopoietic stem cell transplants in Europe 2008 by main indication and stem-related and unrelated CB products. Numbers refer to patients with HLA-B\*57:01; BM, Bone Marrow; CB, Cord Blood; PB, Peripheral Blood. Proportion: Percentage of CB as stem cell source amongst allogeneic HSCT.

| Main indication          | Family   |    | Donor-related |     | Total  | Proportion |        | Total    |        |
|--------------------------|----------|----|---------------|-----|--------|------------|--------|----------|--------|
|                          | BM/PB/SC | CB | BM/PB/SC      | CB  |        | BM/PB/SC   | CB     | BM/PB/SC | CB     |
| Leukemia                 | 2514     | 11 | 1413          | 496 | 2704   | 6.3        | 818    | 0        | 2881   |
| Autism                   | 204      | 8  | 202           | 12  | 214    | 5.6        | 115    | 0        | 202    |
| Chronic                  | 970      | 3  | 1131          | 119 | 2243   | 5.5        | 122    | 0        | 2327   |
| Immunoglobulin disorders | 88       | 0  | 22            | 33  | 103    | 3.3        | 12,908 | 0        | 14,991 |
| Solid tumor              | 26       | 0  | 14            | 1   | 41     | 3.6        | 1,400  | 0        | 1,407  |
| Non-malignant disorders  | 302      | 36 | 319           | 111 | 1250   | 11.7       | 168    | 0        | 1309   |
| Bone marrow failure      | 730      | 5  | 175           | 14  | 929    | 23.2       | 2      | 0        | 538    |
| Congenital disorders     | 440      | 20 | 178           | 93  | 684    | 15.5       | 7      | 0        | 332    |
| Auto immune disease      | 1        | 1  | 5             | 1   | 9      | 22.2       | 140    | 0        | 144    |
| Others                   | 71       | 1  | 23            | 14  | 109    | 19.7       | 24     | 0        | 88     |
| Total                    | 6270     | 41 | 4022          | 839 | 10,458 | 6.6        | 15,437 | 0        | 25,298 |

A. Gerson, R. Asherson/Transfusion and Apheresis Science 42 (2012) 267-273

---

---

---

---

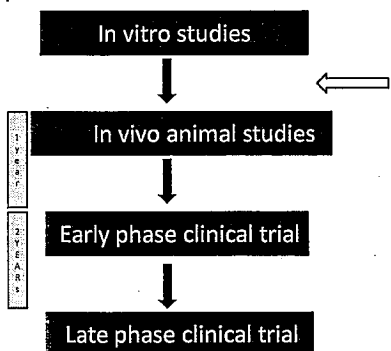
---

---

---

---

### Expansion of umbilical cord blood stem cells timeline




---

---

---

---

---

---

---

---

### Wharton's jelly mesenchymal stem cells

- KU and KUMC researchers have been involved in Wharton's jelly mesenchymal stem cell research for cancer and various regenerative applications

---

---

---

---

---

---

---

---

### Umbilical cord's Wharton's Jelly mesenchymal stem cells



<http://board.sagepub.com/online/whartonjellymesenchymalstemcell-2-1-0404e-with-figures.html>



Wharton's Jelly mesenchymal stem cells

---

---

---

---

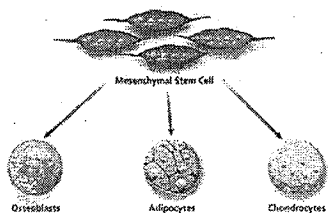
---

---

---

---

### Mesenchymal stem cells



[www.sigmaldrich.com/life-science/stem-cell-b...](http://www.sigmaldrich.com/life-science/stem-cell-b...)

---

---

---

---

---

---

---

---

Wharton's jelly mesenchymal stem cells undergoing osteogenic differentiation (Bone differentiation)

---

---

---

---

---

---

---

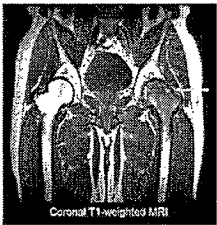
---

Wharton's jelly mesenchymal stem cells...Potential applications

Cartilage and bone regenerative purposes

- Joints
- non-healing fractures
- Bone defects secondary to tumors or trauma

Hip bone avascular necrosis



Coronal T1-weighted MRI

---

---

---

---

---

---

---

---

3 dimensional cancer models for personalized medicine

---

---

---

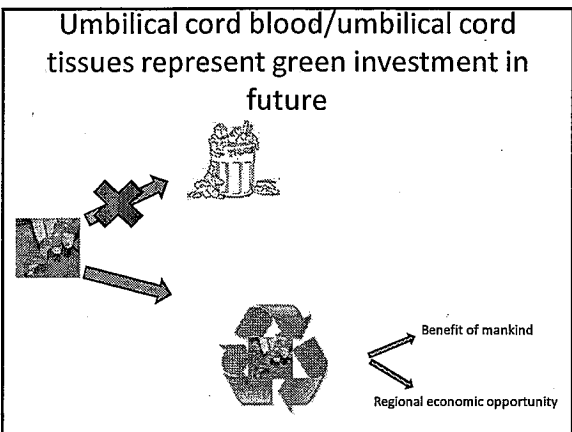
---

---

---

---

---



---

---

---

---

---

---

---