

The endless potential of the umbilical cord blood for investigation, research and treatment

Prof d-r Elizabeta Zisovska

Agency for Quality and Accreditation of Healthcare Institutions, Skopje, Republic of Macedonia
Faculty of medical sciences, University "Goce Delcev" Stip, R. Macedonia

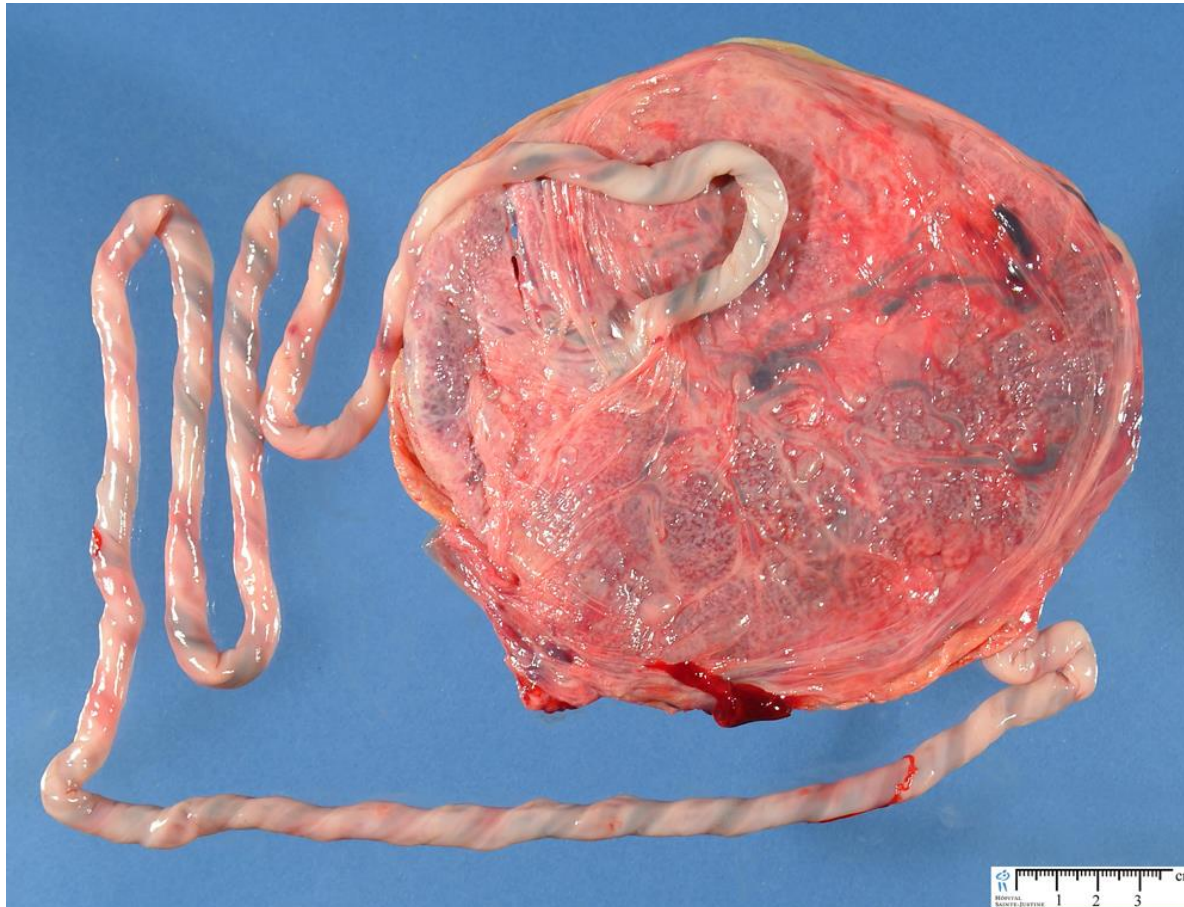
The importance of the umbilical cord

- ▶ The umbilical cord is not only tissue, but a whole organ connecting mother and fetus. It develops from and contains remnants of the yolk sac and allantois, and is therefore derived from the zygote.
- ▶ The cord is not directly connected to the mother's circulatory system, but instead joins the placenta, which transfers materials to and from the mother's blood without allowing direct mixing.
- ▶ The cellular component of umbilical cord blood (UCB) is primarily comprised of lymphocytes and monocytes. It has a comparable B-lymphocyte population and a lower absolute number of T-lymphocytes.

Challenges for cord blood investigation

- ▶ Many of the UCB features can be used for research and therapeutic purposes. After the delivery, umbilical cord is completely out of any function, therefore it can be discarded.
- ▶ It is the least harmful intervention, and at the same time extremely unexplored tissue
- ▶ Last decade the interest for the umbilical cord blood is growing with an extremely pace. The explanation comes from different perspectives.

Placenta and umbilical cord



Biochemical value

- ▶ The blood for the first neonatal analyses can be drawn without any harm to the baby, thus enabling the neonatologist investigating blood gasses, full blood count, bilirubin, etc.
- ▶ Delayed cord clamping can prevent from anemia of prematurity and improve the health status of the premature newborns.



Umbilical cord blood



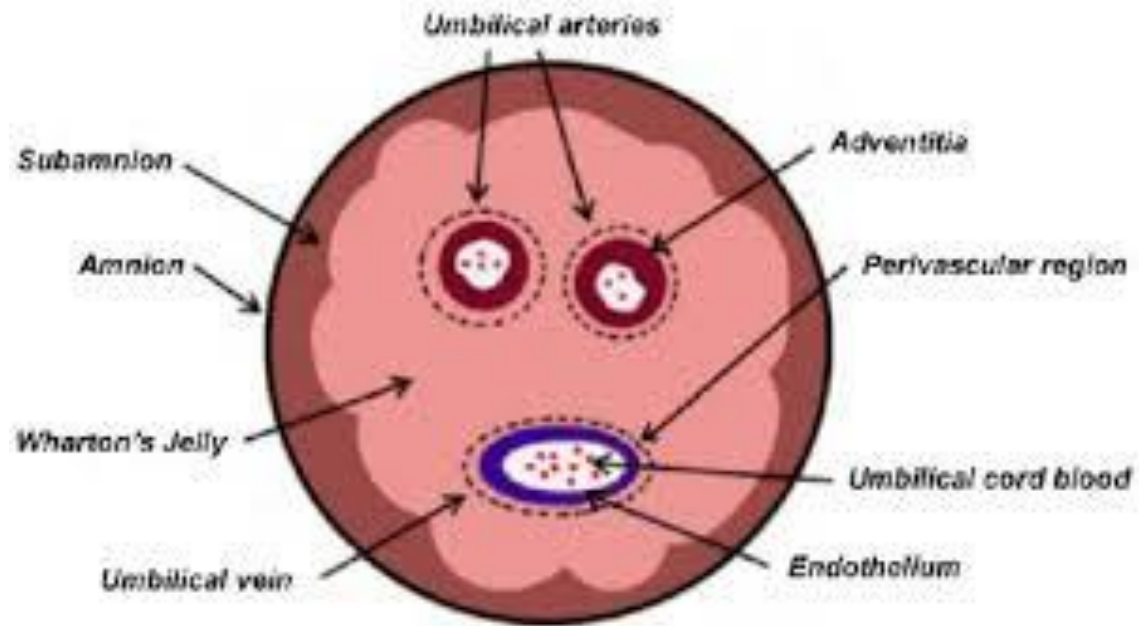
Genetic testing

- ▶ From 24 to 34 weeks of gestation, when the fetus is typically viable, blood can be taken from the cord in order to test for abnormalities (particularly for hereditary conditions).
- ▶ This diagnostic genetic at hereditary procedure procedure is known as percutaneous umbilical cord blood sampling.
- ▶ Immunological analysis can be performed for determination of the blood group, Rhesus factor, and other immunological investigations.

Central vessel approach - Therapeutical value

- ▶ Catheterization of the cord blood vessels is the best way to reach neonatal circulation, i.e. the umbilical vein is directly connected to the central circulation, so it can be used as a route for placement of a venous catheter for infusion and medication, applying medication, even during resuscitation, and performing blood exchange in hemolytic disease of the newborn.
- ▶ The umbilical vein catheter is a reliable alternative to percutaneous peripheral or central venous catheters and may be employed in resuscitation or intensive care of the newborn. Umbilical arteries can be used for taking blood for analysis, measuring directly blood pressure.
- ▶ Catheterization of the both blood vessels, artery and vein, enables long term monitoring of the homeostasis, and administration of the drugs. It serves as a central vein.

Content of the umbilical cord



Cord blood banking

- ▶ Umbilical cord blood banking has become a new obstetrical trend. It offers expectant parents a biological insurance policy that can be used in the event of a child or family member's life-threatening illness and puts patients in a position of control over their own treatment options.
- ▶ It means that the UCB, a once discarded material, is an organ that could be transplanted to either oneself or to another recipient. Such complicated treatment is possible due to some properties of the UCB.

Properties of the umbilical cord blood

- ▶ relative immaturity compared to adult cell sources, having higher proportion of immature T-lymphocytes and decreased numbers of mature memory T-lymphocytes UCB cells also produce fewer absolute levels of cytokines than adult cell sources. This lack of mature immune function is attributed to UCB's low incidence of Graft versus Host Disease (GvHD) and viral transmission. Such cellular constitution could allow for less stringent donor–recipient matching requirements, hence leading to shorter waiting period for treatment.
- ▶ contains a large population of hematopoietic stem/progenitor cells compared to adult sources. These easily procured, low immunogenic sources of multipotential cells are thought to have the capability to become any type of cell in the body under specific conditions.

Properties of the umbilical cord blood-ctd.

- ▶ non-hematopoietic stem cell, the mesenchymal stem cell (MSC), has also been found in UCB in much lower numbers than in bone marrow. The MSC can give rise to such diverse phenotypes as osteoblasts, chondroblasts, adipocytes, and hematopoietic and neural cells (astrocytes and neurons) because they are multipotent.
- ▶ Identification of this cell population is challenging because it currently lacks a definitive phenotype as well as agreement on exactly which surface antigens designate this cell.
- ▶ The blood within the umbilical cord, is a rich and readily available source of primitive, undifferentiated stem cells.

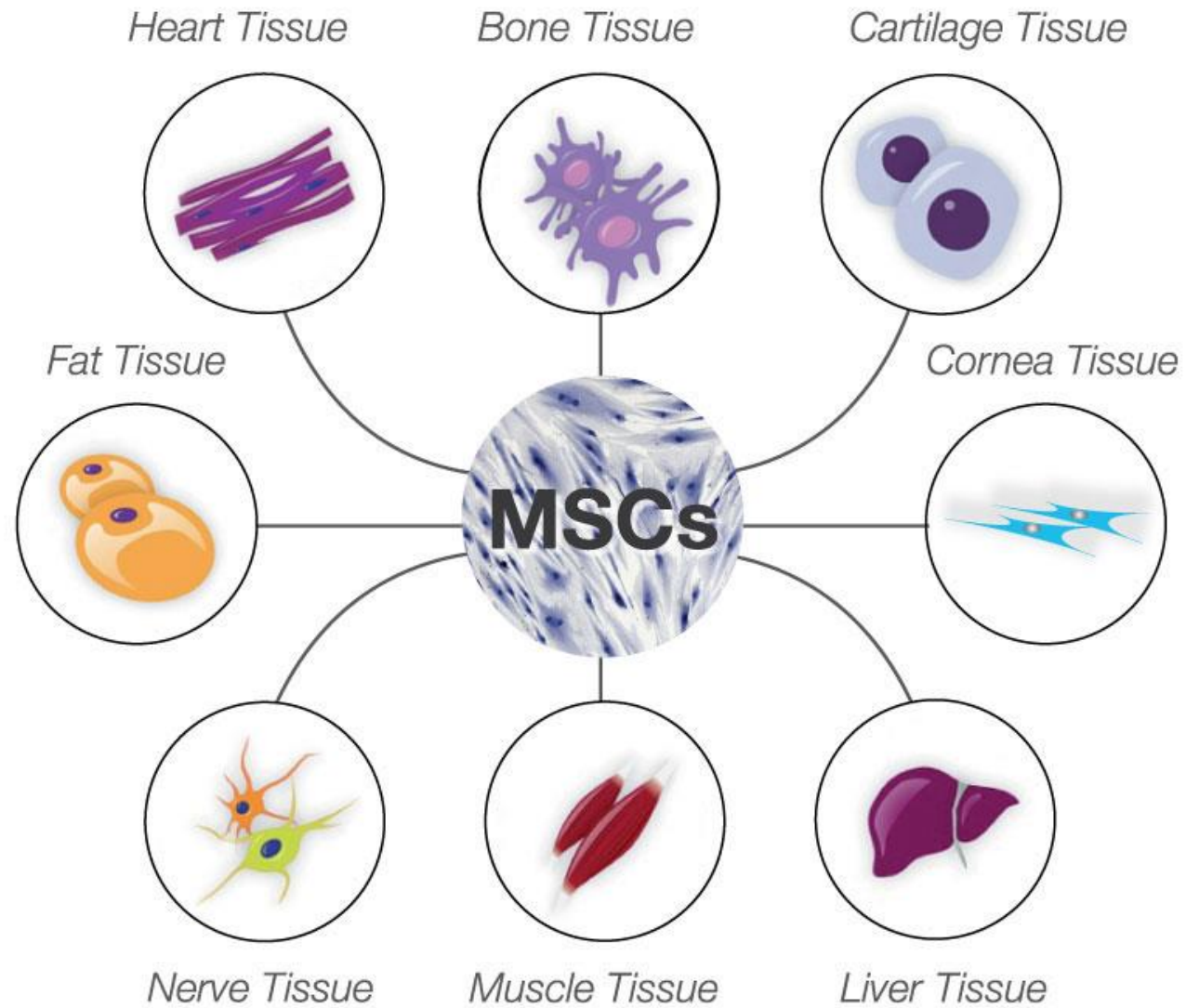
Advantages of UCB in treatment of leukemia

- ▶ The advantages of the UCB compared to bone marrow in treatment of leukemia and other diseases mainly are the following: no risk or discomfort to donors, lower incidence of viral contamination (38.2%) compared to BM, able to be stored at cryogenic temperatures indefinitely without significantly affecting cell viability, immediately available and easily shipped and many others.
- ▶ There is a high immune tolerance of UCB cells because they are unable to generate cytotoxic T-Lymphocytes, which respond to allogenic antigens.

Potential for replacement of dead cells

- ▶ Current research shows some potential therapeutic effects as the ideal source of cells used for replacement of dead and/or diseased cells in a number of injuries and diseases. In vivo research has found that human UCB can ameliorate behavioral and physiological consequences in a number of animal disease models, the most exciting of which included diseases and injury of the brain. The most recent researches on animals have demonstrated UCB's growth as a multidimensional treatment, mostly as a neurotrophic, neuroprotective, and anti-inflammatory agent.

Potential for replacement of dead cells



Disadvantages of the UCB

- ▶ But, besides many advantages, there are some hazardous effects of the UBC. In multiple American and international studies, cancer-causing chemicals have been found in the blood of umbilical cords. These originate from certain plastics, computer circuit boards, fumes and synthetic fragrances among others. Over 300 toxic chemicals have been found, including bisphenol A, tetrabromobisphenol A, teflon-related perfluorooctanoic acid, galaxolide and many other air pollutants among others.

Conclusions

- ▶ As a summary, the UCB has some clinical uses in many rare diseases and in the treatment of malignant diseases and dead cells and tissues, has advantages against bone marrow transplantation, can be used for many testing, and although there are some toxic effects, still the benefit overweighs the damage.
- ▶ But, what are the other possibilities of the use of the UCB? The research will never come to its end, because the umbilical cord is one of the most unexplored organ, and on the other hand, the most harmless target organ for research.

