Cord Blood Banking

Cord blood banks are institutions designed to store umbilical cord blood (UCB) stem cells. UCB, a source of hematopoietic stem cells (HSCs), has garnered attention from scientific and medical communities since its first successful use in a hematopoietic stem cell transplant (HSCT) in 1988. The umbilical cord is the lifeline by which the growing fetus is nourished by the mother. Once regarded as medical waste, the umbilical cord has become a source of lifesaving treatment. The extraction of HSCs from umbilical cord is non-invasive since the umbilical cord is delivered immediately after the baby exits the womb. The most common application of umbilical cord blood derived stem cells is in unrelated (between donor and host) HSCT. Since these cells are not often needed at the time of delivery, cord blood banks have been established to preserve these cells for future use. In addition to harvesting a supply of cells for treatment, UCB stem cells can be used in research.

The first public bank of UCB stem cells, the New York Blood Center, was established in 1992. This institution launched the Placental Blood Project and began collecting umbilical cord blood units in 1993, primarily to study their use in clinical applications. By 1995 the project had collected about 4000 units of UCB and transplanted twenty-four units to unrelated patients, but only 50% of these transplants were successful. Since the establishment of this public bank, other countries have follow suit by establishing their own public cord blood banks.

Cord blood banks exist as both public and private institutions. Public banks derive most of their samples from donations of umbilical cords. The institution will withdraw the blood and store if for future use in treatment, or for research. The donation of umbilical cord blood is free of charge and is often encouraged. Public institutions are funded by federal and local governments, and thus the HSCs stored at the institution are available to the general public. Typically, human leukocyte antigen (HLA) typing is used to find a match for patients who need stem cells for treatment. Private cord blood banks differ from public banks on many levels. Private banks function solely for profit. They are funded by private individuals and the revenue they receive from banking cord blood stem cells. On average, it costs about $2,000 for initial storage of stem cells and about $100 a year for continued storage. Since these businesses function to serve the individual person who wishes to store their child's stem cells, only those individuals have access to the stored cells. Banking with private businesses can be expensive and is only recommended by physicians for those families with congenital diseases.

Stem cells derived from cord blood can be preserved by storing whole units of cord blood, but this method is inefficient due to the space and costs associated with storing large samples. A new standard procedure established by the Institutional Review Board of the New York Blood Center and Mount Sinai Medical School minimizes the volume per unit of blood, allowing more units to be stored. The procedure comes with no medical risk to the mother and newborn child, but requires informed consent prior to its implementation.

The first step in isolating umbilical cord blood stem cells occurs right after birth, with the retrieval of cord blood from the placenta and umbilical cord. A special 16-gauge syringe is inserted into the umbilical vein of the placenta and the blood is allowed to drain, by gravity, into a blood-collecting bag; the volume collected is usually less than 170 mL. To prevent clotting of the blood, an anticoagulant such as citrate/phosphate/dextrose/adenine (CPD A) is added to the blood-collecting bag prior to collection of the umbilical cord blood. To avoid contamination by maternal blood and secretions, a specialized support frame with a plastic-lined, absorbent cotton pad is used to suspend the placenta; this also aids in the retrieval process.

Following the retrieval of blood, the volume must be reduced by removing unnecessary components.

First, hydroxylethyl starch (HES) is added to the blood-collecting bag to increase the precipitation of erythrocytes (red blood cells). By centrifuging the bag, a plasma rich in leukocytes (white blood cells) is formed and then removed from the precipitated erythrocytes into another bag. The leukocyte-rich plasma is also centrifuged, and the precipitated cells and supernatant (liquid overlying sediment cells) are removed to isolate the leukocytes. These cells are then re-suspended in plasma but at a significantly lower volume (about 20 mL). This entire process is typically done in a closed system to prevent contamination. Following volume reduction, the suspension of cells is ready for cryopreservation. In order to cryopreserve the cells, dimethyl sulfoxide (DMSO) is added to the plasma while on ice over a fifteen minute period. After the addition of the DMSO, the bag is deposited in an aluminum canister and placed horizontally in a -80oC freezer. Once the temperature reaches -50oC the unit is stored in the liquid phase of an LN (liquid nitrogen) freezer. Freezing the cells helps sustain the stem cells' potential to differentiate by preventing their cellular activity.

When UCB stem cells are to be used, the cells are removed from cryopreservation. First, the bag is transferred to the gas phase of an LN freezer for fifteen minutes, followed by exposure to air for five minutes. These exposures give the collection bag some elasticity. The bag is then submerged in 37oC water to begin the thawing process. As soon as the thawing is complete, an isotonic solution containing human albumin and dextran is added to the cell suspension and the bag is centrifuged. Once the cells have aggregated to the bottom of the bag, the overlying liquid is removed. This centrifugation step removes the DMSO solution that was added during cryopreservation. The aggregated cells are then slowly suspended in a solution containing albumin and dextran. The final volume should be appropriate for infusion into a patient.

As UBC stem cells grow in clinical importance, so does the awareness of banking them. Both private and public banks advertise the importance of banking cord blood stem cells, which has led to an increase in awareness by expecting parents. Cord blood banking has provided an easily accessible source of HSCs that can be used in both treatment and research. In terms of public banking of cord blood, scientists find that by having a large supply of stored samples, it increases the probability of finding matches between unrelated recipients and donors.

Sources

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