ABSTRACT

When archiving biological specimens, researchers have a choice of methodologies and technologies. This poster compares the most common methods from scientific and economic standpoint. The parameters of consideration are the storage temperature, e.g., liquid nitrogen vs. -80°C. Storage in liquid nitrogen or in cryogenic freezers (-140°C) is more expensive due to the need for liquid nitrogen refilling. The choice of container, e.g., vials vs. straws, used for the repository. Different methods that were assessed according to the following criteria: "Quality", preservation as measured by markers stability and cell survival rates, "Safety" assessed from the standpoint of bio-contamination and cross-contamination risk, and "Efficiency" quantified by the number of aliquots per container unit. "Ease" of use of the sample handling and retrieval steps, as shown on figure 3 below (Pope, 2007). The poster presents the results and outlines the scientific and economic benefits of a straw-based, integrated and automated solution such as the Cryo Bio System.

QUALITY CONCERNS

Aliquot packaging considerations

Simple physics dictates that a larger radius impedes heat transfer so that the cooling rate achievable lags behind the cooling curve, and there is uneven heat exchange throughout the specimen (Mori, 2002). The issue was discussed at length by Mortimer (2004a), whose analysis showed this to be a marked disadvantage of cryovials, and likely to lead to impaired survival of specimens frozen in such large diameter packages.

The other side of this issue is the effective warming rate that can be achieved, impacting not only the effective thawing of specimens but also the risk of their warming during handling for brief periods outside the cryogenic storage tank. Here the ability to achieve rapid warming rates in straws is a double-edged sword as it leads to a reduced risk of damage to dry ice, degradation of cryobanked biological materials, and less likely to cause any storage failure.

This margin of safety becomes crucial in a dynamic biobanking situation with respect to the occurrences of opening and closing the freezer, and handling the specimen container or input or retrieve samples, as shown on figure 3 below (Pope, 2007). When considering storage in liquid nitrogen vapor or in mechanical cryogenic freezers (-140°C), a major concern is that liquid nitrogen vapor and super-cool air are poor conductors of heat and have very low thermal capacity, so that cryopreserved specimens poorly and heat up very quickly in the presence of a warm object, even ambient air. Because every second spent above -132°C (and especially above -80°C, see above) potentially causes accumulation of irreversible damage to the frozen materials, extreme care must be taken to ensure that specimens are kept below -132°C throughout storage, manipulation, and sampling.

The poster presents the results and outlines the scientific and economic benefits of a straw-based, integrated and automated solution such as the Cryo Bio System.

COST CONSIDERATIONS

When assessing the true costs of the biorepository activity consisting of aliquoting, packaging and storing biological specimens, one needs to consider the following variables over the intended duration of storage (e.g., 10 years):

- **CONSUMABLES**: e.g., vials, straws, pipette tips, etc.
- **LABOR**: technician time to accomplish processing operations (e.g., aliquoting, labeling, etc.).
- **FREEZE EQUIPMENT**: capital expense of the freezer units.
- **STORAGE ELEMENTS**: rack system to install inside the freezer.
- **MAINTENANCE**: cost of maintenance contract + expected spare parts replacement.
- **FUEL**: consumption of either LN2 or electricity (or both in cases of -140°C mechanical freezers).
- **AIR CONDITIONING**: needed to evacuate additional head produced with electrical freezers.
- **SPACE**: cost of using the storage space - was not included in present cost model, due to high geographical variability.

Assuming the same protocol of 12 aliquots per sample to be stored over a 10 year period, we run the model for 2 types of packaging system (CSB™ straws and cryovials, and across 3 types of freezer container): 1) a LN2 freezer (model Chart-MVE 1899P-119), ii) a -40°C mechanical freezer (model REVCO 24.4 cu ft), iii) a -140°C "cryogenic" mechanical freezer (model REVCO ULMFA II - 10.3 cu ft), resulting in 4 configuration scenarios. The table in figure 4 summarizes the results obtained for the overall cost per sample and figure 5 provides the cost breakdown for each considered storage configuration.

CONCLUSION - Benefits of Straw-based Specimen Banking

- Storage efficiency: 4-fold improvement factor vs. cryovials
- Enhanced TRACEABILITY: color-coding & barcoding of each aliquot management software
- Better QUALITY preservation: biocompatibility of material
- Higher SAFETY conditions: sealed container, no cross-contamination, no infiltration of LN2 inside sample
- Increased ALIQUOTING possibilities: aliquot size of 500µl, 300µl or 150µl.
- Fully-automated aliquoting platform
- Overall STORAGE cost savings > 35%