

Freezer Inventory/Sample Tracking Case Study

How the Freezerworks Unlimited® software design provides unique advantages in managing a biological repository for diabetes research

By Rick Michels
February, 2007

Managing the process has the makings of a real logistical challenge: Enroll two thousand diabetes patients into clinical trials across the U.S. and Canada. From these patients, draw blood three to four times over the course of a number of years. From this blood, spin down and ship for storage in a centralized facility 24-38 vials of serum, plasma, cells and urine. Label and catalog these samples for distribution to a number of researchers so they can perform hundreds of tests in accordance with up to 12 protocols overall (at times 3-4 simultaneously). Keep scrupulous track of the number of times a sample has been frozen and thawed prior to testing, as this is vital for ensuring standardized results and quality control of those hundreds of tests. All this is necessary for unlocking the keys to effective treatment for people living with diabetes, more than 18 million in the U.S. alone.

Overseeing this process, from collection to repository to dispersal, has been the primary work over the last six years of **Marlene Brabham**, Researcher Coordinator for the Medical University of South Carolina (MUSC) Division of Endocrinology, Diabetes and Medical Genetics. Brabham will be resigning her post at the end of January 2007. In her absence, assistant coordinator **Erica Hood** will continue running the operation of the repository. **Dr. Maria Lopes-Virella** serves as Principal Investigator. The sample data management backbone of the project is the software program **Freezerworks Unlimited**, from Dataworks Development.

The EDIC Study

The current diabetes research effort began in the mid 1990's and is well known among diabetes patients and caregivers as the EDIC (Epidemiology of Diabetes Interventions and Complications) study. The study has 1,184 enrollees and is funded by an NIH program project grant under the **National Heart, Lung and Blood Institute**. EDIC is focused on type 1 diabetes research. Meanwhile, the **U.S. Department of Veterans Affairs** is engaged in type 2 diabetes research, and has 1,000 patients enrolled, each providing three collections for additional longitudinal research. Using these two large patient data sets, four research projects are involved in looking at the why people with diabetes often experience cardiovascular complications such as heart attacks or strokes.

According to government statistics, at least 65 percent of people with diabetes will die from a heart attack or stroke. Through these studies and others, the diabetes research community seeks to discover why, and what can be done to lower mortality and improve quality of life. The research effort has paid off with significant and life enhancing dividends: the EDIC researchers in 2005 reported that tightly controlling glucose levels in patients with type 1 diabetes can cut in half the chances of having a cardiovascular event, such as a heart attack, stroke or angina.

“There are common themes that run through each project in the program,” Brabham explained. “One aspect is the contrast how certain diseases are developing in Type 1 diabetes patients compared to Type 2. It’s an exciting study, a great study, but very time consuming.”

Brabham noted that there is a goldmine of statistical data collected for analysis from the study, much of which hasn’t been touched – analysis that “could go on for years.”

To produce such a goldmine, hundreds of tests must be performed on thousands of sample vials. “The protocols are quite huge,” Brabham explained. “Each sample has vast amounts of mostly plasma and serum, and some cells and urine. There is also a need for sub-aliquotting [developing child vial from parent vials].”

Managing the Repository with Freezerworks Unlimited

Currently, the Freezerworks Unlimited database is housing data for 6,679 patient collections, consisting of 160,000 total aliquots as of October 2006. Brabham expects the latter number to climb beyond 200,000 aliquots before the collection of samples is complete and the program becomes one merely of “maintenance, moving samples around as opposed to adding” to the eight -80 freezers currently housing the collection.

Advantages of the Relational Structure

There are certain design features in Freezerworks Unlimited that make the program uniquely helpful in allowing Brabham and Hood to manage their collection, particularly when compared to the structure of a typical freezer inventory program. The structure of the Freezerworks database is relational, with parent records representing a patient visit, and child records representing aliquots. There are distinct advantages to such a design, when compared to one that treats all aliquots equal, forcing every aliquot record to maintain duplicate data. Such a design would not allow Brabham and Hood to manage the unique information (e.g., aliquot type – which includes the sample type and cap color, unique aliquot number, and freeze/thaws) stored for each aliquot. The Freezerworks Unlimited structure allows Brabham and Hood to organize each patient collection as a sample record at the top of the screen, with all associated aliquots listed below.

Thus, a patient who undergoes 4 collections done over time, each represented by 24 or more associated aliquots, is not reflected by a spreadsheet or non-relational file listing 98 vial records. Rather, the data is displayed and organized by four sample records, each with 24 vials listed below – displaying freezer locations and unique vial data. Since each

Sample record will have multiple sample types (serum, plasma, cells, urine, DNA), these are tracked at the aliquot level, again simplifying the number of sample records. As each aliquot is taken out for shipping and testing, a transaction is made that is linked to the aliquot record. Freeze/thaws are tracked at the aliquot level as well. All this is logically displayed within one Sample entry screen.

The screenshot shows a software window titled "Search Samples: # 1 of 1 -- Internal Bar Code ID 108918". It features a menu bar with "Samples", "DNA", "Notes", "Transact", "Aud Trail", and "Attachments". Below the menu are several input fields for sample information:

- Sample ID: 4501
- Sample Date: 12/09/2003
- Pt. ID#: 13126
- Pt. Initials: (empty)
- Pt. Source: EDIC
- Clinic/Center #: 13
- New Pt.: no
- Transfer Pt.: no
- Protocol Type: 4A
- D Kit Requested: 01/23/2004
- D Kit Mailed: 01/23/2004
- D Samp. Collect: 03/08/2004
- D PIF Received: 03/11/2004
- D Sample Rec'd: 03/10/2004
- D Check Mailed: 04/16/2004
- SubAliquot: (empty)

Below these fields is a "Positions" section with a "Status" tab. It displays summary statistics: "Total Number of Aliquots: 7", "Number of Aliquots with Positions: 7", and "Total Current Amount is 27". To the left of a table are buttons for "Add Aliquots", "Sub-Aliquot", "Modify", and "Delete". The table itself has columns for Vial, FreezerName, Position1-5, and Aliquot Type. The rows are color-coded by Aliquot Type:

Vial	FreezerName	Position1	Position2	Position3	Position4	Position5	Aliquot Type
1	PPG Freezer 4	4	K	3	B	5	4th C-PurpV1
2	PPG Freezer 4	2	K	2	C	1	4th P-Orange1
3	PPG Freezer 4	2	K	2	C	2	4th P-Orange2
4	PPG Freezer 4	3	A	1	F	3	4th S-Red1
5	PPG Freezer 4	2	D	2	C	1	4th P-Purp1
6	PPG Freezer 4	2	D	2	C	2	4th P-Purp2
7	PPG Freezer 4	5	A	1	E	5	4th Urine1

At the bottom of the window are "Previous", "Next", "Save", and "Cancel" buttons.

Above: a screen shot of a sample record in the Freezerworks Unlimited database at MUSC. Sample data is displayed at the top of the screen, aliquot data with the multiple freezer locations and type of sample in the bottom scroll window. Entry and view screens are configured by the user. At the MUSC repository, the vials are differentiated by "aliquot type" and are color coded according to the researcher who will receive it for testing.

Sample Tracking issues

The vials stored from each visit are dispersed for testing among different researchers, both in and outside of the university. To track the distribution, Hood has assigned a color for each researcher. The color coded vial top thus indicates which samples are dispersed to which researchers. Colors are stored by box – all greens in one box, yellow in another, etc. Each box is assigned a freezer location, and because of the Freezerworks design, when Hood views a sample record, she can scroll through the aliquot records linked to that record to see which researchers have been shipped their assigned samples, which still remain, and where the aliquots are located. As boxes are dispersed to different testing labs, Hood moves the box to the researcher's freezer by a "drag and drop" *Move Samples* option in Freezerworks, from a repository freezer to the researcher's laboratory freezer,

also configured in Freezerworks. The audit trail tracks all vial movements automatically by user, date and time.

Sub-aliquotting, making “baby” aliquots

Unique aliquot numbers are important in the database because of the increasing use in the project of “sub-aliquotting” – or creating what Hood calls “baby” aliquots from parent aliquots. Tracking aliquot “ancestors” and “descendants” is a recent addition to Freezerworks Unlimited and will play an important role in maintaining the integrity and quality control of the test data.

Preparing collection kits with Freezerworks Unlimited

To prepare for a patient sample collection, Hood imports the Sample IDs from a spreadsheet into Freezerworks Unlimited, creating the sample records in advance while printing the cryovial labels to be used for collecting and ultimately storing the sample fluid. To maintain patient confidentiality, only the bar code number and the Sample Identifier are printed on the label (patient data resides password protected in the software). She then creates collection “kits” to send to the collection center, each sample type is collected in a different size vial (e.g., 10ml for urine samples, 7 ml for serum, smaller ones for cells and plasma). At the collection facility, technicians draw the samples, spin the blood, and place the sample material in the appropriate tube. These vials are shipped back on dry ice to the MUSC facility, where Hood organizes the samples by color and assigns the freezer locations, creatively using the import feature with spreadsheet templates to speed up the process. The **Freezerworks Unlimited** import option locates the sample records and updates each one by attaching the appropriate aliquot records. Hood finds the error checking feature in the import option a big help in ensuring data quality, checking for mistakes she may have made in the process.



Above: Erica Hood inundated with kit boxes, returned from collection sites from across North America

Once the data is stored in Freezerworks Unlimited, and the vials stored in the proper freezer locations in the facility's biological repository, the job of finding and shipping the samples to various researchers to conduct assays and testing becomes a manageable operation. Searches can be done either at the sample or the aliquot level, utilizing search criteria from data fields in either table, and even though vials are stored across freezers and freezer boxes, the entire collection of vials for a sample record is listed on one viewing screen – parent (sample data) at the top, child (aliquot data) below – with a tab screen for viewing transactions/shipping information for each vial.

Spreadsheet software is an extremely useful tool for Hood, who uses them with the Freezerworks Unlimited powerful import feature to run batch processes that greatly simplify the data entry tasks. But both Hood and Brabham shudder to consider what life would be, and once was, when spreadsheets were used for data storage and retrieval of these valuable samples, which Hood termed “priceless” (a number of these are from deceased patients, and cannot be replaced).

“It would be impossible to do this job with an Excel spreadsheet,” Brabham said. “In fact, I have another study not in Freezerworks, using Excel, and it is a lot more trouble.”

“Before Freezerworks, finding samples was chaotic. We had a billion spreadsheets,” Hood added. Prior to installing Freezerworks Unlimited, the program had an entire year's worth of sample and aliquot data stored in these spreadsheets. Fortunately, the job of moving the data to Freezerworks Unlimited could be done using the import option. The import option saved time as well as provided for quality control. “It would have taken years to re-enter that data by hand, and we'd have had a million mistakes,” Hood said.

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