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Investigating the labeling workflow and incorporation of automation for increased collaboration

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Introduction

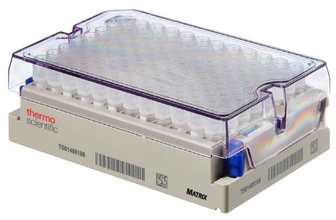
Biobanks have long since served as foundational facilities, storing varying amounts of biomaterial and data for translational research efforts. In order to improve biobanking operations, innovation is required in how sample information is captured to facilitate sample identification, viability, and sharing with collaborators. It may seem easiest to continue handwritten labeling methods, but the possibility of mistakes that render a sample useless is too high of a risk. Here we test a protocol that includes a barcode scanner intended to increase speed, security, and support of persistent tagging for the traceability of biological material and associated data in a biobank [1].

Once implemented as a standard practice, biobankers can maintain confidence through the chain of custody that accompanies many samples. Incorporating sample information into a laboratory information management system (LIMS) helps increase the value of the well-organized biomaterial without burdening the vial with potentially identifiable information. With an initial investment and potential plans to move towards automation, most facilities can recover these costs in a short period from the ability to handle higher volumes of samples, increasing capacity at scale [2].

Materials

Tubes: Thermo Scientific™ Matrix™ ScrewTop Tri-coded Tube (Cat. No. 3741-WP1D-BR)

- 1.0 mL, sterile with barcoded rack
- Space for writing on tube: 11/16 in.



Automation reader: Thermo Scientific™ VisionMate™ HSX High Speed Barcode Reader

- 7.9 in. x 5.9 in. x 6.3 in. (L x W x H); 6 lb
- Reading area: 5 in. x 3.39 in.

Procedure

Scientists were provided with 5 simulated samples of information to mimic the last stage of labeling a tube for storage in a biobank (Figure 1). Their job was to copy all information onto the tube while being as fast and as accurate as possible. All 15 tubes were then mixed, and each scientist took 5. They had to recopy the information onto new tubes, to simulate transferring a sample. This process was repeated once more. The tubes were then analyzed for accuracy.

To compare to automation, these data were aligned with 15 tubes using Microsoft™ Excel™ software and the VisionMate HSX High Speed Barcode Reader. To better simulate processes at a biobank, the data were typed into Excel software.

Figure 1. The data provided for marking the tubes in this exercise. Each tube was marked with (1) sample ID, (2) aliquot sample type [3], (3) clinic ID, (4) collection date, and (5) date of birth. The data were all made-up but generated based on a realistic system.

Scientist 1	Scientist 2	Scientist 3
0218973 PL2 0001151 2/24/2001 12/14/2022	6900128 SAL 0007735 7/11/1995 12/18/2022	0000197 BLD 0002837 12/8/1956 11/15/2022
1039273 BMA 0009889 1/10/1994 12/15/2022	0048917 TIS 0001151 6/25/1984 12/19/2022	1153277 RBC 0001151 11/23/1970 11/21/2022
2381904 BON 0007735 10/15/2005 12/15/2022	5098270 CLN 0002837 5/13/1980 11/30/2022	3399557 TER 0007735 10/23/1960 10/31/2022
0975283 URN 0001151 6/30/2002 11/28/2022	3980117 AMN 0002837 4/19/1992 11/11/2022	2270019 CEL 0003278 9/11/1945 10/27/2022
7182004 CRD 0002837 1/17/2019 11/29/2022	4078291 ZZZ 0003278 3/14/1999 11/15/2022	5170228 U24 0003278 8/30/1972 10/27/2022

Results

Handwriting

Figure 2. Statistics of the handwriting study. This handwriting test was imperfect because the same person could get the same tube more than once. However, since the scientists were told speed was important, the information was likely not memorized between rounds.

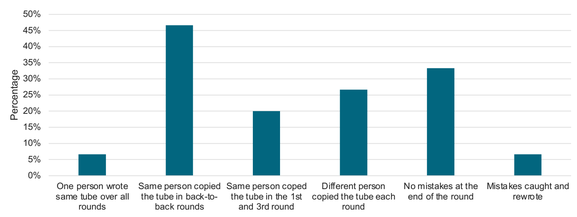
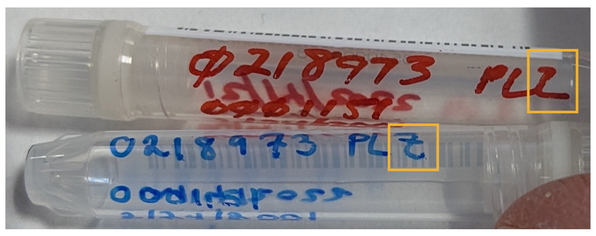


Figure 3. Comparing the writing on the tubes. The information in red is where errors were introduced during the rounds. In general, no one specific type of data was misrepresented more than others.

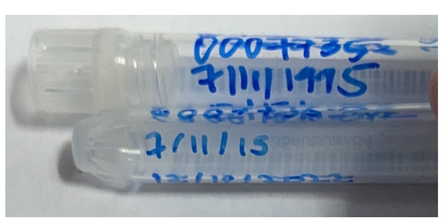
0218973 **PL2** 0001151 2/24/2001 12/14/2022	0975283 URN 0001151 **6**/30/2002 11/28/2022	7182004 CRD 0002837 **1/17**/2019 11/29/2022	6900128 SAL 0007735 7/11/**1995** 12/18/2022	**0048917** **TIS** 0001151 6/25/1984 12/19/2022
3980117 AMN 0002837 4/19/1992 11/11/2022	**1153277** **RBC** 0001151 11/23/1970 11/21/2022	3399557 TER **0007735** 10/23/1960 10/31/2022	5170228 U24 0003278 **8/30/1972** **10/27/2022**	**5098270** CLN 0002837 5/13/1980 11/30/2022

Figure 4. Example tubes showing mistakes, and comments made by scientists during the study.



"Holding onto the cap was more comfortable and made it easier to write on the tube, but being left-handed meant the orientation of the label is different."

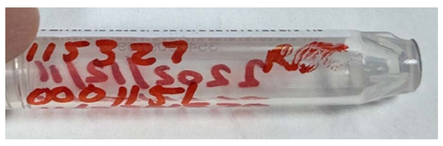
–Scientist 1



Observation: Tubes that were written by a left-handed person (holding the cap with the right hand) were more convenient for a right-handed person to pick out of the rack and read. However, the two left-handed people in this study did not write in the same orientation. These differences should be considered at each specific biobank.

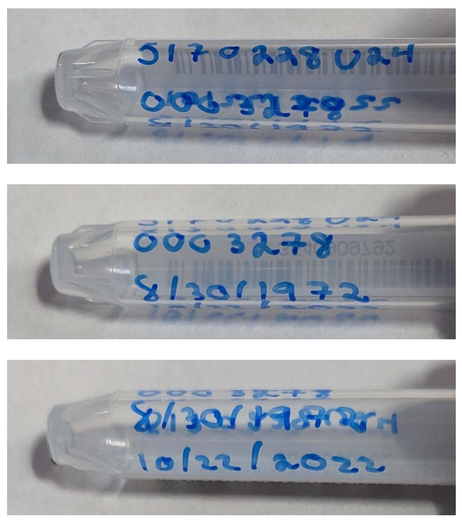
"The tubes roll so it is hard to hold them and transfer information from one to another."

–Scientist 2



"One of the things I was worried about when writing down the information was smearing the ink."

–Scientist 3



Same tube, different viewing angles

"Looking through to copy the data from one tube to another was hard."
–Scientist 3

"My neck feels strained even after only copying down 5 tubes."
–Scientist 1

Observation: The data were provided with dates using a slash (/), but during the experiment the scientists found that using a dash (–) was easier and was no more likely to be misinterpreted as a slash. This would likely be a convenience set by the specific biobank.

Automation

Figure 5. The interface of VisionMate HSX software with the different parameters that can be optimized for convenient export of data. The VisionMate HSX High Speed Barcode Reader comes with software for exporting data from tubes into a workable format, such as with Excel software. While straightforward, a 15 min training session was arranged to make sure users understood the minutiae of how to export plate data into Excel software.

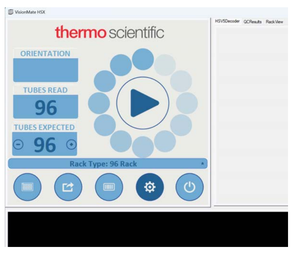


Figure 6. A successful (top) and unsuccessful (bottom) read of the 96-tube rack of the Matrix tubes. These images illustrate some of the capabilities of the automation software, such as alerting the user if the number of samples is not as expected.

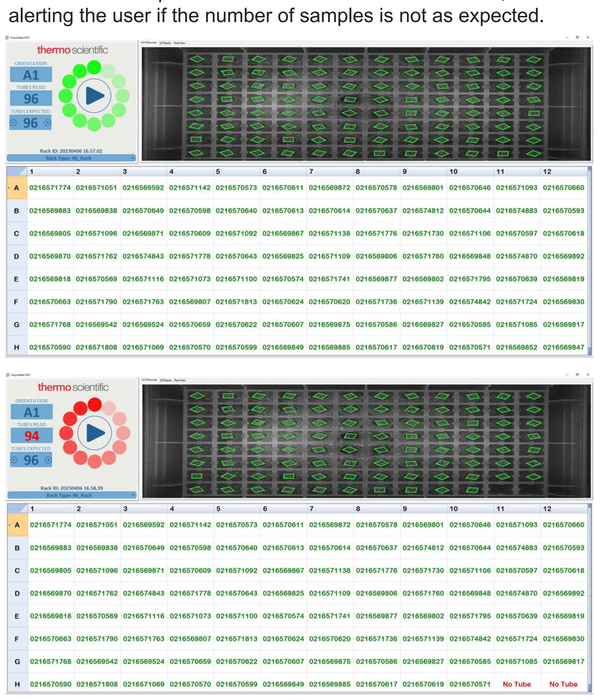
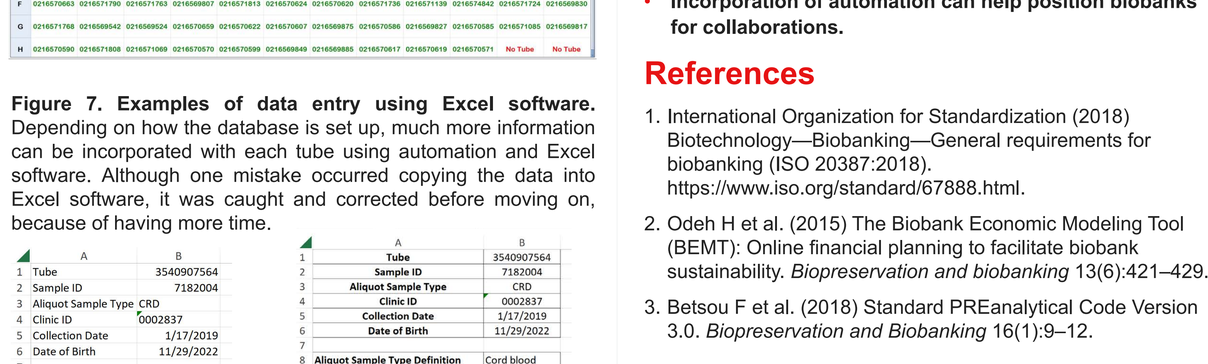


Figure 7. Examples of data entry using Excel software. Depending on how the database is set up, much more information can be incorporated with each tube using automation and Excel software. Although one mistake occurred copying the data into Excel software, it was caught and corrected before moving on, because of having more time.

	A	B
1	Tube	3540907564
2	Sample ID	7182004
3	Aliquot Sample Type	CRD
4	Clinic ID	0002837
5	Collection Date	1/17/2019
6	Date of Birth	11/29/2022
7		
8		

	A	B
1	**Tube**	3540907564
2	**Sample ID**	7182004
3	**Aliquot Sample Type**	CRD
4	**Clinic ID**	0002837
5	**Collection Date**	1/17/2019
6	**Date of Birth**	11/29/2022
7		
8	**Aliquot Sample Type Definition**	Cord blood
9		XXXXXXXXXX
10		AAAAAAAAAA
11	**Additional Samples Tube Numbers:**	BBBBBBBBBB
12		
13		
14	**Additional Sample Information:**	YYYYYYYY
15		YYYYYYYY
16		

	A	B	C	D	E	F
1	**Tube**	3540907564	3540909779	3540907557	3540907556	3540909771
2	**Sample ID**	7182004	0975283	2381904	1039273	0218973
3	**Aliquot Sample Type**	CRD	URN	BON	BMA	PL2
4	**Clinic ID**	0002837	0001151	0007735	0009889	0001151
5	**Collection Date**	1/17/2019	6/30/2002	10/15/2005	1/10/1944	2/24/2001
6	**Date of Birth**	11/29/2022	11/28/2022	12/15/2022	12/15/2022	12/14/2022
7						
8	**Aliquot Sample Type Definition**	Cord blood	Urine, random ("spot")	Bone	Bone marrow aspirate	Plasma, double spun
9	**Additional Samples Tube Numbers:**	XXXXXXXXX	CCCCCCCCCC	GGGGGGGGG	HHHHHHHHH	VVVVVVVVV
10		AAAAAAAAA	DDDDDDDDD		PPPPPPPPP	KKKKKKKKK
11		BBBBBBBBB	ZZZZZZZZZ			TTTTTTTTT
12			LLLLLLLLL			
13						
14		YYYYYYYY	YYYYYYYY	YYYYYYYY	YYYYYYYY	YYYYYYYY
15	**Additional Sample Information:**	YYYYYYYY	YYYYYYYY			YYYYYYYY
16						

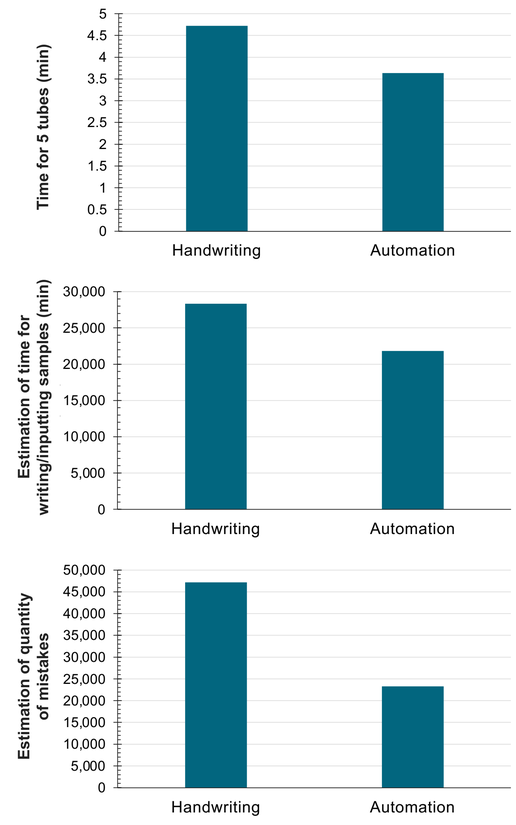


Observation: Specific biobanks will dictate which LIMS is best for their purposes and what information they need recorded with respect to each sample. The capabilities of the VisionMate reader enable it to be flexible and meet many different needs.

Conclusions

Scaling up

Figure 8. Comparing handwriting versus automation for data entry. Writing information by hand on tubes requires more time, on average, per tube than using automation (data entry of information into Excel software in this case). Actual reading of the tubes using automation is fast (~1 sec), though there is some initial time needed to install, learn the software, and set up how exports will occur. The potential for time savings and fewer mistakes is apparent when looking at scaling up to a realistic number of tubes, such as 30,000 per day.



- **Automation can save biobanks time and lead to less erroneous data. Automation can be more scalable.**
- **Incorporation of automation can help position biobanks for collaborations.**

References

1. International Organization for Standardization (2018) Biotechnology—Biobanking—General requirements for biobanking (ISO 20387:2018). https://www.iso.org/standard/67888.html.
2. Odeh H et al. (2015) The Biobank Economic Modeling Tool (BEMT): Online financial planning to facilitate biobank sustainability. *Biopreservation and biobanking* 13(6):421–429.
3. Betsou F et al. (2018) Standard PREanalytical Code Version 3.0. *Biopreservation and Biobanking* 16(1):9–12.

Acknowledgments

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