Helping Ensure Workflow Accuracy: Labeling, Tracking and High-Quality Slides

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Learning Objectives



Discuss how on-demand printing contributes to improved patient safety



Analyze the performance benefits of using validated consumables



Identify the necessary steps to transition from batch to ondemand printing



Recognize the importance of slide adhesion in maintaining specimen integrity

Disclosures

Rachel Finn, Arielle Hobson and Bill Martin are employees of StatLab



Labeling and tracking accuracy is critically important to ensure the best patient outcomes.

A CAP study revealed that up to 55% of errors in clinical laboratories are attributed to mistakes in specimen identification.1

Poll #1

How do you print – batch or on-demand?

- Batch
- On Demand

On-demand printing helps reduce errors, but **printer size** becomes critically important when labs are starved for space at workstations.

The smaller the better!



Batch vs. on-demand printing What's the difference and why is it important

On-demand printing supports single piece workflow right at the microtome or grossing station

Batch printing utilizes a shared printer where cassettes or slides are then transferred to workstations and paired up with specimens—creating a higher margin for error





Poll #1 Responses

How do you print – batch or on-demand?

- Batch
- On Demand

Prevent errors before they begin

Multiple opportunities for transcription errors are created when batch printing cassettes

- Sample mix-ups can occur in the laboratory at transition points where a requisition form or cassette are being matched to a specimen container or slide
- Batch workflow methods are used without automated systems that prevent errors
- An incorrect cassette or slide can easily be picked up



Batch Printing: Is the sample paired with the right matching printed cassette?



Transitioning from batch to on-demand

A few steps can help your lab start the journey to improved specimen tracking



PRINTER PLACEMENT

Begin by placing existing printers at the grossing station (cassette printers), or at the microtomy station (slide printers)



CONNECT AND TRACK

- Ensure the printer is connected with your LIS system if used
- If acquiring a new printer, look for a partner who offers supported integration with application specialists
- Set up protocols within the printer to deliver the right number—and type—of slides or cassettes for specific sample types



TRAIN STAFF ON THE BASICS

- Staff should all know how to scan individual blocks or slides for single slide or cassette printing as needed
- Train how to print from hopper of choice
- Look for a printer with a simple interface, and one that matches between slide and cassette printers to reduce training needed



- Work instructions
- Training checklists

Choosing an on-demand printer

Choosing the right printer and service partner can make printing easy for your lab

LOOK FOR A PRINTER THAT IS:

Small

• Workstations are often crowded--the smaller the printer footprint, the better

Fast and easy to use

- Cassettes or slides should print quickly, ~5 seconds
- Integrated label designers within the printer mean that you don't need additional software or computers
- Look for slide and cassette printers with the same software interface to reduce training burden

Designed with built-in tools for accuracy

- Integrated scanners can support the ability to scan data from a request form or tissue sample barcodes
- Ask if the printer has user login and tracking for traceability for root cause analysis
- Look for a printer with intelligent slide and cassette selection, printing the right type and number of slides or cassettes based on the protocol selected for each tissue type

Designed with connectivity in mind

- Easy to connect to any LIS system
- Flexible connectivity options depending on use

Ask if your printer vendor partner will support your team with LIS integration and training



Preventing common challenges with automated printing

- Print washes off or fades during processing due to harsh chemicals
 - Barcodes do not scan well as a result
 - This could be due to incompatible slides or cassettes
- Burden of matching cassettes to specimen containers + opportunity for mismatch errors
 - Move to on-demand printing
- High burden of printer maintenance
 - Look for a system with low maintenance
- Difficult connection to LIS or other systems
 - Ask about LIS compatibility and integration before you complete a purchase

Why consumables matter

Compatibility between consumable and printing method prevents errors

Choosing validated consumables designed for your printer ensures:

- Reliable barcodes that scan every time
- Downstream automation enablement
- Consistency in quality and performance
- Reduced risk of errors and downtime
- Reliable use month after month
- Look for a vendor partner who manufactures **both** the printer and consumables



Poll #2

What challenges do you face with adhesion slides?

- Tissue wash
- Background staining
- Printing
- Digital pathology



Is there a perfect slide? It depends on the needs of your lab

- What applications will the slide be used for?
- Hydrophilic or hydrophobic slide?
- How does your lab label and track slides?
- Is digital pathology used in your lab?
- Workflow is your lab set up to use different slides for different applications?

Anatomy of a slide

PAINT

Compatible with printers or hand labeling, various colors available

GLASS

Quality and purity

ADHESIVE COATING

Compatible with your tissues, processes, performance

SLIDE SEPARATORS

Small enough to not interfere with tissue and staining but large enough to separate slides to aid in printer throughput



WHAT MATTERS MOST IN YOUR LAB?

Applications

H&E

- Non-adhesion or Adhesion?
- Sticky for Tricky? Trickier tissues like breast, skin, nail, or bone?







Hydrophilic or Hydrophobic?

Hydrophilic	Hydrophobic
 Water loving "Chase" tissue section with slide Forceps to anchor tissue to slide Tissue section can be repositioned quickly if needed 	 Water repelling – almost like a raincoat Tissue section "jumps" onto slide and adheres easily, allowing you to pick up more slides in less time Tissue section "stuck" to slide and cannot be repositioned

Slide label paint compatibility with printing method matters

- Slide Printers
 - Ink jet
 - Thermal transfer
 - Laser
 - UV laser
 - IR laser
- Hand Label
- Print Labels



Thermal Transfer

S24-01114 Rodriguez. Simon Dr. Marvin Jones Alcian Blue 9/12/2024 Premium Slides



UV Laser



Showcased at NSH 2024

Demonstrates performance differences across histology applications, especially with tissue wash and background staining



Understanding slide adhesion NSH Poster

Assessing Adhesion Slide Performance Across Histology Applications

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OBJECTIVES

 Analyze the differences in contact angles and in tissue adherence during microtom Investigate whether different adhesion slides exhibit similar levels of background staining during histological staining procedure Evaluate and compare the tissue adhesion properties of adhesion slide brands across different tissue types and applications

BACKGROUND

Adhesion slides are widely preferred for IHC to aid in securing tissue sections to the slide and prevent reworks that could potentially postpon a patient diagnosis and drive-up costs in the lab. The cost of reworking a failed IHC slide due to poor tissue adhesion is estimated to be ~\$80 per slide, considering the reagent cost and workload administration.¹ Adhesion slides reinforce tissue adherence and integrity, mining zing the need to recut and restain the sample to ensure proper tissue morphological characteristics. Adhesion slides may also be used for H&E stains and special stains for added adhesion, but could retain excess reagent, or background staining, on the slide.

MATERIALS AND METHODS

Slides	Slides Ctd.	Stains • StatLab Vintage Hematoxylin	Instruments Biochrom Libra UV-visible
 StatLab Millennia[™] 1000 (M1000) StatLab Millennia[™] Command (MCOMM StatLab Millennia[™] 2000 (M2000) StatLab InkPro[™] + StatLab KT3+[™] 	 StatLab Colorview^{IM} + Marienfeld HistoBond[®] S+ Matsunami TOMO[®] DAKO Flex 	StatLab Village Hematoxylin StatLab Gill 3 Hematoxylin Quantum HDx Antigen Retrieval kits	Spectrophotometer Quantum HDx IHC Stainer MYR SS-30 Stainer KRUSS Drop Shape Analyzer
 StatLab KT5+™ 	 Epredia SuperFrost[™] 	 MasterTech GMS Stain Kit 	DSA100E

Contact Angle

The measurement of water droplet dispersion onto the slide surface is also used to determine the hydrophilicity / hydrophobicity of a slide's surface themistry³. A RMSS Drop Shape Analyzer was utilized to measure 1 mm of distilled water onto 8 locations on the slide and analyze the contact angle of the water as it mut the slide's surface (see Table 2).

Water Bath Behavior

When picking up tissue sections in a water bath, tissue can "jump" onto the slide (hydrophobic) or the slide "chases" the tissue prior to picking up leaving a thin layer of water spread underneath which allows the section to be positioned (hydrophilic). A "hybrid" slide exhibits dual behaviors: the section quickly jumps onto the slide but the tissue does not achor completely, allowing the tissue to be re-positioned. Three slides of the section quickly jumps onto the slide but the tissue does not achor completely, allowing the tissue to be re-positioned. Three slides of the section quickly jumps onto the slide but the tissue does not achor completely, allowing the tissue to be re-positioned. Three slides of the section quickly jumps onto the slide but the tissue does not achor completely allowing the tissue to be re-positioned. are second query long to the tits and too the called boost with altern compactly boost or the second point or the second of the

H&F Testing

H&E staining was performed on all slides to determine reagent coverage, adhesion and any excess stain remaining with spectrophotometer measurements. 21 slides of each brand/type were stained and assessed for tissue adhesion and reagent coverage. Samples of gut and fat were sectioned on each slide at 4 microns, incubated/dried, and stained on a Myr SS-30 automated stainer with three different hematoxylins StatLab Vintage, StatLab Reserve, and StatLab Gill 3. Slides were assessed visually for tissue adhesion, tissue adhesion, and reagent coverage. (see Tables 1 and 2)

Spectrophotometer Testing Protocol

Spectrophotometer testing was performed using the Biochrom Libra UV-visible Spectrophotometer to measure how much background spectrophotometer of many performance of the standard of the standard of the spectrophotometer of many spectrophotometer first as a reference, followed by the H&E stained slide of the same type. This testing was done to compare the intensity of any background color (see Tables 1 and 2).

Special Stains Testing Grocott Methenamine Silver (GMS) is a high-volume silver stain notorious for background staining. A GMS special stain was completed on each slide to assess background staining. Positive tissue for GMS was sectioned onto each slide at 4 microns and stained with a GMS stain kit using the manufacturer's suggested protocols. Following testing, slides were examined visually for background staining (see Tables 1 and 2).

IHC Testing

Fissue adhesion is one of the most important factors in Immunohistochemical (IHC) staining due to the aggressive nature of antigen retrieval IHC staining was performed on each adhesion slide to assess adhesion using a tissue microarray block composed of easy difficulty tissue (lymph, appendix, spleen, kidney), medium difficulty tissues (lung, foreskin, placenta, cervix, melanoma, colon), and hard difficulty tissues (skin fat, breast) sectioned onto slides at 4 microns, and dried for 50 minutes at 65°C. Tissue difficulty is based on the expectation of tissue wash or detachment based on combined knowledge in the field of histology. Appendix and spleen very rarely become detached where breast is well known to have tissue wash³. Antigen retrieval solutions at pH 6, pH 8, and pH 9 were used to include standard options available and to the aggressiveness of each one. After staining, each tissue section was graded microscopically for tissue adhesion (see Tables 1, 2, 3 and 4).

RESULTS

The differentiator for adhesion slides was apparent with IHC tissue adhesion. Easier tissues such as appendix and kidney performed well with most slide showing minimal failures. Variations in adhesion performance become more noticeable with medium difficulty tissues but was most substantial with tissue with hard difficulty, like breast. Failure rates due to tissue wash, folding, and separation with more difficult tissue were observed at a rate over 50% in more than half of the slide types tested (see Tables 3 and 4). This may result in additional material costs and histotech workload. Background staining showed some variation for both H&E and Special Stains. While excessive slide background may not affect tissue staining, it could be cause for an unacceptable slide for digital pathology and/or pathologist review, resulting in extra time and costs to repeat the stain. While contact angle and waterbath behavior affects tech workflow and preference, data did not support a correlation between slides for higher adhesion and lower background staining,









★ StatLab



CONCLUSION

After wide-ranging testing of adhesion slide characteristics, this study shows that not all adhesion slides are created equal. While water bath behavio showed to not be a relevant factor, there is considerable variation in background staining and tissue adhesion between slides. The results of this study suggest to labs that it is important to determine what the needs are for your laboratory based on the types of staining done and tissue types used, and test adhesion slides to find the right slide for your lab. The Matsunami TOMO and Dako Flex slides exhibited the strongest adhesion, but also had the least desirable background staining scores. The StatLab KT5+ scored similarly to TOMO and Dako Flex for adhesion, however background staining scores indicated minimal excess stain on the slide

Disclaimer: The finalings and canch

Background staining

Excessive background can be problematic in two ways:

 Pathologists view it as a sign of "sloppy" work

 \checkmark Can interfere with digital pathology

- H&E measured with a Spectrophotometer
- H&E and GMS measured visually

Image 1 Special stain testing (GMS) assessing background staining



IHC tissue adhesion

- True differentiator between adhesion brands
- Only a few slides were able to hold onto hard tissues like breast and skin
 - Matsunami TOMO
 - StatLab KT5+
 - Dako Flex



Sample B Shows tissue wash and folding

on breast tissue post-staining.



What is your repeat rate?

Poor slide adhesion could be driving up costs in your lab

Cost to rework failed IHC slide ~\$80/slide considering reagents costs and workload administration **Table 4** IHC Failure Rates for Tissue Types

	Overall Failure	Easy	Medium	Hard
Matsunami TOMO	2%	0%	5%	0%
Dako Flex	9%	0%	0%	22%
StatLab KT5+	8%	0%	5%	19%
Marienfeld HistoBond	30%	6%	18%	81%
StatLab MCOMM	22%	3%	7%	69%
StatLab KT3+	16%	0%	5%	47%
StatLab M2000	21%	0%	5%	68%
StatLab M1000	26%	0%	23%	65%
StatLab InkPro+	20%	0%	9%	50%
Epredia Superfrost+	29%	0%	9%	61%
StatLab Colorview+	25%	0%	10%	69%

IHC Tissues Tested Per Brand (N: ~100)

Failure Rate: a slide which lost 50% or more tissue during staining Easy Difficulty Tissues Tested Per Brand (N: ~30) Medium Difficulty Tissues Tested Per Brand (N: ~40) Hard Difficulty Tissues Tested Per Brand (N: ~30) Any slide which scored at a 1,2, or 3 out of 5 for tissue loss was considered a failure

Learning more about adhesion & background staining impact



Ventana BenchMark ULTRA Testing

Performance can vary depending on slide type used in specific IHC stainer platforms

Sample A

Tissue adhesion scoring results after aggressive antigen retrieval.

				Benign	Breast	Breast		
	Overall	Skin Shaves	Skin	Tonsil	Breast	Cancer A	Cancer B	
Sample A	4.60	5.00	5.00	5.00	4.17	4.25	4.17	
Sample B	4.19	4.83	4.17	4.83	2.75	4.75	3.83	
Sample C	3.31	4.50	4.33	4.67	1.42	2.58	2.33	

Table 2.

Failure rates by brand.

	Slides Tested	Slides Failed	% Fail	
Sample A	72	7	10%	
Sample B	72	16	22%	
Sample C	72	37	51%	

Grading Scale A.

Adhesion Scoring Criteria: % of tissue intact post-staining.



Failure defined as any slide scored at a 1, 2, or 3 out of 5 for tissue adhesion, indicating that 50% or less of the tissue remained on the slide after staining.

Is tissue wash preventing diagnosis?

Poor slide adhesion can lead to tissue wash and folding, preventing accurate diagnoses



Same block of breast cancer tissue

- Sample A maintained tissue integrity
- Sample B maintained tissue integrity
- Sample C lost more than 50% tissue (wash / folding)



Many factors contribute to an accurate diagnosis in a lab

Factors covered today:

- Best practices for accurate specimen identification and tracking
- Using automation to minimize human error
- Validated slides and cassettes for your printer
- High slide adhesion when it matters to prevent tissue wash
- Minimal background staining
- Look for a vendor partner who manufactures both the printer and consumables

Simple steps can improve results *Get curious in your lab*



- Ask questions to understand if incompatible consumables are making automation harder than it needs to be
 - Clues
 - Ribbon burning
 - Smeared slides or cassettes
 - Scanning errors
- Take steps to support on-demand printing
 - Look for a vendor partner who manufactures **both** the printer and consumables
- Choose the right slides for your application