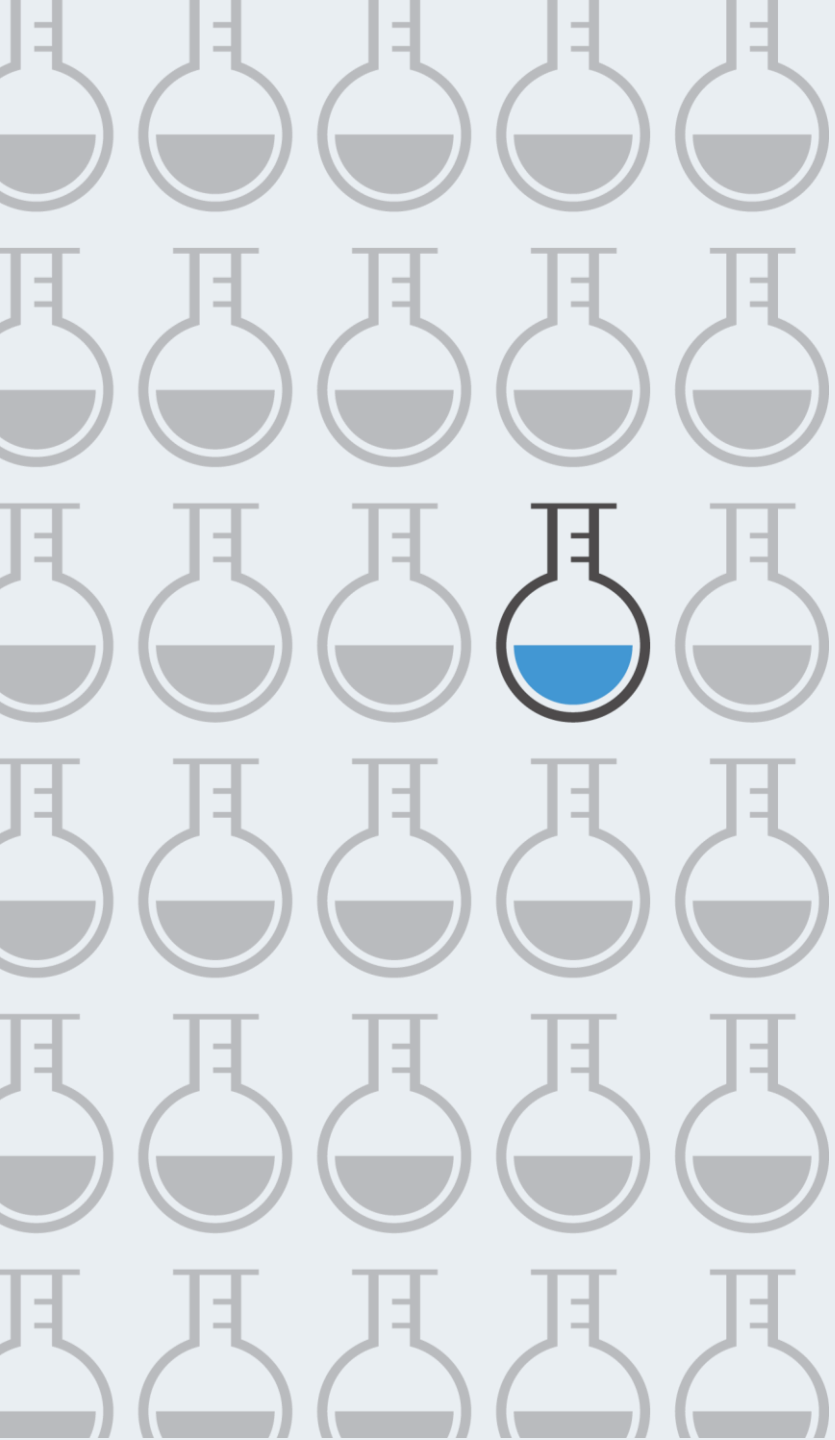
Division of Laboratory Systems

OneLab TEST

Developing and Implementing an Individualized Quality Control Plan

Dr. James Nichols

August 30, 2023



Agenda

- Introductions
  - Relevant OneLab TEST Resources
  - Today's Presenter
- Presentation: Developing and Implementing an Individualized Quality Control Plan
- Q&A
- Upcoming OneLab TEST events
- Closing Remarks

Related Division of Laboratory Systems (DLS) Resources

Lab Training | CDC

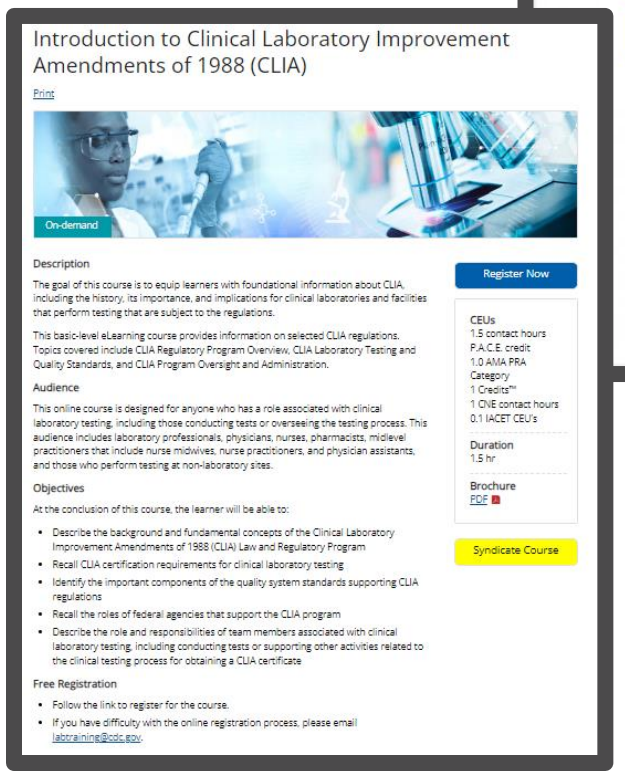
https://www.cdc.gov/labquality/iqcp.html

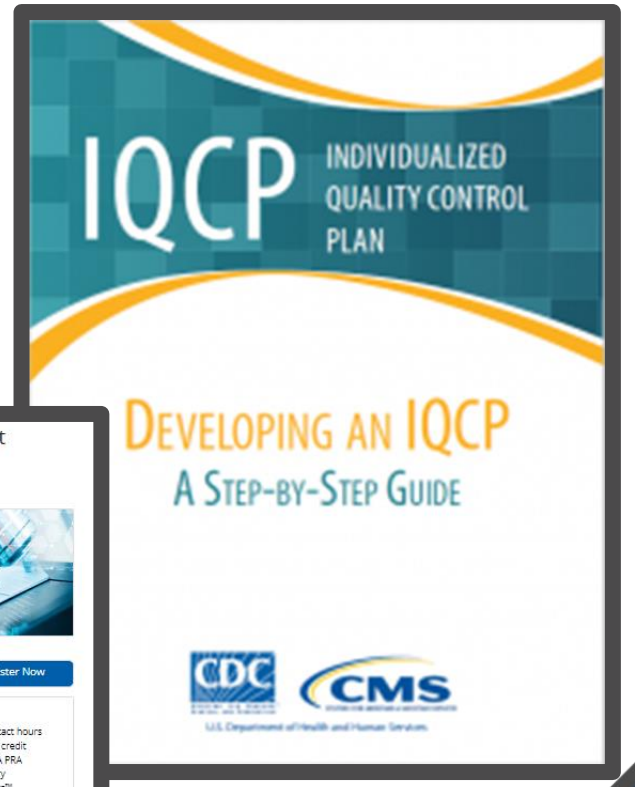
- Basic information on selected CLIA regulations.
- Topics covered include CLIA Regulatory Program Overview, CLIA Laboratory Testing and Quality Standards, and CLIA Program Oversight and Administration.
- To request hard copies, click here.

https://www.cdc.gov/labquality/waived-tests.html

- Enroll your laboratory or testing site in the CLIA program by completing an application available on the CMS CLIA website or from your local State Agency.

,





Presenter

James Nichols, PhD, DABCC, FAACC

Professor of Pathology, Microbiology and Immunology

Medical Director of Clinical Chemistry and
Point-of-Care Testing

Vanderbilt University Medical Center, Nashville, TN

Disclaimer

Slide decks may contain presentation material from panelists who are not affiliated with CDC. Presentation content from external panelists may not necessarily reflect CDC's official position on the topic(s) covered.

OneLab™ is a registered trademark

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

Developing and Implementing an Individualized Quality Control Plan

James H. Nichols, PhD, DABCC, FAACC

Professor of Pathology, Microbiology and Immunology

Medical Director of Clinical Chemistry and Point-of-Care Testing

Vanderbilt University Medical Center

Nashville, Tennessee, USA

james.h.nichols@vumc.org

Objectives

1. Recognize common sources of laboratory error
2. Identify CLSI EP23 guideline as a resource for risk management and building an IQCP
3. Appreciate the variety of engineered control processes manufacturers have built into POCT devices

History of Clinical Lab Risk Management

- CLIA 88 requires 2 levels of QC each day of testing!
- Newer lab devices offer internal and engineered control processes that make daily liquid QC duplicative and redundant.
- CMS implemented Equivalent QC (EQC) in 2003
- CLSI EP23 introduces industrial and ISO risk management principles to the clinical laboratory
- CMS adopted key risk management concepts to develop the IQCP option for quality control in 2016
- IQCP replaced 2003 Equivalent QC (EQC) options.

IQCP 2016

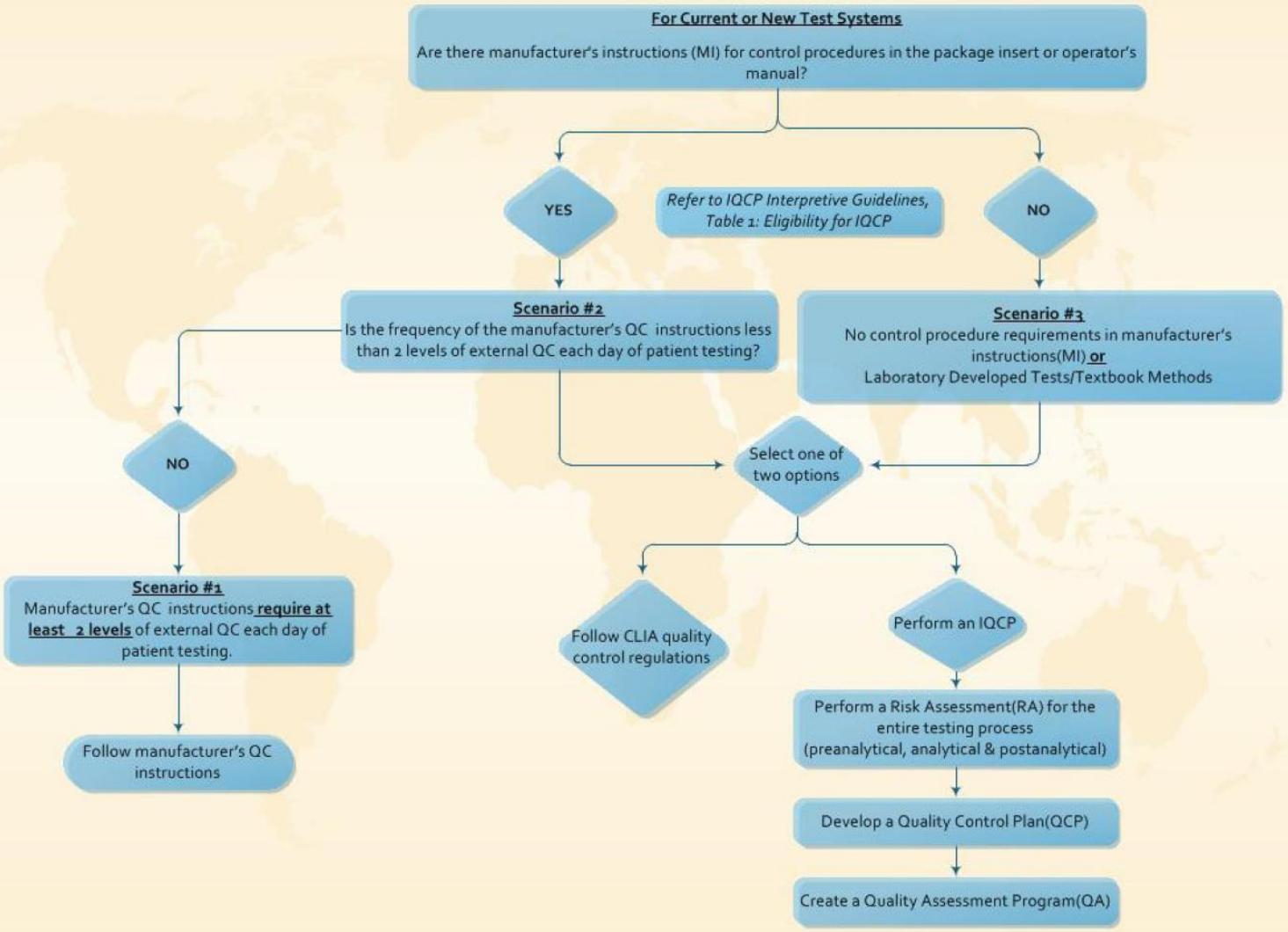
- Two levels of liquid QC required each day of testing

OR

- Laboratory develops an IQCP:
  - Balance internal control processes with external controls
  - Reduce frequency of liquid QC to minimum recommended by manufacturer
  - Maximize clinical outcome, available staff resources and cost effectiveness in the lab

CONSIDERATIONS FOR DEVELOPING AN INDIVIDUALIZED QUALITY CONTROL PLAN (IQCP)

This flowchart depicts the scenarios described in Brochure #12



VANDERBILT UNIVERSITY MEDICAL CENTER

CAP - Is My Test Eligible for an IQCP?

- To be eligible a test must meet both of these criteria:
  - Nonwaived tests that employ an internal (electronic/procedural/built-in) quality control system
    - Exception: Microbiology media and reagents used for microbial identification and susceptibility testing may implement an IQCP
  - Tests performed in specialties other than Anatomic Pathology and Cytopathology
    - Exception: If an Anatomic Pathology or Cytopathology test can be assigned to a different CMS subspecialty, it may quality
- IQCP requirements do not apply to waived testing

Individualized Quality Control Plan

Risk in the Laboratory

- There is no “perfect” laboratory device, otherwise we would all be using it!
- Any device can and will fail under the right conditions
- A discussion of risk must start with what can go wrong with a test (errors or nonconformities)
- Lab tests are not fool-proof!

What Could Go Wrong?

Risk Mitigation

- Liquid quality control is historic means of detecting and preventing errors (nonconformities or incidents)!
  - Liquid controls detect systematic errors that affect every sample the same way (calibration errors, pipette errors, reagent degradation)
  - Liquid controls do a poor job at detecting random errors that affect a single sample uniquely (hemolysis, lipemia, clots, drug interferences)
  - For unit-use tests, liquid controls consume entire test and do not ensure performance of next test
- Newer devices have built-in electronic controls, and “on-board” chemical and biological controls.

VANDERBILT UNIVERSITY
MEDICAL CENTER

Types of Quality Control

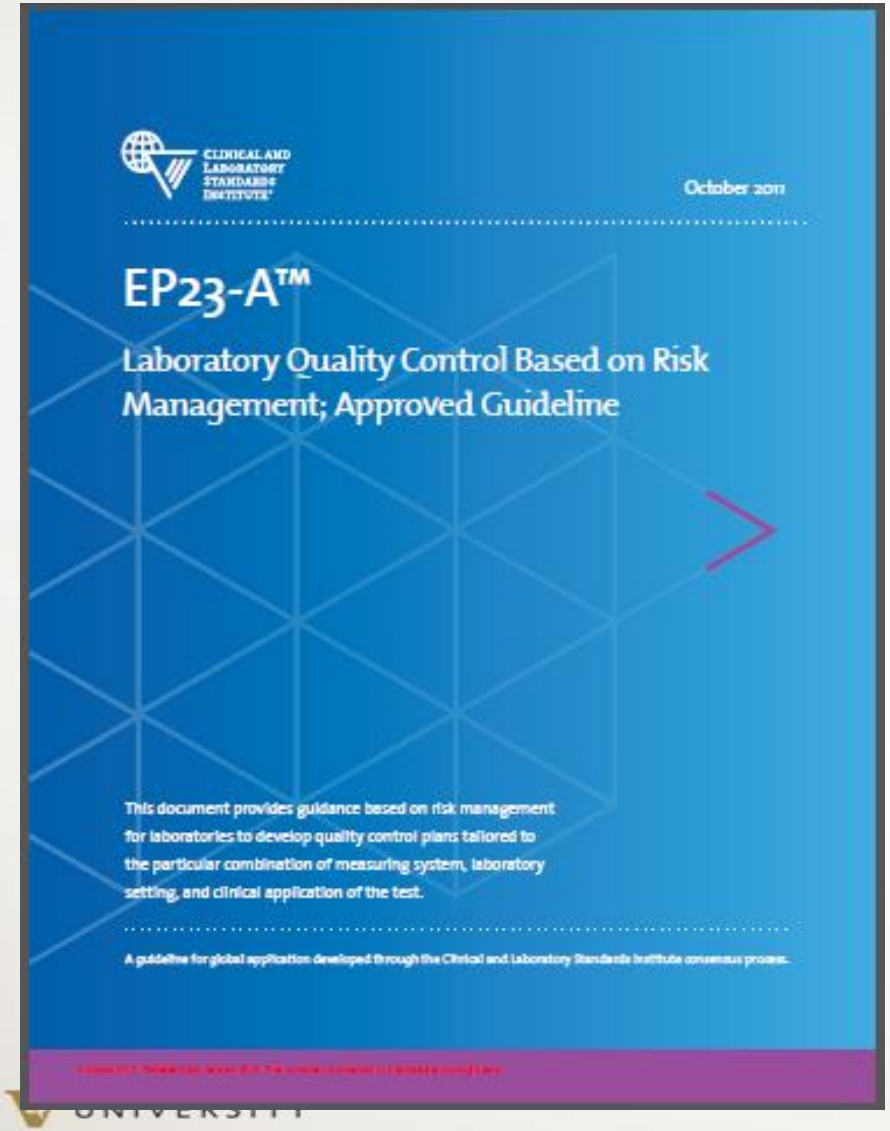
- "On-Board" or Analyzer QC – built-in device controls or system checks
- Internal QC – laboratory-analyzed surrogate sample controls
- External QC – blind proficiency survey
- Other types of QC – control processes either engineered by a manufacturer or enacted by a laboratory to ensure result reliability

Laboratory-Manufacturer Partnership

- No single QC procedure can cover all devices, because the devices may differ.
- Newer devices have built-in electronic controls, and “on-board” chemical and biological controls.
- Developing a quality plan surrounding a laboratory device requires a partnership between the manufacturer and the laboratory.
- Some sources of error may be detected automatically by the device and prevented, while others may require the laboratory to take action, such as analyzing surrogate sample QC on receipt of new lots of reagents.
- Clear communication of potential sources of error and delineation of laboratory and manufacturer roles for how to detect and prevent those risks is necessary.

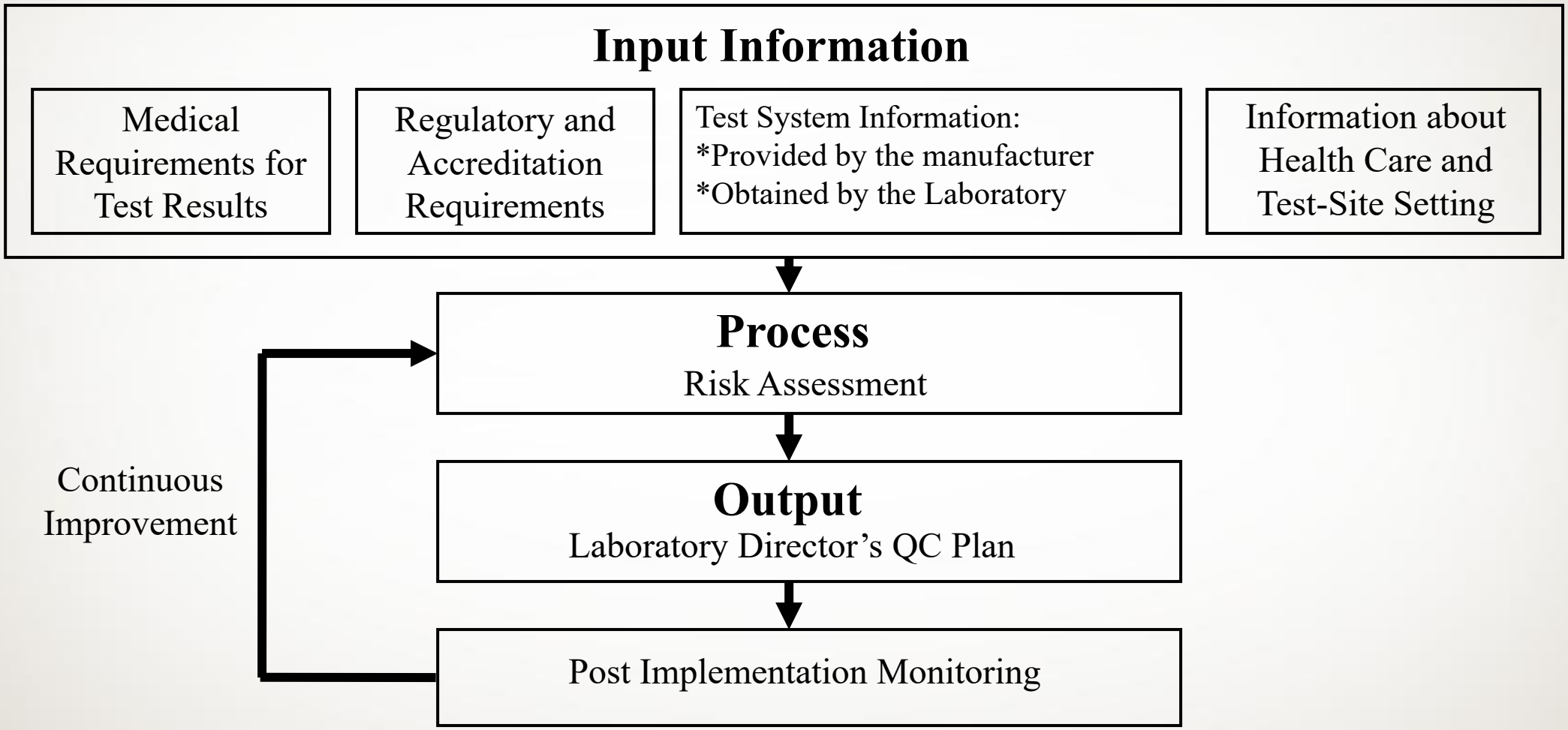
ISO. *Clinical laboratory medicine – In vitro diagnostic medical devices – Validation of user quality control procedures by the manufacturer*. ISO 15198. Geneva, Switzerland: International Organization for Standardization; 2004.

CLSI EP23



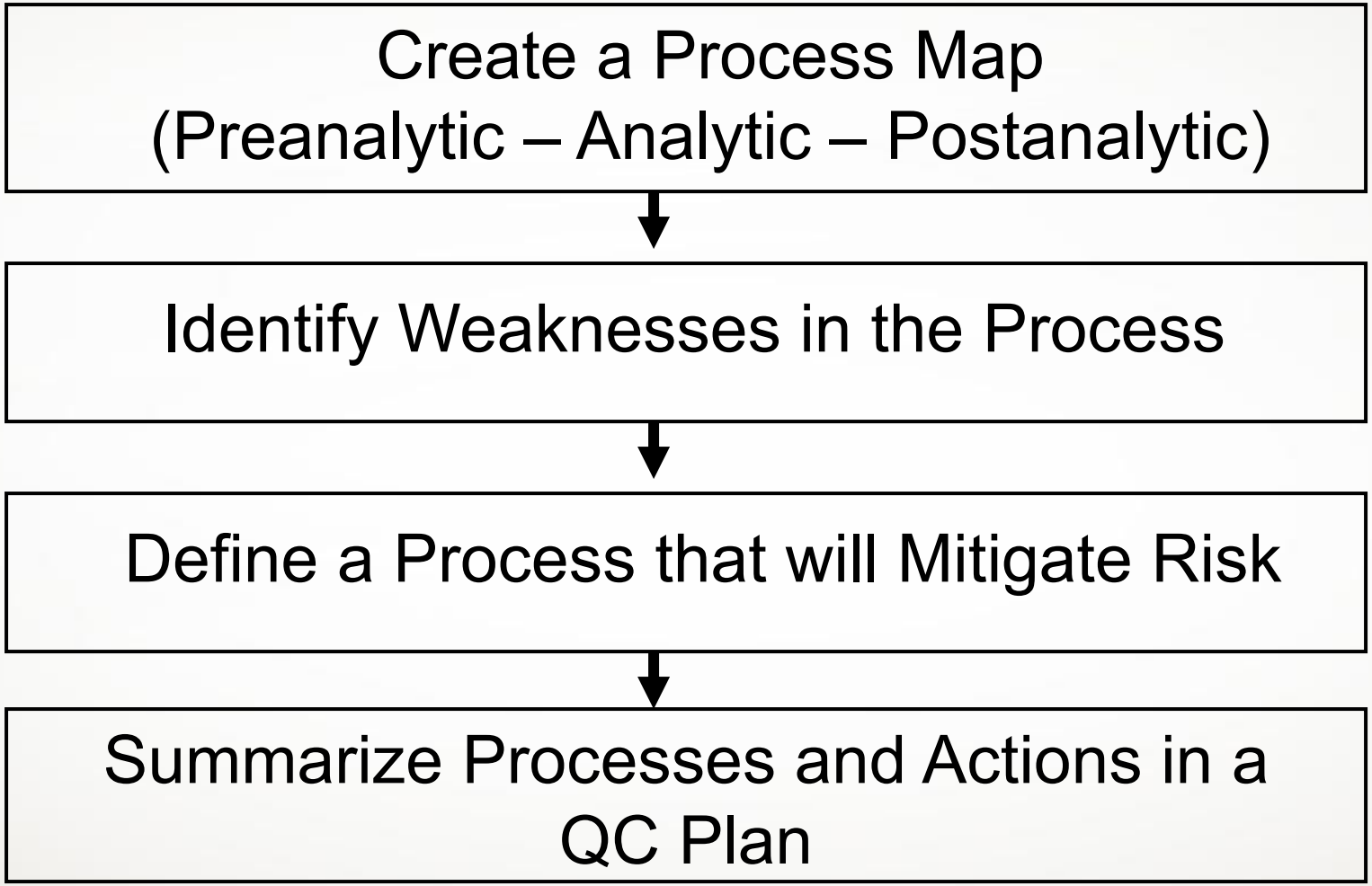
- Laboratory Quality Control Based on Risk Management.
- James H. Nichols, Ph.D., Chairholder
- EP23 describes good laboratory practice for developing a quality control plan based on manufacturer's information, applicable regulatory and accreditation requirements, and the individual healthcare and laboratory setting

EP23 Laboratory QC Based on Risk Management



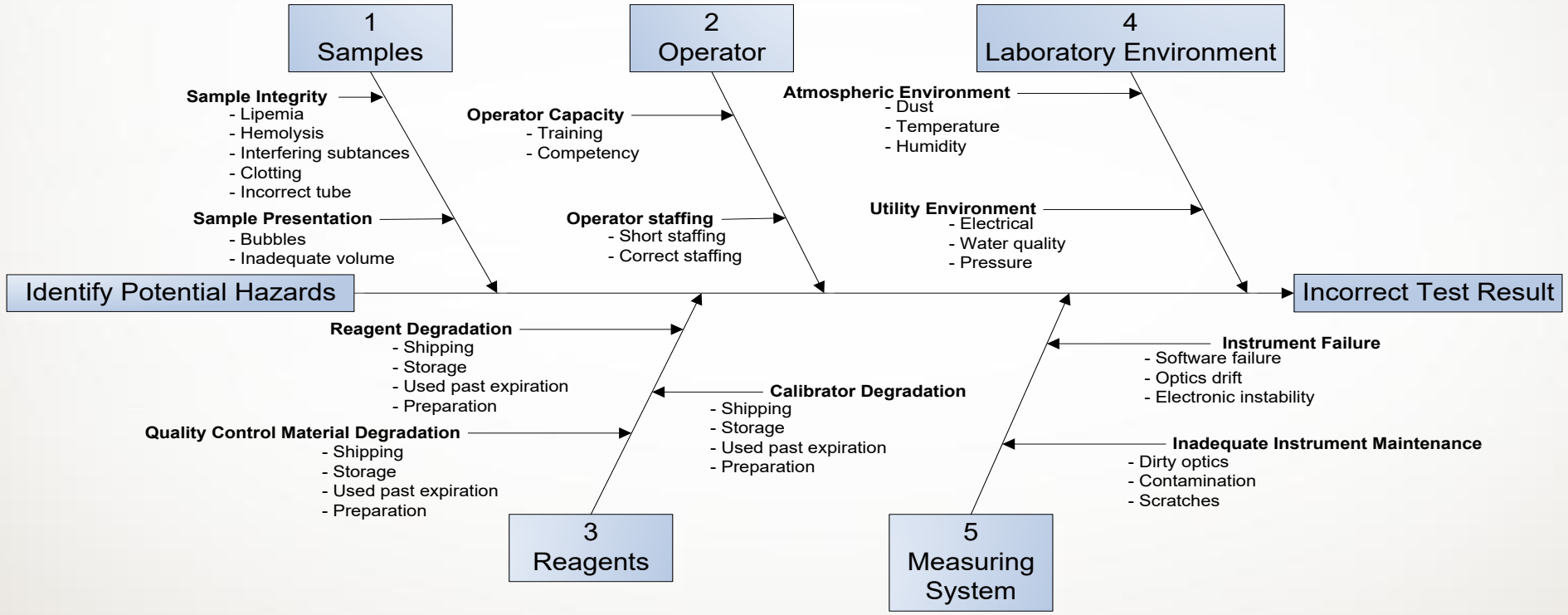
CLSI EP23 Table

EP23 Laboratory QC Based on Risk Management



Developing a Process Map

- Follow the testing process as if you were a sample…
- Look for weaknesses in each step of process



POCT

- Dozens of sites
- Hundreds of devices
- Thousands of operators!
- Too many cooks…

  spoil the broth!
- The number of sites, devices and operators plus the volume of testing creates a situation where rare events can become probable in every-day operations

Nothing is foolproof…

for a sufficiently talented fool!

(attributed to a distinguished colleague)

Risk Management

- Manufacturers consider potential for errors and address how these hazards are mitigated or reduced in FDA submissions based on “use-case scenarios”
- Use-case scenarios describe real-world examples of how one or more people interact with a device
- For example:
  - A POCT device may be taken to the patient’s bedside, or
  - A sample may be collected and transported to a device
- These two scenarios have different workflows and present different opportunities for error or risks!

Where is the Risk in Our Process?

Falsely Decreased Glucose Results

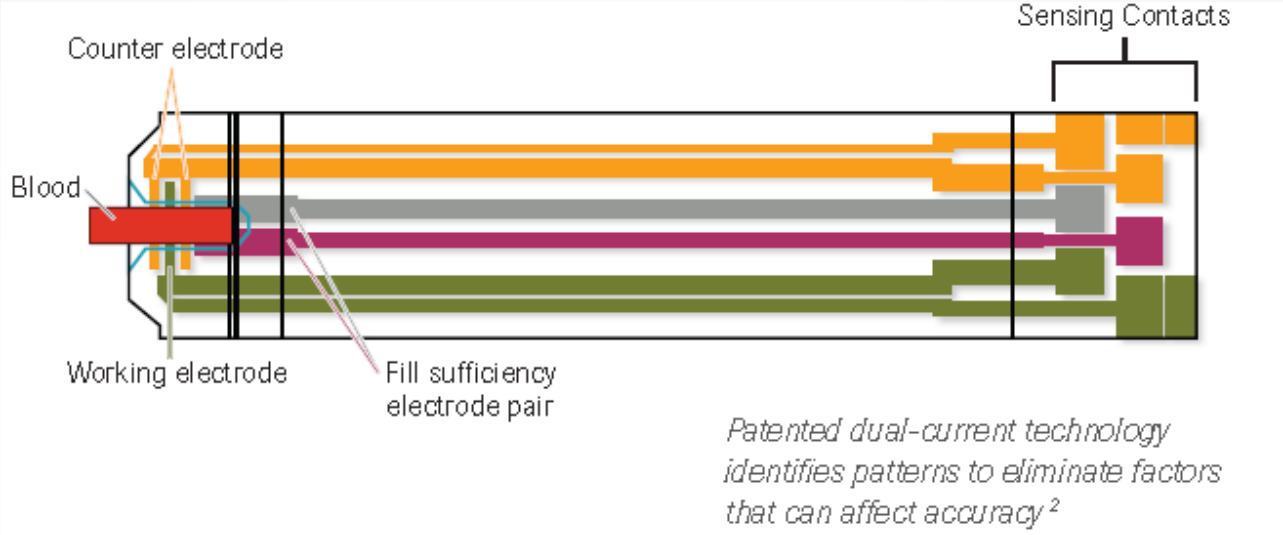
- Complaint from an ICU of sporadic falsely decreased glucose results
- Immediate repeat test on same meter, gave significantly higher “clinically sensible” values
- Inspection of unit found nurses taking procedural shortcuts to save time
- Bottles of test strips dumped on counter in spare utility room
- Some strips not making it into trash, falling back on counter and being “REUSED”

Risk of Error from Open Reagents

- Glucose test strips exposed to air for as little as 2 hours have been shown to cause -26% bias.[1]
- Strips left on counters pose risk of reuse, leading to falsely low results.
- Some meters catch reuse and "error" preventing a result. Other meters do not![2]

1. Keffer P, Kampa IS. *Diabetes* 1998; 47; abs 0170.
2. Silverman BC, Humbertson SK, Stem JE, Nichols JH. Operational errors cause inaccurate glucose results. *Diabetes Care* 2000;23:429-30.

Manufacturer Engineered Checks

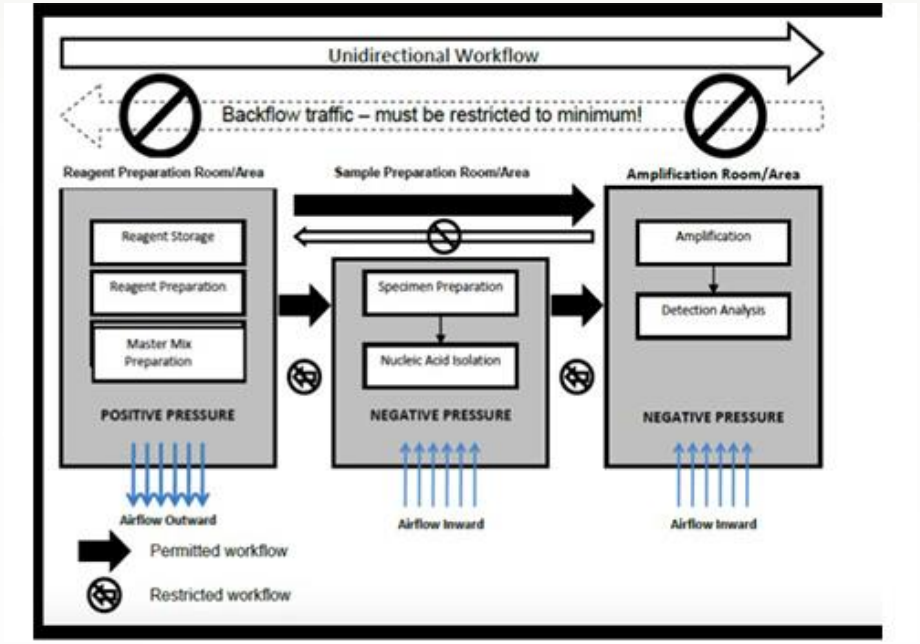


- Internal test strip checks can detect damage or abuse to strip (scratches, humidity, temperature)
- Used or wetted test strips
- Strip and code key match
- Compensate for hematocrit and temperature

POCT Molecular Infectious Disease

- Single-use cartridges – no carry-over
- Connectivity – cell or wired/wireless
- STDs, respiratory viruses, MRSA, C. difficile, next?
- Portable
- Minimal education for operation
- CLIA waived in US
- Clinic and other healthcare settings
- Developing countries/emerging markets
- Military deployment
- Disaster relief

Typical Molecular Lab Workflow



- Separation of reagent preparation, sample preparation and amplification to prevent cross-contamination
- With POCT sample prep and amplification is contained in same cartridge

Donato L. et al., Assessment of Test Performance and Potential for Environmental Contamination Associated with a Point-of-Care Molecular Assay for Group A Streptococcus in an End User Setting JCM 2019 http://doi.org/10.1128/JCM.01629-18

Sample Errors: Contamination

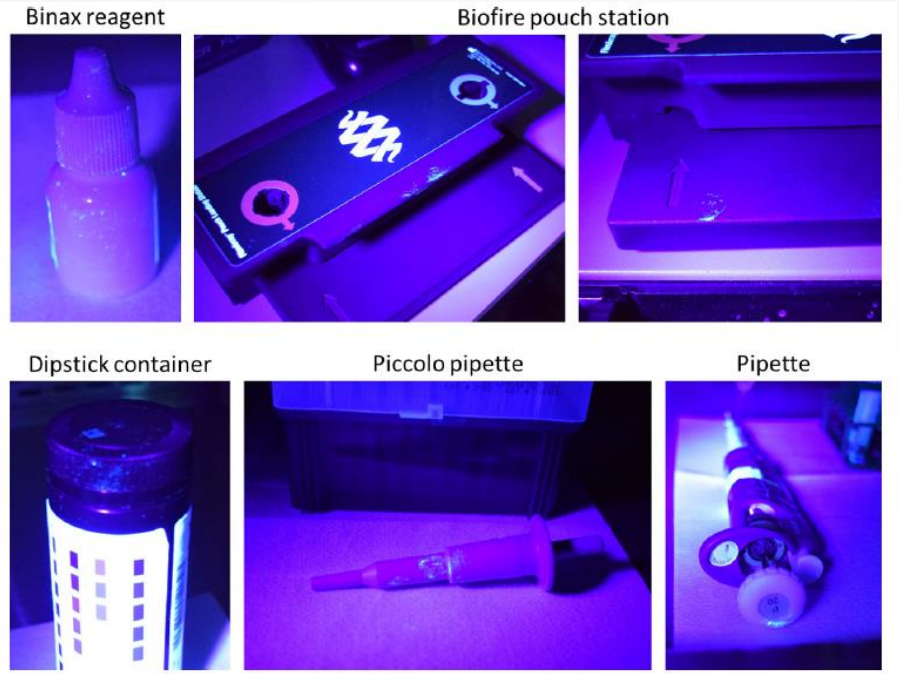


FIG 2 Examples of reagent bottles and accessory equipment contaminated during test setup.

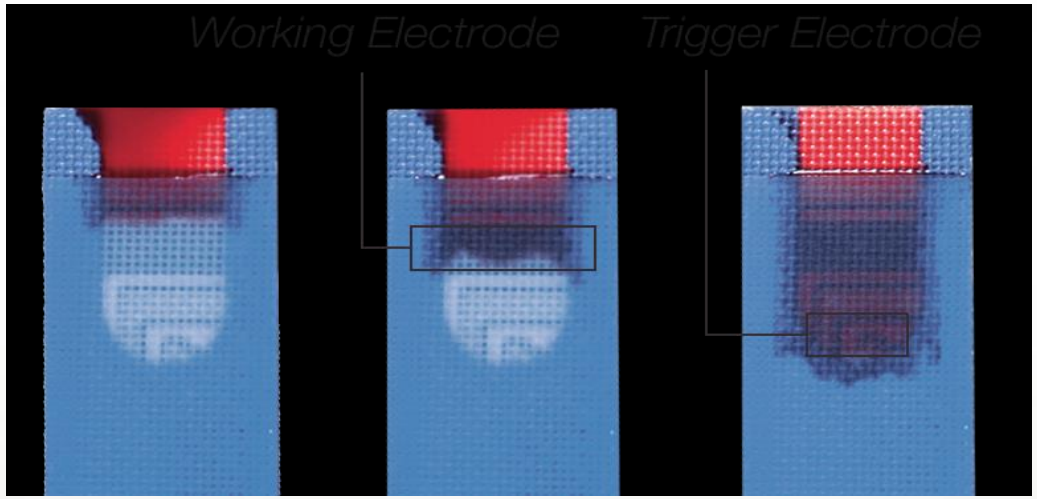
- Highly sensitive – small amounts nucleic acid amplified many fold!
- Yarbrough ML, et al. Frequency of Instrument, Environment, and Laboratory Technologist Contamination during Routine Diagnostic Testing of Infectious Specimens. J Clin Microbio 2018; Vol 56; e00225-18.
- Despite common spread of fluorescent powder, few amplifications of harmless bacteriophage noted during routine testing (3/268 = 1%)

Sample Errors: Contamination (continued)

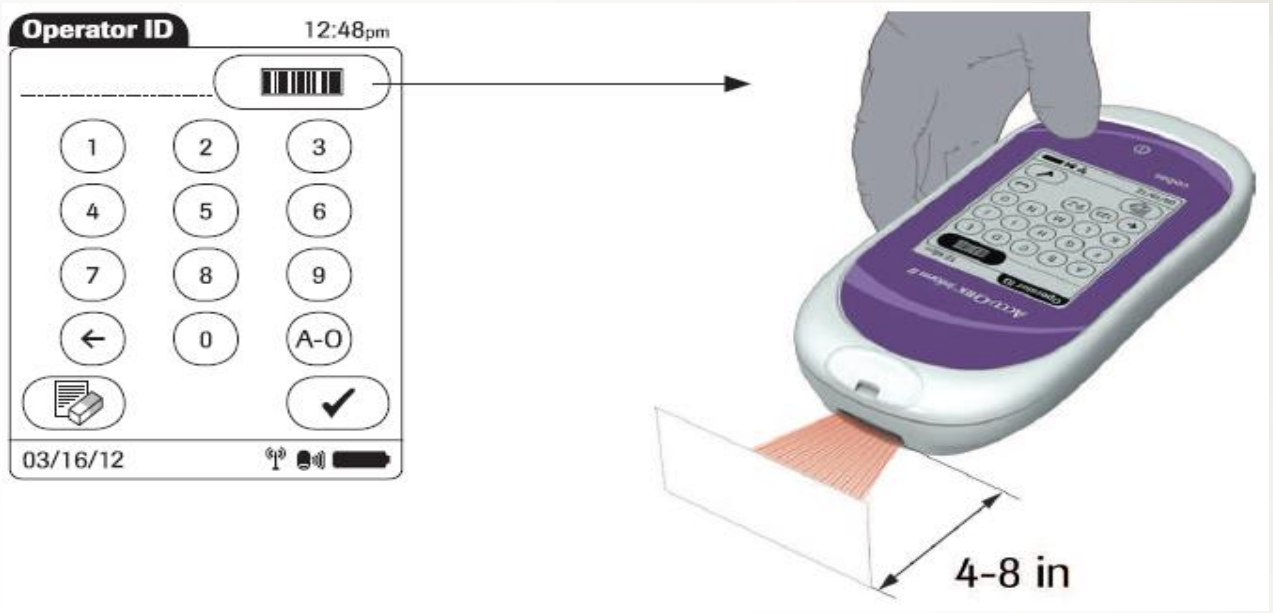
- Environmental - virus and fomites can persist on surfaces –
  - We teach staff common sources of contamination. Handle one sample at a time, routinely clean counter and instrument. Change gloves between samples, use integrated disposable pipette to transfer, do not allow swabs to drip on counters.
- Carry-over – single tube sampling, reaction contained in cartridge – train operators to not touch positive control swabs and then handle samples
- Waste contained - Dispose of cartridge/amplicons after reaction – do not crush cartridges (trash compactor)
- Color coded - sample device snaps to reaction cartridge – protects amplicon tubes

Sample Errors: Specimen Volume

- Some glucose meters recommend that operators visually inspect strips for uniform color development after each test (detects underfilling and bubbles)
- Other meters have automate sample detection. (Fill-trigger is designed to prevent short-sampling.)
- Test starts only when enough blood has been applied.



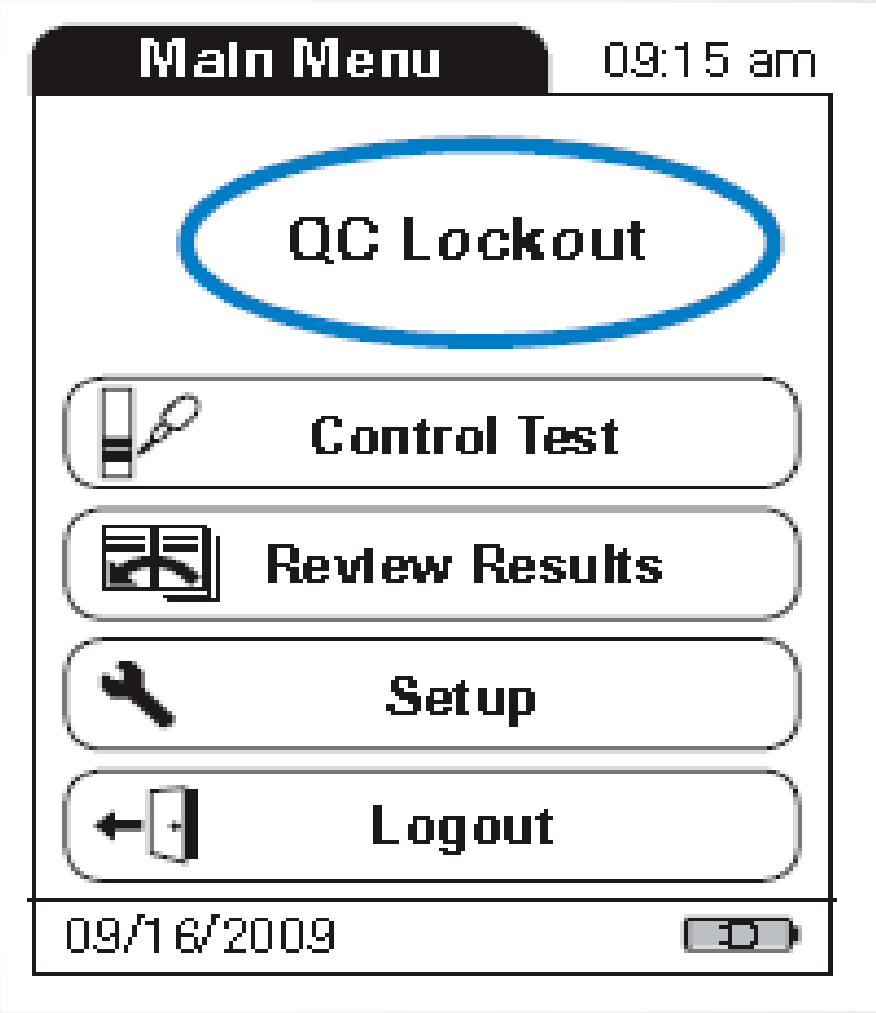
Operator Errors: Training/Competency



- Operator lockout
- Functions through number code, name or barcoded ID
- List of operators and training/competency dates maintained in data manager system–
- Devices can warn operators of impending certification due dates (in advance of lockout)

Operator Errors: Performing QC

- Devices require periodic QC
- QC lockout shuts off patient testing if QC not performed or fails target ranges.
- Prevents patient testing unless QC documented
- Operators workaround QC lockout by performing patient testing in QC mode!
- Newer devices distinguish QC samples, prevent patient testing in QC

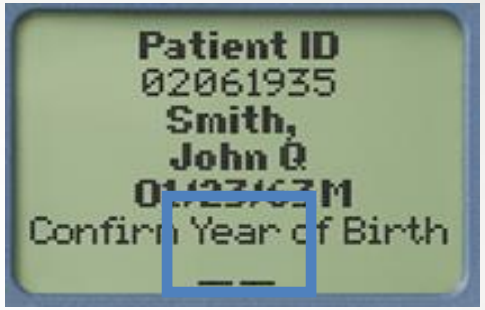


Operator Errors: Patient Identification

- Incorrect entry of patient identification can
  - Chart results to the wrong patient's medical record
  - Lead to inappropriate medical decisions and treatment
  - Improper billing and compliance
- Barcoded patient wristbands reduce the chance of misidentification, but patients can be banded with:
  - Another institution's identification
  - Outdated account numbers
  - A wrong patient's wristband
- Residual risk of error even with barcoded ID bands
- Barcoded ID entry alone doesn't satisfy requirement for patient safety - 2 unique identifiers

Operator Errors: Patient Identification (continued)

- Some devices have positive patient ID – ADT feed to device
- Two identifiers plus active confirmation (also satisfies Joint Commission time out)
- Positive patient ID reduced errors from 61.5 errors/month to 3 errors/month.[1] (unregistered patients; 2 ED and 1 non-ED) conducted over 2 months—38,127 bedside glucose tests.



J Pathol Inform

Technical Note

Reducing patient identification errors related to glucose point-of-care testing

Gaurav Alreja[1], Namrata Setia[2], James Nichols[2], Liron Pantanowitz[3]

[1]Department of Internal Medicine and [2]Pathology, Baystate Medical Center, Tufts University School of Medicine, Springfield, MA, [3]Department of Pathology, University of Pittsburgh Medical Center, Pittsburgh, PA, USA

E-mail: *Liron Pantanowitz – pantanowitzl@upmc.edu
*Corresponding author

Received: 31 July 10 Accepted: 27 November 10 Published: 11 May 11

This article may be cited as:
Alreja G, Setia N, Nichols J, Pantanowitz L. Reducing patient identification errors related to glucose point-of-care testing. J Pathol Inform 2011;2:22.

Copyright © 2010 Alreja G. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Background: Patient identification (ID) errors in point-of-care testing (POCT) can cause test results to be transferred to the wrong patient's chart or prevent results from being transmitted and reported. Despite the implementation of patient barcoding and ongoing operator training at our institution, patient ID errors still occur with glucose POCT. The aim of this study was to develop a solution to reduce identification errors with POCT.
Materials and Methods: Glucose POCT was performed by approximately 2,400 clinical operators throughout our health system. Patients are identified by scanning in wristband barcodes or by manual data entry using portable glucose meters. Meters are docked to upload data to a database server which then transmits data to any medical record matching the financial number of the test result. With a new model, meters connect to an interface manager where the patient ID (a nine-digit account number) is checked against patient registration data from admission, discharge, and transfer (ADT) feeds and only matched results are transferred to the patient's electronic medical record. With the new process, the patient ID is checked prior to testing, and testing is prevented until ID errors are resolved.
Results: When averaged over a period of a month, ID errors were reduced to 3 errors/

1. Alreja G, Setia N, Nichols J, Pantanowitz L. Reducing patient identification errors related to glucose point- of-care testing. J Pathol Inform 2011; 2: 22 [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3097526/]

Reagent Errors: Expired Reagents

- **Centers for Disease Control**
- "Check and record expiration dates of reagents/kits, and discard any reagents or tests that have expired."[1]

- **U.S. Food and Drug Administration**
- "Check the expiration date on the test strips. As a test strip ages, its chemical coating breaks down. If the strip is used after this time, it may give inaccurate results."[2]

1. Ready? Set? Test! Centers for Disease Control booklet http://wwwn.cdc.gov/dls/waivedtests/ReadySetTestBooklet.pdf
2. Useful Tips to Increase Accuracy and Reduce Errors in Test Results from Glucose Meters, U.S. Food and Drug Administration http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/TipsandArticlesonDeviceSafety/ucm109519.htm

Strip Wastage When Outdated

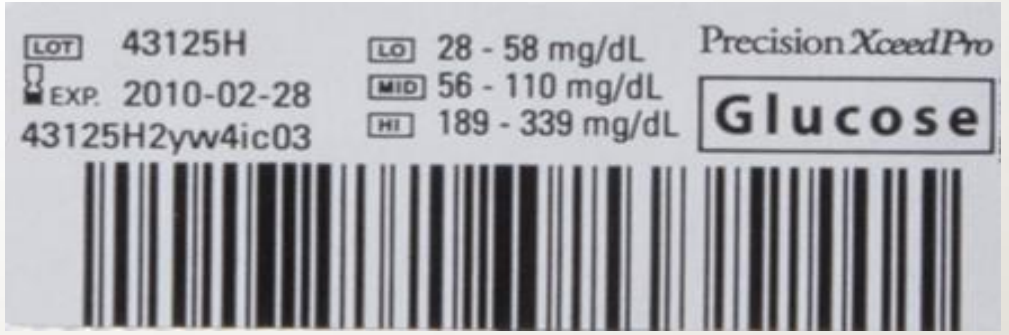
- Operator must check manufacturer's expiration date prior to testing.
- Vials/strips and controls must be manually dated when opened by operator (prematurely expires once opened)
- Undated, opened vials must be discarded. (? expiration)

Discarded strips due to no date[1]

1. Undated vials between September, 2010 and May, 2011, Willis-Knighton Medical Center, Shreveport, Louisiana

Reagent Errors: Expired Reagents

- Serialized vials/strips and controls barcoded for lot number and expiration date (good to stamped expiration date) can recognize individual vials on opening (30, 60 or 90 day open expiration)
- Automatic lockout for expired test strips and controls
- Some devices can also recognize exposure to humidity (few hours), wet or reused strips as additional control measure



Revised CAP Molecular POCT Checklist Questions

***REVISED** 10/24/2022*

POC.08675 Quality Monitoring Statistics **Phase I**

The laboratory monitors for the presence of false positive results (eg, due to nucleic acid contamination) for all molecular microbiology tests.

NOTE: Examples include: review of summary statistics (eg, monitoring percentage of positive results relative to current local and regional rates and increased positive Strep results above historical rate within a run or over multiple runs), performance of wipe (environmental) testing, and review and investigation of physician inquiries. Based on monitoring data, the laboratory may implement additional mitigation strategies to minimize the risk of contamination, such as process controls.

Evidence of Compliance:

✓ Records of data review, wipe testing, statistical data evaluation and corrective action if indicated

REFERENCES

1) Borst A, Box AT, Fluit AC. False-positive results and contamination in nucleic acid amplification assays: suggestions for a prevent and destroy strategy. *Eur J Clin Microbiol Infect Dis.* 2004; 23(4):289-99.
2) Cone RW, Hobson AC, Huang ML, Fairfax MR. Polymerase chain reaction decontamination: the wipe test. *Lancet.*1990; 336:686–687.
3) McCormack JM, Sherman ML, Maurer DH. Quality control for DNA contamination in laboratories using PCR- based class II HLA typing methods. *Hum Immunol.* 1997;54:82–88.
4) Clinical and Laboratory Standards Institute (CLSI). *Establishing Molecular Testing in Clinical Laboratory Environments;* 1st ed. CLSI document MM19-A. Clinical and Laboratory Standards Institute, Wayne, Pennsylvania, 2011.

POC.08690 Specimen Handling **Phase II**

The laboratory uses appropriate processes to prevent specimen loss, alteration, or contamination during collection, transport, processing and storage.

NOTE: Specimen collection, processing and storage must follow manufacturer's instruction and limit the risk of preanalytical error. For example, there must be a procedure to ensure absence of cross-contamination of samples during processing/testing for respiratory specimens tested at the point-of-care that may be sent to the laboratory for further testing.

It is also essential to follow the manufacturer's instructions for the handling of wastes (eg, used test cartridges) to prevent contamination.

***REVISED** 09/22/2021*

POC.08715 Safe Specimen Handling/Processing **Phase II**

The laboratory safely handles and processes specimens, including those suspected to contain highly infectious pathogens.

NOTE: These policies may be part of an institution's plan, but the plan must specifically address point-of-care.

Suggested topics to be considered in the policies and procedures include the need for tight sealing of containers, avoiding spills of hazardous materials, requirements for wearing gloves, the need for respirator protection, availability and use of vaccinations.

For specimens suspected of containing highly infectious pathogens, laboratories must review national, federal, state (or provincial), and local guidelines for the handling of specimens from patients suspected to have high risk pathogens, such as Francisella tularensis, avian influenza, Ebola, MERS coronavirus, SARS coronavirus, SARS-CoV-2 coronavirus, or any infectious agent that has a high potential to cause disease in individuals and communities.

Evidence of Compliance:

✓ Records of universal precaution training for all personnel handling suspected infectious pathogens

REFERENCES

1) Fleming DO, Hunt DL. Biological Safety, Principles and Practices, 3rd ed. ASM Press; Washington DC; 2006.
2) Miller JM, Astles R, Baszler T, et al; Biosafety Blue Ribbon Panel; Centers for Disease Control and Prevention (CDC). Guidelines for safe work practices in human and animal medical diagnostic laboratories. Recommendations of a CDC-convened, Biosafety Blue Ribbon Panel. *MMWR.* 2102; 61(suppl):1-102.
3) Department of Health and Human Services. Biosafety in Microbiological and Biomedical Laboratories, 6th ed. June 2020.

POC.08730 Final Report **Phase I**

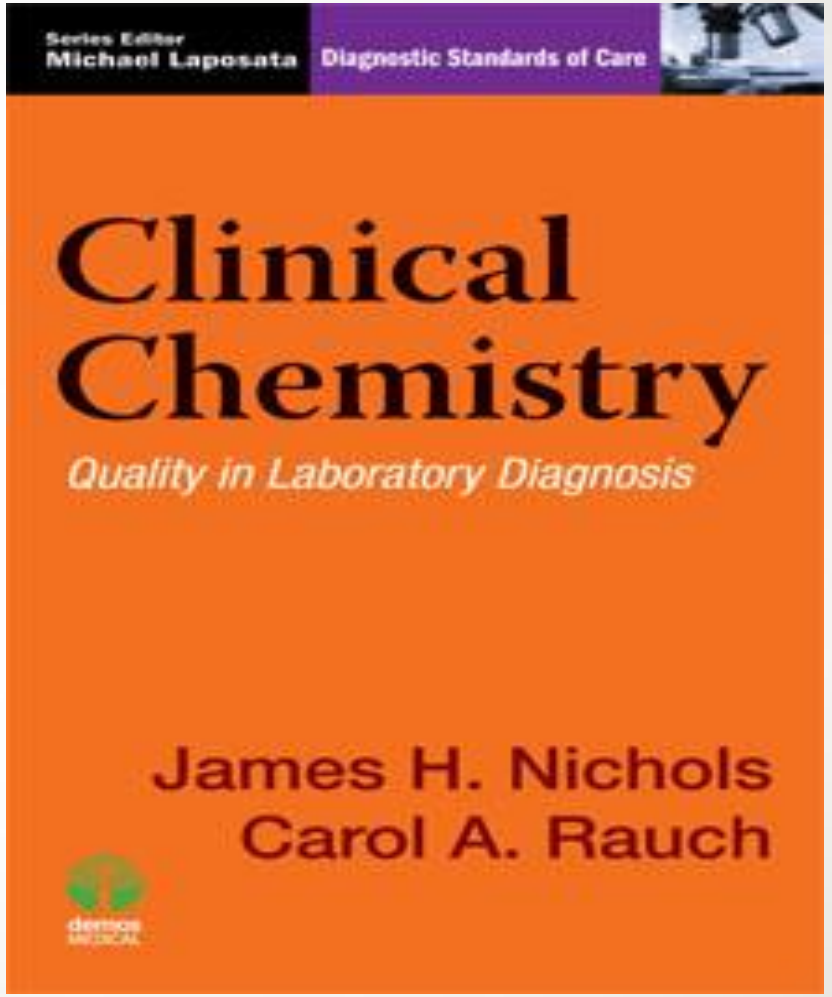
The final report includes a summary of the test method and information regarding clinical interpretation if appropriate.

Where is the Risk in the Process?

What Could Possibly Go Wrong?

Resource for Reducing Errors

- Clinical Chemistry book recently released!
- Focus on errors in the Chemistry Laboratory including POCT
- Discussion of real-world errors and what can be done to detect and prevent errors.



CLSI EP23 Revision Changes to Expect

- Align CLSI EP23 with ISO 22367 and ISO 14971
- Incorporate detectability in the risk assessment
- Replace “Glucose Concentration Measurement on an Automated Measuring System” example with real-world examples of quality control plans for non-instrumented, single-use device;instrumented, single-use device; and exempt microbiological media.
- Update references

Summary

- Many sources of laboratory error!
- Risk management assesses workflow for weaknesses and allows labs to take action before errors occur
- IQCPs are more than reducing the frequency of QC
- IQCPs provide opportunity for laboratories to interact with clinical departments on a shared QI project
- Improve workflow and operational efficiency
- IQCPs justify our actions, giving meaning to why we need to perform certain activities – beyond just meeting regulations

Q&A

Please send questions or suggestions for training content to

OneLabTEST@cdc.gov

Join OneLab TEST

or learn more

OneLab TEST

COMING SOON!

OneLab **TEST Event**

Personal Protective Equipment for Point-of-Care Testing Sites

October 31, 2023, 12 PM – 1 PM ET

Registration details coming soon!

OneLab Network

Attention Laboratory Professionals!

OneLab Network Upcoming Webinar

CLIA Proficiency Testing (PT) Final Rule, CMS-3355-F

September 7, 2023 12-1 PM ET

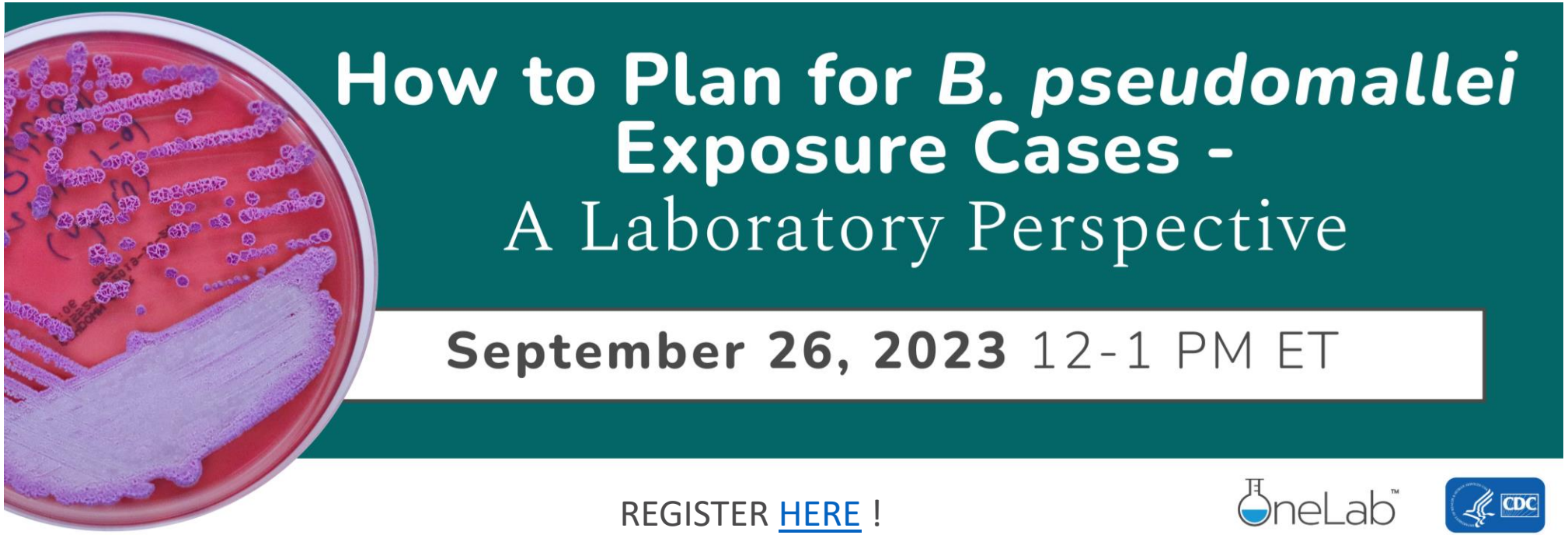
REGISTER HERE !

OneLab™ CDC

OneLab Network

Attention Laboratory Professionals!

OneLab Network Upcoming Webinar



REGISTER HERE !

OneLab™ CDC

OneLab Summit

COMING SOON!

OneLab **Summit 2023**

Thrive: People. Planning. Preparedness.

OCTOBER 3-5 | A Three-Day Virtual Learning Event

Developed for Laboratory Professionals to:

- Improve their skills through hands-on technologies, learning and development tools, and practices
- Glean insights from the laboratory community's success and resilience
- Collaborate and connect with CDC and laboratory education and training peers

REGISTER HERE!

Thank you!

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

OneLab™ is a registered trademark

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of Centers for Disease Control and Prevention.