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Autoverification & Moving Averages  
Lisa Kubit Palanca

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### Disclosures

- None



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### Speaker

- Lisa Kubit Palanca, MBA, MT (ASCP)
- Director of Enterprise Applications
- Cleveland HeartLab
- Specialty Reference Lab
  - We maintain a robust research and development program that partners with leading academic and medical institutions to bring unique biomarker technologies to market.



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## Objectives

- Participants will be able to recognize the challenges and benefits of auto-verification of clinical laboratory results in a reference laboratory setting.
- Participants will be able to recognize the challenges and benefits of moving averages for clinical chemistry results in a reference laboratory setting.
- Participants will be able to recognize the clinical laboratory tests that are amenable to moving averages and auto-verification.



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## Autoverification - Definitions

- Traditionally result verification done by tech on mental algorithms on a single test or group of tests considering patient status, diagnosis, location, etc.
- Autoverification "is a process where computer-based algorithms automatically perform actions on a defined subset of laboratory results without the need for manual intervention by a laboratorian."
- "Autoverification ensures that every result consistently receives the very same review process."

Autoverification of Clinical Laboratory Test Results; Approved Guideline, CLSI AUTO10-A, Vol. 26, No. 32.



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## Autoverification Resources

- Middleware Options
  - Data Innovations – Instrument Manager - Roche
  - Centralink™ Data Management System - Siemens
  - DXLab Workflow Manager – Beckman
  - Molis WAM - Sysmex
  - More?
- CLSI Document - Autoverification of Clinical Laboratory Test Results; Approved Guideline, CLSI AUTO10-A, Vol. 26, No. 32.
- CAP – Lab General Checklist



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## Challenges in Laboratory Medicine

- Economy – decreasing reimbursement
- Staffing Levels, shortage of skilled techs
- Lab consolidation, mothership taking smaller labs “routine” labs
- Regulations
- Lab errors – Pre-Analytical, Analytical, Post-Analytical
- Closing of MT/MLT schools
- Lack of college students entering field
- AACC Survey in 2009 found that 56% of laboratories do not autoverify lab results primarily because they lack the time to “figure it out.”



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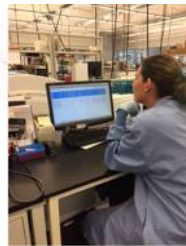
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## Verification of Tests – Manual Decisions

- Is QC acceptable?
- Should this be repeated?
- Does the result match previous?
- Are there any instrument flags?
- Does this need to be called
- Is the result medically feasible?
- Does the result match patient diagnosis
- Is the patient outpatient or inpatient?



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## Pre-Implementation Planning

- State Goals
- Lab Director consent
- Which tests to include
- LIS/Middleware capabilities
- Identify personnel
- Data gathering
- AutoV Plan
- Rules Writing
- Validation
- Beta testing
- Go Live
- Maintain/Add more tests/annual testing



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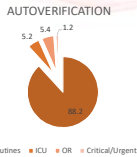
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### Autoverification Goals - Lab Leadership

- To autoverify \_\_\_ % of lab tests set up for Autoverification
- Decrease TAT from sample received to approved
- Reduce # of FTE hours spent manually reviewing test results
- Standardization of result review
- Techs focus on the problematic samples
  - Criticals/Urgents
  - < LDT or > CRR
  - Instrument flags or errors
- Reduce human error




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### Laboratory Director Consent

- It is important for Laboratory Director(s) to approve the use of autoverification before you even start
  - CAP GEN.43850 Autoverification Approval
- There is a policy signed by the laboratory director approving the use of autoverification procedures
  - CLSI Autoverification of Clinical Laboratory Test Results; Approved Guideline (AUTO10-A)
- Qualified Laboratory Director must establish policies and procedure for allowing autoverification

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### Best Tests to Include in AutoV

**Yes**

- Clinical Chemistry
- Hematology
- Urinalysis
- Coagulation

Focus on high volume,  
lower complexity testing

**No**

- Immunology
- Blood Bank
- Microbiology
- Special Chemistry
- MS/MS
- Molecular
- Genetic
- Pathology

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### LIS/Middleware Capabilities

- Do you have middleware? Purchase?
- LIS capable of rule writing?
  - Result Evaluation Rules, Reflex Rules, Calculations etc.
- LIS capable of AutoV?
- Do you have the capability to suspend AutoV if QC failure?
- Security access changes to suspend AutoV in LIS?
- Rules in middleware, LIS or both?



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### Personnel Challenges

- Gather team
  - LIS Staff
  - Technical Coordinator/Supervisor
  - Techs
  - SME
- Talent that can write rules?
- Send staff for training?
- Time – can someone be scheduled off bench to work on AutoV prep?



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### SME – Data Gathering

- How do you want to handle critical/urgent results?
- Do you have delta checks in place?
- Do you have locations/units that you would exclude? Ex. ICU, OR, Peds
- Do you have HIL levels/comments
- If Hold test or entire sample/accession?
- Specimen integrity issues
- What is current lab repeat process



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### Data Gathering

- Instrument Errors and Flags
- Indices
- <LDT or >CRR
- Specimen Integrity (ex. EDTA Contamination, Delay Centrifugation...)
- Delta Check
- Calculation
- Dilutions
- Formatting test results/Rounding
- Reflexes
- Criticals and Urgents
- Reruns

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### Challenges with Data Gathering

- Procedure vs. Tech's knowledge
- Procedure vs. Laboratory Director
- Up-to-date Technical Resources, ex. package inserts
- Techs vs. techs (one does it one way, another tech another way)
- Shifts vs. shifts
- We've always done it this way
- Procedures must be clear – how results are reported!

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### Rule Planning


- Write out main Algorithms

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      S249 -- NO --> S499{ }
      S250 -- YES --> S500{ }
      S250 -- NO --> S501{ }
      S251 -- YES --> S502{ }
      S251 -- NO --> S503{ }
      S252 -- YES --> S504{ }
      S252 -- NO --> S505{ }
      S253 -- YES --> S506{ }
      S253 -- NO --> S507{ }
      S254 -- YES --> S508{ }
      S254 -- NO --> S509{ }
      S255 -- YES --> S510{ }
      S255 -- NO --> S511{ }
      S256 -- YES --> S512{ }
      S256 -- NO --> S513{ }
      S257 -- YES --> S514{ }
      S257 -- NO --> S515{ }
      S258 -- YES --> S516{ }
      S258 -- NO --> S517{ }
      S259 -- YES --> S518{ }
      S259 -- NO --> S519{ }
      S260 -- YES --> S520{ }
      S260 -- NO --> S521{ }
      S261 -- YES --> S522{ }
      S261 -- NO --> S523{ }
      S262 -- YES --> S524{ }
      S262 -- NO --> S525{ }
      S263 -- YES --> S526{ }
      S263 -- NO --> S527{ }
      S264 -- YES --> S528{ }
      S264 -- NO --> S529{ }
      S265 -- YES --> S530{ }
      S265 -- NO --> S531{ }
      S266 -- YES --> S532{ }
      S266 -- NO --> S533{ }
      S267 -- YES --> S534{ }
      S267 -- NO --> S535{ }
      S268 -- YES --> S536{ }
      S268 -- NO --> S537{ }
      S269 -- YES --> S538{ }
      S269 -- NO --> S539{ }
      S270 -- YES --> S540{ }
      S270 -- NO --> S541{ }
      S271 -- YES --> S542{ }
      S271 -- NO --> S543{ }
      S272 -- YES --> S544{ }
      S272 -- NO --> S545{ }
      S273 -- YES --> S546{ }
      S273 -- NO --> S547{ }
      S274 -- YES --> S548{ }
      S274 -- NO --> S549{ }
      S275 -- YES --> S550{ }
      S275 -- NO --> S551{ }
      S276 -- YES --> S552{ }
      S276 -- NO --> S553{ }
      S277 -- YES --> S554{ }
      S277 -- NO --> S555{ }
      S278 -- YES --> S556{ }
      S278 -- NO --> S557{ }
      S279 -- YES --> S558{ }
      S279 -- NO --> S559{ }
      S280 -- YES --> S560{ }
      S280 -- NO --> S561{ }
      S281 -- YES --> S562{ }
      S281 -- NO --> S563{ }
      S282 -- YES --> S564{ }
      S282 -- NO --> S565{ }
      S283 -- YES --> S566{ }
      S283 -- NO --> S567{ }
      S284 -- YES --> S568{ }
      S284 -- NO --> S569{ }
      S285 -- YES --> S570{ }
      S285 -- NO --> S571{ }
      S286 -- YES --> S572{ }
      S286 -- NO --> S573{ }
      S287 -- YES --> S574{ }
      S287 -- NO --> S575{ }
      S288 -- YES --> S576{ }
      S288 -- NO --> S577{ }
      S289 -- YES --> S578{ }
      S289 -- NO --> S579{ }
      S290 -- YES --> S580{ }
      S290 -- NO --> S581{ }
      S291 -- YES --> S582{ }
      S291 -- NO --> S583{ }
      S292 -- YES --> S584{ }
      S292 -- NO --> S585{ }
      S293 -- YES --> S586{ }
      S293 -- NO --> S587{ }
      S294 -- YES --> S588{ }
      S294 -- NO --> S589{ }
      S295 -- YES --> S590{ }
      S295 -- NO --> S591{ }
      S296 -- YES --> S592{ }
      S296 -- NO --> S593{ }
      S297 -- YES --> S594{ }
      S297 -- NO --> S595{ }
      S298 -- YES --> S596{ }
      S298 -- NO --> S597{ }
      S299 -- YES --> S598{ }
      S299 -- NO --> S599{ }
      S300 -- YES --> S600{ }
      S300 -- NO --> S601{ }
      S301 -- YES --> S602{ }
      S301 -- NO --> S603{ }
      S302 -- YES --> S604{ }
      S302 -- NO --> S605{ }
      S303 -- YES --> S606{ }
      S303 -- NO --> S607{ }
      S304 -- YES --> S608{ }
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      S306 -- YES --> S612{ }
      S306 -- NO --> S613{ }
      S307 -- YES --> S614{ }
      S307 -- NO --> S615{ }
      S308 -- YES --> S616{ }
      S308 -- NO --> S617{ }
      S309 -- YES --> S618{ }
      S309 -- NO --> S619{ }
      S310 -- YES --> S620{ }
      S310 -- NO --> S621{ }
      S311 -- YES --> S622{ }
      S311 -- NO --> S623{ }
      S312 -- YES --> S624{ }
      S312 -- NO --> S625{ }
      S313 -- YES --> S626{ }
      S313 -- NO --> S627{ }
      S314 -- YES --> S628{ }
      S314 -- NO --> S629{ }
      S315 -- YES --> S630{ }
      S315 -- NO --> S631{ }
      S316 -- YES --> S632{ }
      S316 -- NO --> S633{ }
      S317 -- YES --> S634{ }
      S317 -- NO --> S635{ }
      S318 -- YES --> S636{ }
      S318 -- NO --> S637{ }
      S319 -- YES --> S638{ }
      S319 -- NO --> S639{ }
      S320 -- YES --> S640{ }
      S320 -- NO --> S641{ }
      S321 -- YES --> S642{ }
      S321 -- NO --> S643{ }
      S322 -- YES --> S644{ }
      S322 -- NO --> S645{ }
      S323 -- YES --> S646{ }
      S323 -- NO --> S647{ }
      S324 -- YES --> S648{ }
      S324 -- NO --> S649{ }
      S325 -- YES --> S650{ }
      S325 -- NO --> S651{ }
      S326 -- YES --> S652{ }
      S326 -- NO --> S653{ }
      S327 -- YES --> S654{ }
      S327 -- NO --> S655{ }
      S328 -- YES --> S656{ }
      S328 -- NO --> S657{ }
      S329 -- YES --> S658{ }
      S329 -- NO --> S659{ }
      S330 -- YES --> S660{ }
      S330 -- NO --> S661{ }
      S331 -- YES --> S662{ }
      S331 -- NO --> S663{ }
      S332 -- YES --> S664{ }
      S332 -- NO --> S665{ }
      S333 -- YES --> S666{ }
      S333 -- NO --> S667{ }
      S334 -- YES --> S668{ }
      S334 -- NO --> S669{ }
      S335 -- YES --> S670{ }
      S335 -- NO --> S671{ }
     
```

## Organize Rules

- Put rules into categories for easier writing and organization
- QC Rules
- Urgent & Critical Rules
- Result Formatting Rules
- HIL Rules
- Reflex Rules
- Calculations
- Delta Checks, etc.....
- Error flags

 Know your risk.

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## Write Rules

- Rules are logic statements “If” “then” statements or “Condition” “Action”
- Example: “If” it is raining and I left my car windows open, “then” remind me to close them.
- Include checking for numeric results

```
If: ( {Test Result of} "Na" < "130" ) (AND) ( {Test Result of} "Na" [Is Numeric] )
Then: {Hold Test for Verification} "Na"
```

 Know your risk.

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## Write Rules - Examples

If: ( {Test Result of} "CR" > "200" ) (AND) ( {Test Result of} "CK" [Is Numeric] ) Then: {Order Test} "CK-MD"	Reflex Rule
If: ( {Test Result of} "BINOCREA" [Is Numeric] ) Then: {Round Last Result of} "BINOCREA" [to] "2" [Decimal Places]	Rounding Rule
If: ( {Test Result of} "Na" [Is Numeric] ) (AND) ( {Test Result of} "Na" < "130" ) Then: {Order Test} "Na"	Rerun Rule
If: ( {Test Result of} "Na" [Is Numeric] ) (AND) ( {Test Result of} "Na" < "130" ) Then: {Add Test Comment of} "Na" "Below Reference Range"	Test Comment Rule

 Know your risk.

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# Reference Range Testing

Test at cutoffs

BiCCEP	Gender	Age/Height	Age/Height	IS	MG/DL	Expected result to (check) red dot
4030	M	<17	160-170	1.70	496235	all of the following: Magnesium Panel 1-1-16
4030	M	17-19	160-170	1.70	496235	all of the following: Magnesium Panel 1-1-16
4030	M	20-39	160-170	1.70	496235	all of the following: Magnesium Panel 1-1-16
4030	F	16-18	160-170	1.70	496235	all of the following: Magnesium Panel 1-1-16
4030	F	19-39	160-170	1.70	496235	all of the following: Magnesium Panel 1-1-16
4030	F	40-99	160-170	1.70	496235	all of the following: Magnesium Panel 1-1-16
4111	M	0	0	2.0-2.5	4111	all of the following: Magnesium Panel 1-1-16
4111	M	0	0	2.5-3.0	4111	all of the following: Magnesium Panel 1-1-16
4111	M	0	0	3.0-3.5	4111	all of the following: Magnesium Panel 1-1-16
4111	M	1-3	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	M	4-16	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	M	17-19	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	M	20-39	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	M	40-99	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	F	0	0	2.0-2.5	4111	all of the following: Magnesium Panel 1-1-16
4111	F	0	0	2.5-3.0	4111	all of the following: Magnesium Panel 1-1-16
4111	F	0	0	3.0-3.5	4111	all of the following: Magnesium Panel 1-1-16
4111	F	1-3	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	F	4-16	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	F	17-19	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	F	20-39	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16
4111	F	40-99	1.6-1.7	1.6-1.7	4111	all of the following: Magnesium Panel 1-1-16

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# Plan – Sign off on Cover Sheet

Completed by:	Sharon M. Miller	Date:	07/13/17
Reviewed by:	Director of Clinical Operations	Date:	
Approved by:	Sharon M. Miller	Date:	07/13/17
Reviewed by:	Director of Quality Improvement	Date:	

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# Plan – Test at all Possibilities

If Calcium result is <= 5.0 and Potassium >8.0  
Then "Hold" test and Error Description = "Check results-Possible EDTA contamination"

≥5.0, test at 4.9, 5.0, 5.1  
>8.0, test at 8.0, 8.1

IS	MG/DL	IS	MG/DL	IS	MG/DL	IS	MG/DL
4030	2.0	4030	2.0	4030	2.0	4030	2.0
4030	2.5	4030	2.5	4030	2.5	4030	2.5
4030	3.0	4030	3.0	4030	3.0	4030	3.0
4030	3.5	4030	3.5	4030	3.5	4030	3.5
4030	4.0	4030	4.0	4030	4.0	4030	4.0
4030	4.5	4030	4.5	4030	4.5	4030	4.5
4030	5.0	4030	5.0	4030	5.0	4030	5.0
4030	5.5	4030	5.5	4030	5.5	4030	5.5
4030	6.0	4030	6.0	4030	6.0	4030	6.0
4030	6.5	4030	6.5	4030	6.5	4030	6.5
4030	7.0	4030	7.0	4030	7.0	4030	7.0
4030	7.5	4030	7.5	4030	7.5	4030	7.5
4030	8.0	4030	8.0	4030	8.0	4030	8.0
4030	8.5	4030	8.5	4030	8.5	4030	8.5
4030	9.0	4030	9.0	4030	9.0	4030	9.0

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## Plan – Test at all Levels

Critical Ranges:	Units	Critical Ranges:	Details:
101-102 mg/dL - 12.2 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2
101-102 mg/dL	mg/dL	12.2 mg/dL	101.0-12.2

Test	Test Code	Result	Expected result (Units/Reference Interval)
1	101-102 mg/dL	12.2	101.0-12.2 mg/dL
2	101-102 mg/dL	12.2	101.0-12.2 mg/dL




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## Plan – Test Absurd Values/Non-numeric

- Test with Characters
  - " # "
  - " . "
  - " / "
  - " + "
  - " "
- Negative numbers




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## Plan – Wet Testing

- Test with all rules on
- Test to ensure comments flow from middleware rules to LIS
- Upper and Lower approval limit edge
- <LDT and >CRR
- Criticals/Urgents
- With and without instrument errors/flags
- Results all the way to reporting with comments
- Tests with calculations




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### Wet Testing

- Make best effort to test:
  - Every test included in AutoV
  - Upper and Lower boundaries of AutoV
  - Rules individually and combined
  - Result flow from instrument to middleware to LIS to report/HIS




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### Validation Challenges

- Need “Test” environment
- Need lab to “give up” instrument for testing
- Cannot test every scenario in wet testing
- Spiking or mixing of samples to create condition testing
- Lab knowledge/understanding of current instrument or middleware setup




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### Wet Testing – H=361, I=0, L=243

Ref	Code	Desc	Unit	Method	Instrument	Operator	Result	Unit	Method	Instrument	Operator	Result
1	001	001	001	001	001	001	001	001	001	001	001	001
2	002	002	002	002	002	002	002	002	002	002	002	002
3	003	003	003	003	003	003	003	003	003	003	003	003
4	004	004	004	004	004	004	004	004	004	004	004	004
5	005	005	005	005	005	005	005	005	005	005	005	005
6	006	006	006	006	006	006	006	006	006	006	006	006
7	007	007	007	007	007	007	007	007	007	007	007	007
8	008	008	008	008	008	008	008	008	008	008	008	008
9	009	009	009	009	009	009	009	009	009	009	009	009
10	010	010	010	010	010	010	010	010	010	010	010	010




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### Turn on AutoV – Beta Testing Mode

- Turn on Rules but do not “Auto-Approve” in LIS yet
- Time frame ~ 1-2 weeks
- Make sure didn’t miss any rules/errors/flags, etc.
- Document!!



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### Go Live

- Medical Director sign off
- Lab Training
- IT staff available



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### Benefits of AutoV – (previous goals)

- Decrease TAT from sample received to approved
- Reduce # of FTE hours spent manually reviewing test results
- Standardization of result review
- Techs focus on the problematic samples
  - Criticals/Urgents
  - < LDT or > CRR
  - Instrument flags or errors
- Reduce human error



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# Moving Averages



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## Moving Averages – Vendor Resources

- Contact Vendor see what is available
  - Siemens – QC – practical applications using CentraLink™ Data Mgmt System
  - Beckman Coulter, Remisol Advance (middleware)
  - Roche Diagnostics, Data Innovations – Instrument Manager
  - Others??
- Hematology
  - Xbar B (Bulls MA Algorithm)
  - XM analyses



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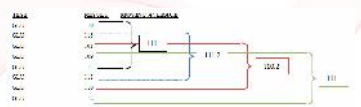

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## Moving Average - Definition

- Mean of time series data from consecutive periods. Called “Moving” because the mean is continually recalculated as new data becomes available.
- The earliest data point is dropped and the later is added and the mean is recalculated.

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### Data Collection

- Determine tests to setup MA on (consult with Vendor)
  - Consider recommendations from manufacturer
  - AST, CO2 - sample drifts
  - BUN, Creat, Glucose – sample pipetting
  - ALP, Ca – chance of drift
  - CL, NA – reference electrodes
  - FT4, TSH – Immunoassays
- Assays with wide normal ranges, generally not recommended
- Collect Data, need mean, SD of test results




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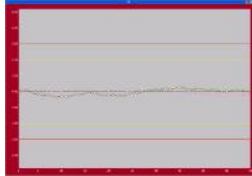

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### Setup

- Data
  - Days to keep raw result data – 30 days (setting)
  - Days to keep averaged points – 3M
- Graph
  - Number of data points to display in graph - 50
  - Graph minimum and maximum value
  - Graph major unit


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### Protocol Details

- Calculation Method
- Automatically calculate Target Mean and Target SD
- Target Mean
- Target SD
- Number of results to use in calculation
  - 20 – The more variation on graph
  - 50 - The more data points the longer it takes to trigger warning, more data points to correct if issue.




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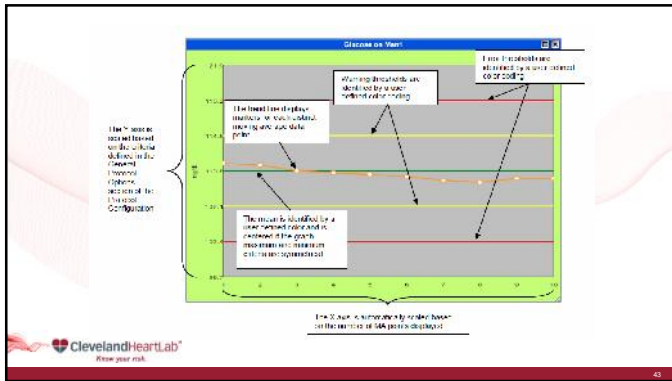
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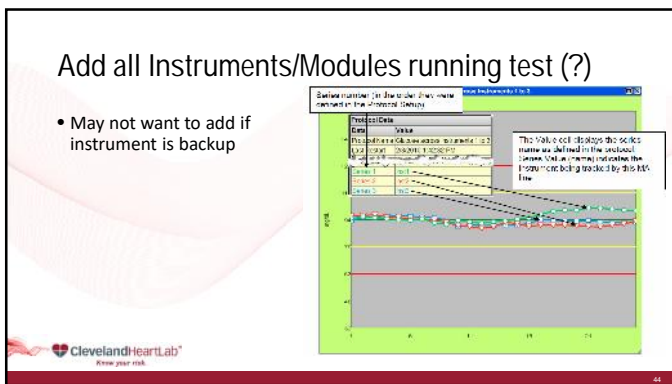
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- ### Filters & Exclusions
- Filters:
- Filter out QC
  - Filter ID's not starting with "C"
  - Other's by test
    - K – filter out  $\geq 7.1$
    - Filter out OGTT from Glucose
    - Filter out Pediatric Units
    - Filter out OR/ED/ICU

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### Exclusions

- Exclude below \_\_ standard deviations
- Exclude above \_\_ standard deviations



### Create Guide

Restarted protocol

IC Code	Test	10SD	9SD	8SD	7SD	6SD	5SD	4SD	3SD	2SD	1SD	Mean	1SD	2SD	3SD	4SD	5SD	6SD	7SD	8SD	9SD	10SD	Special Filter	
AST	AST	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	
ALT	ALT	11	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220	231	242	
ALP	ALP	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	
Calcium	Calcium	7.7	7.9	8.1	8.3	8.5	8.7	8.9	9.1	9.3	9.5	9.7	9.9	10.1	10.3	10.5	10.7	10.9	11.1	11.3	11.5	11.7		
Cholesterol	Cholesterol	80	83	86	89	92	95	98	101	104	107	110	113	116	119	122	125	128	131	134	137	140		
Hemoglobin	Hemoglobin	12.0	12.2	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.6	14.8	15.0	15.2	15.4	15.6	15.8	16.0		
Iron	Iron	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	765	810	855	900	945		
Urea Nitrogen	Urea Nitrogen	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5		
Albumin	Albumin	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5		
Bilirubin	Bilirubin	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2		
Glucose	Glucose	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250		
Triglycerides	Triglycerides	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210		
Protein	Protein	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0		
Uric Acid	Uric Acid	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5			
Phosphorus	Phosphorus	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5			
Ammonia	Ammonia	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315		
Urea Nitrogen	Urea Nitrogen	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5		
Iron	Iron	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	765	810	855	900	945		
Hemoglobin	Hemoglobin	12.0	12.2	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.6	14.8	15.0	15.2	15.4	15.6	15.8	16.0		
Urea Nitrogen	Urea Nitrogen	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5		
Albumin	Albumin	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5		





### Alerts

- Warning's (2SD – yellow line)
- Errors (3SD – red line)

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Know your risk.

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### Notifier

- Setup Notifier
- Can setup emails, Popup box, light pole

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### Moving Average Drift

- Slow reagent degradation
- Photometric system changes
- Calibration change from lot change

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Know your risk.

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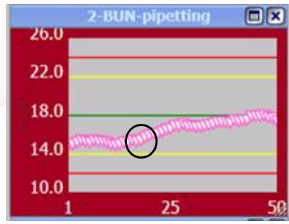
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### Moving Average Shift

- Accepting a high intercept when calibrating
- Reagent prep errors
- Reagent lot changes




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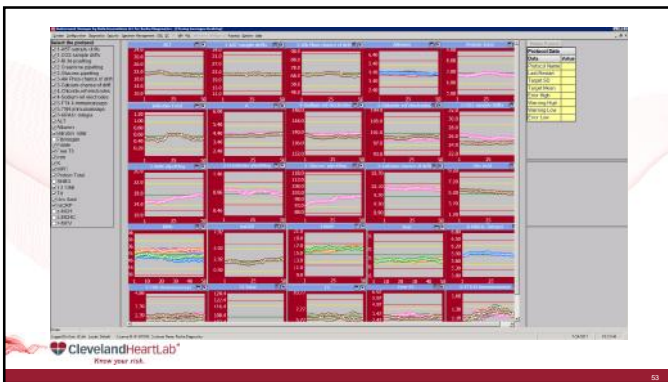
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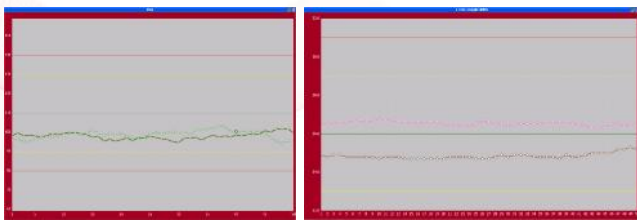
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### Iron and CO2 - Discussion




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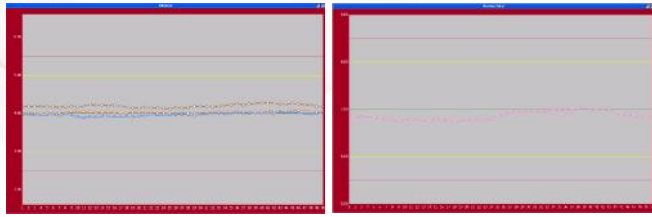
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### Albumin and TP



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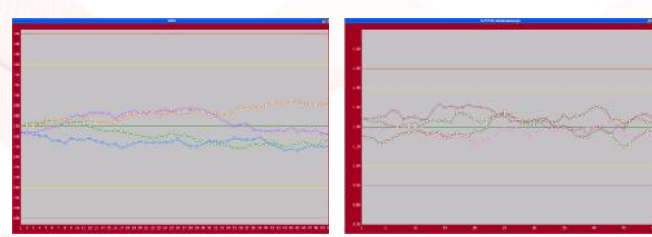
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### MPO and FT4



ClevelandHeartLab® 50 data points

20 data points displayed in graph

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### Tweek, Tweek, Tweek

- Recommendations
- Setup and watch, tweek before turning on for Lab
- Need dedicated personnel

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### Post Moving Averages



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### Challenges in Moving Averages

- Setup time
- Time waiting for data points to appear
- Tech training and understanding

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### Questions



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