It’s not Black and White: Unraveling the puzzles of Hematology
Part 2, Delta Checks

Disclosures

- I am receiving an honorarium from Sysmex for preparing and delivering this presentation.
- The views expressed in this presentation are those of the presenter and their healthcare facility and provided for illustration purposes only. Results of case studies are not predictive of other cases and results may vary. Prior to using these devices, please review the manufacturer’s instructions for use.

Objectives

At the end of this presentation, the attendee will be able to:
- List common preanalytical issues with hematology specimens
- Determine if a sample has a true abnormal value or a spurious result
- State the steps to resolving problematic samples, which include clumped platelets, cold agglutinins, critical low or high counts, and abnormal distribution/scattergrams
- Correlate cells seen on slides with numerical values of parameters
- Describe how to select, implement, and review delta check practices
- Investigate and interpret delta check alerts
- Make decisions as to when to report or cancel samples with delta failures
Comparison of a current patient result and the patient’s previous results
Delta means change
Function of LIS and middleware
Delta first described 1967
LIS first used for delta checks in late 1970’s
Allows operator to detect large variations in patient results
Results that exceed the standard will be flagged
Choose Stable parameters
Predefined limit
Within set time frame

Delta checks in Hematology

Choosing Delta Check Parameters
- WBC count
- Hemoglobin
- Hematocrit
- MCV
- MCH
- MCHC
- RDW
- Platelet count
- Stable parameters
- Low index of variability
- Reduces false alerts
- Different rules for different populations
- NICU
- Oncology
- Outpatients

Index of Individuality- fluctuation within an individual
- High Index of individuality
- Individual values fluctuate anywhere within reference range
- Not a tight range for individual
- Large changes may fall outside reference range
- Thus, the reference range itself may alert us to change in results and patient status change
- Low Index of individuality
- Little fluctuation within an individual
- Variation exists between people
- Individual’s results expected to remain in a small area within range
- With large change, result will probably still be within reference range
- Reference range may not be helpful to indicate a change in patient status
- **Delta check is useful!**
Implementing Delta Checks

Choose analytes with low biological variation
Choose individuals with results across reference range
Run or review serial specimens
Determine delta values between serial specimens
Determine intervals that are valuable for monitoring
Establish laboratory specific limits

Laboratory specific limits

ABSOLUTE PERCENT RATE OF CHANGE MAY VARY BY ANALYTE

Investigate Delta Checks

- Don’t just repeat
- Tech should identify the reason before resulting
- Check current and previous samples and investigate
  - Detects testing problem with either former or current sample
  - Important component of autoverification procedures
  - Improves laboratory efficiency
  - Investigation required extra work for technologists
  - May delay TAT
Delta checks as Quality Control

- Patient based Quality Control
- Detects testing problems
- Specimen collection
- Analysis
- Reporting problems
- Safety net
- Detect problems that may be normal or may otherwise go unnoticed

Why do we use Delta Checks?

- Identify patient specific errors
- Early error detection leads to better patient care and safety
- Helps prevent errors such as incorrect drug dosing, blood transfusions, etc.
- By using delta checks, we can notify providers
- Changes in patient's results may alter diagnosis or trigger additional testing
- Changes in patient's results may indicate need for medical intervention

Causes of Discrepant Results

- Delta Checks Can detect
  - Pre-Analytical variations
  - Patient identification
  - Specimen collection
  - Analytical variation
  - Instrument
  - Methods
  - Biological variations
  - Physiological
  - Changes with patient age
  - Lifestyle changes
Pre-Analytic Variation

If multiple delta check limits fail, this indicates a likelihood of sample mislabeling or misidentification.

Pre-Analytic Variation

"Mislabeled" specimens
- 2 unique identifiers needed
- Label does not match order
- 2 contradictory labels on tube
- 0.1% of samples submitted to laboratory and Anatomic pathology in US\(^1\)

Misidentified
- Wrong label
- Wrong blood in tube (WBIT)
- Sleeping, unconscious patients
- NICU, ER, elderly
- Language barriers
- Identical names
- Multiple births
- WBIT rate 0.05-8.8\(^2\)

Identification Errors Statistics\(^1\)
- Misidentified/WBIT were majority of ID errors in studies
- Statistics Patient ID errors
  - General lab 1.7.4%
  - Stat lab 8.8%
  - Transfusion medicine 0.05%
- Smaller hospitals have greater rates
- Rates greater in Stat labs and general lab than in Blood Bank
- 85.5% of errors were caught by techs pre-verification
  - Delta checks work!
Pre-analytic Variation - Collection

Delta checks designed to identify:
- Contaminated specimens
- Difficulty in phlebotomy
- Fibrin
- Clots
- Hemolysis
- Overfilled or underfilled tubes
- Sample transport
  - Refrigerated specimens - Platelet clumping
  - Pneumatic tubes can cause RBC damage

Analytical Variation

Analyzer problems
- Clogs
- Variations in reagent volumes, delivery
- Reagent, lot changes
- Calibration

Operator errors
- Dilution errors
- Improper mixing

Biologic variation
- The human body always tries to maintain homeostasis
- RBC indices, hemoglobin tend to be very stable
- Ideal parameters for delta checks
- Delta check limits may vary by age
- Nutrition status may cause variation
  - Iron deficiency anemia
  - Dehydration/fasting
  - Lipemic specimens
- Disease states and treatment may cause variation
  - Anemia
  - Chemotherapy
Goals of Delta checks

- Identify changes in patient conditions
- Identify sample quality issues/patient misidentification

Deltas - is it real?

Spurious results - sample quality
- Patient identification errors
- Clotted samples
- Short samples
- Contaminated specimen

Changes in patient condition - Biologic variation
- Newborn ages
- Trauma
- True disease states
- Cancer
- Anemia
- ITP
- Chemotherapy, surgery, dialysis
- Blood transfusion
- Nutrition
- Dehydration/rehydration

Delta Case Study - Platelet decrease

- Drop in platelet count, delta flag, not below 100
- No plt clump flag
- SOP and OP alert do not say “check for clot”
- You’ve repeated it, but need to investigate why count dropped, review smear
- Low plt with previous normal result, suspect spurious result
Delta Case Study - Platelet increase

75-year-old oncology patient, CBC before infusion
- WBC = 5.6, Hgb = 11.9, Hct = 35, Plt = 164
- PLT delta, no other flags
- Rerun added, slide made
- Repeat PLT = 166, no flags, PLT count held for slide review
- Infusion services requests platelet count
- Patient history T7, PLT = 42, prior PLT = 167,155
  - outlier was the 42
- Check previous history, not just most recent!
  - Saves time, no slide review needed
  - Improves TAT

Platelet Delta Check failures

Spurious samples
- Clots
- Difficult draws, failure to mix properly
- EDTA induced Thrombocytopenia

True patient change in status
- Platelets go up and down in oncology patients/chemotherapy
- Thrombocytopenia, ITP, TTP

Tips to confirm discrepant Results

- Do values match previous results?
  - Look at result history
  - Look at past results to confirm trend
- Were the previous results questionable?
  - If so, Was it investigated?
- Look at patient history
  - Reason for these results
MCV Delta Case Study

- MCV Deltas on patients, trending up
- Several patients rerun, 2nd run matched first run, reported
- Change of shift, no communication
- 3 more new delta flags in a row
- Problem recognized

Starting the investigation

Investigate
- Repeat
  - Confirm correct label, patient ID on tube
- Investigate for sample collection issues
  - Sufficient sample
  - No clots
  - Hemolysis, lipemia, icterus
- Investigate analytical issues
  - QC
  - Reagents
  - Isolated event, or others?
MCV Delta Case Study - Some Things we noticed

- All deltas occurred on the same side
- Samples rerun on alternate instrument, on rerun MCV matched history
- Samples rerun on same side repeated with a delta flag

Questions to ask yourself

- What might be the problem?
- Steps to resolve?

<table>
<thead>
<tr>
<th>Sample</th>
<th>Previous MCV</th>
<th>Original MCV</th>
<th>Rerun MCV</th>
<th>Reported MCV</th>
<th>Corrected?</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>none</td>
<td>90.3</td>
<td>None</td>
<td>90.3</td>
<td>Yes</td>
<td>Autoverified; no previous, no flags</td>
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<tr>
<td>2</td>
<td>79.7</td>
<td>92.9</td>
<td>82.1</td>
<td>82.1</td>
<td>No</td>
<td>Reran on alternate XN</td>
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<tr>
<td>3</td>
<td>96.0</td>
<td>105.9</td>
<td>95.1</td>
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<td>No</td>
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<td>4</td>
<td>80.8</td>
<td>87.7</td>
<td>88.1</td>
<td>88.1</td>
<td>Yes</td>
<td>Reran on same XN</td>
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<tr>
<td>5</td>
<td>96.2</td>
<td>106.5</td>
<td>None</td>
<td>106.5</td>
<td>Yes</td>
<td>Autoverified; prev from 12/19 exceeded 28 day delta</td>
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</tbody>
</table>
Delta Case Study - Investigation

- All delta flags were on samples run on XN-L
- MCVs erroneously high on XN-L
- If repeated on XN-R, rerun results matched history
- QC failed on XN-L, passed on XN-R
- Reran patients back until we could see when problem started
- Reviewed all results back to last acceptable QC against previous in EPIC
- Clog in RBC aperture!
  - 1st sample- short draw, clot went through
  - Aperture clog removal, Aperture cleaned
  - QC repeated and passed on XN-L
  - 6 reports needed correction for MCV and associated parameters

Analytical Variation

- This case is an example of instrument specific issues
- RBC aperture clog
- MCVs great predictor, few false positive rates
- Transfusion
- To solve, evaluate QC Imprecision Bias

Case Study: High MCHCs

- MCHC >37.5 flags, delta on several patients in a row on same analyzer
- Repeated on same instrument with same results
- Run on alternate analyzer
  - Normal MCHCs
- QC
  - QC failed on 1st instrument
  - OK on alternate instrument
**MCHC Case Study**

- Suspected spurious results due to deltas on several patients
- When delta flag is present, check all parameters
- Several analytes affected. MCH, MCHC, Hgb

### What Happened?

- Delta checks alerted us to problem quickly
- Affected results on only 1 analyzer
- Therefore, not patient related
- Instrument related
- Affected multiple analytes
  - All related to Hgb
  - No sulfolyser
  - Sensor not working. No alarm
  - Sulfolyser is used for Hemoglobin determination
  - Sulfolyser replaced

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<tr>
<td>RBC 3.88</td>
<td>RBC 3.88</td>
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<tr>
<td>Hgb 14.0</td>
<td>Hgb 12.2</td>
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<tr>
<td>Hct 36.2</td>
<td>Hct 36.3</td>
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<td>MCHC 38.7</td>
<td>MCHC 33.3</td>
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<tr>
<td>MCV 93.3</td>
<td>MCV 93.6</td>
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Shortcomings of Delta Checks

- Need to balance error detection with false positives
- Choose stable analytes to monitor
- Investigations cause delay in patient results
- Most delta failures are due to actual patient change in status
- Consider the patient population
  - Inpatient vs outpatient
  - Oncology patients have lots of fluctuation in results
  - Neonates
- Delta check limits are often determined in healthy populations
- Special rules can be written for various patient populations

"If you're gonna play the game, boy, you gotta learn to play it right. You've got to know when to hold 'em, know when to fold 'em"

Kenny Rogers

When to cancel, when to report?

Delta flags - Hgb/Hct

- Hgb/ Hct increased
  - Recently Transfused?
  - Patient dehydrated?
- Hgb, Hct decreased -
  - Surgery?
  - GI bleed?
  - Trauma?
  - Maternity, L&D?
  - History of anemia?
  - Receiving fluids?
  - Oncology?
- True patient change of status
- Review patient chart
- Call nursing floor if questions, to confirm
- Document in notes
- Comment if appropriate
- Report results
Delta flags - WBC
- Fever
- Infection
- Labor
- Trauma
- True patient change of status
- Check patient chart
- Call nursing floor if questions
- Document in notes
- Comment if appropriate
- Report results

Delta Flags- Indicies

**MCV**
- very stable
- Best predictor, fewest false positives

You should not see

**Hgb > Hct**
- High MCV with low MCHC
- Morphology that does not correlate with indices

MCV delta check failures
- Since few false positives, investigate!
  - Transfused?
  - Review WBC, platelet, RDW if contamination with IV fluid is suspected
  - Age related- Neonates
  - Oncology patients not as stable due to meds
  - Check chemistry results - electrolyte balances
Spurious results

Inadequate samples - **Cancel!**
- Exceeds analysis time
- Clotted
- Short draw
- QNS
- Can alter indices
- Hemolyzed sample
  - Confirm by spinning aliquot
  - Check chemistry

Other investigations

- Call provider to question if results are expected
- If results are suspicious but care giver requests results
  - Report and comment per SOP
  - Ex: “questionable results; advise repeat”
- Several deltas on same sample?
  - Suspect mislabeled or misidentified
- If patient has ABO type in LIS, type sample
  - If blood types differ, can determine WBIT
  - If types match, cannot rule out WBIT
- If WBIT suspected, request redraw
  - **Cancel specimen**

To Cancel or Report? Follow SOPs

Result cancellation implications
- Difficult draws
  - Adult
  - NICU
- Loss of blood volume
- Delayed results
- Delay in care

Implications of reporting incorrect results
- Inappropriate medical care
- Expense
- Lengthened hospital stays
- Psychological and social issues
- Beyond hematology
  - Transfusions, infectious diseases, genetic testing
  - Harm may not be realized for hours, days or longer
Conclusions

- Autoverification gives us more time to investigate problem specimens
- Delta checks are important to have in place to use autoverification
- Most handling errors are pre-analytical
- Delta checks used as a laboratory specific quality indicator
- Vital to ensure precise results and patient safety
- We can’t be good detectives without looking at all the clues!
- Questions?

References