Reducing Pre-analytical Errors

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What is the most common POC error?

- A. Patient misidentification
- B. Poor sample collection technique
- C. Deviation from analytical procedure
- D. Improper device maintenance (e.g. QC, reagent storage)
- E. Improper/lack of recording results
- F. Safety (e.g. hand hygiene, device reuse)
- G. Other
Outline

• Introduction

• Pre-analytical Phase:
  – Patient
  – Sampling
  – Transportation, Storage, and Mixing
  – Summary and Key Points

Safety
Objectives

• List three different phases of the testing process and identify which areas have the highest risk of error
• Describe strategies to minimize preanalytical error
• Explain methods to ensure safe practices for point of care testing
The Pre-analytical Phase

• Processes that occur before a specimen is analyzed
• Up to 75% of all testing errors occur in the preanalytical phase
• Preanalytical errors can cause harm to patient
Pre-analytical Challenges

• Many people involved:
  – Physicians: writing orders, instructing patients/staff
  – Nurses/Phlebotomists/RTs: patient ID, specimen collection
  – Runners: transport
  – Lab staff: receipt and processing

• More challenging in a teaching hospital

• Pre-analytical variables/errors are often unknown to testing personnel and the clinicians interpreting the results
Understanding Pre-analytical Issues

- Most steps
- Most people
- High urgency & stress
- Most variation in work environment, technique, and training

![Pie Chart]

- Pre-analysis (60%)
- Analysis (25%)
- Post-analysis (15%)
The Pre-analytical Process: POC

Patient

- Patient stability
- Patient identification

Sampling

- Tube/syringe labeling
- Site preparation
- Sample collection

Transport

Processing

- Specimen delivery to laboratory/storage
- Specimen receipt
- Order/requisition processing
- Mixing

Safety
POC-Specific Pre-analytical Challenges

- Non-lab staff
  - Limited Training & Experience
  - Divided Focus
  - Patient complexity
Steps of the Pre-analytical Phase

1. Patient Variation
2. Sampling
3. Transport
4. Processing
THE PATIENT

Patient Variation

Sampling

Transport

Processing
Starting on the Right Foot: Identify the Patient

- Incorrect/missing patient and sample IDs are frequent and critical pre-analytical errors
Approximately how much does a single misidentification error cost?

- A. 0-5 dollars
- B. >5 to 20 dollars
- C. >20 to 50 dollars
- D. >50 to 100 dollars
- E. >100 dollars
Consequences of Patient Misidentification

- Financial Implication of mislabeling*:
  - $500/incident
  - 250/month
  - Annual cost = USD 1.5 million

- Failure to provide proper and immediate care to a patient

- Inappropriate care to a patient

*Excluding medicolegal or liability costs
Avoiding Identification Errors

• Positive Patient Identification x2
• Correlate Orders with Patient Name
• Identification on Sample Device at site of Collection
  • Patient ID label attached
  • Pre-barcoded arterial syringe
• Enter a patient ID into the analyzer before analysis
• Use barcode readers
Test-Specific Advice: Patient Variables

- FIO2 and application of device
  - Mode of ventilation and Patient compliance with supplemental O2

- Duration of changes in vent settings
  - Approximately 5-10 minutes post change up to 20% in stable Patient (Cakar, 2001, Intensive Care Medicine)
  - Up to 30 minutes post change in Patient with Obstructive Lung Disease (Parsons, 2002)

- Patient's respiratory rate, temperature, position, activity

- Ease of (or difficulty with) blood sampling
SAFETY
POC Testing and Safety

- POC testing != no risk

  - Employee:
    - Needle stick injury
    - Blood exposure

  - Patient:
    - Nosocomial infection
      - Drug resistant pathogens, Hepatitis
POC Testing and Safety

• Reports of multiple deaths for acute hepatitis B infection caused by poor practices with self-monitoring blood glucose meters

• 8/87 assisted living facility residents affected; 6 deaths

• Sharing of lancets

• Lack of disinfection

CDC Morb Mortal Wkly Rep 2011;60:182.
http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6006a5.htm
Reducing the Risk of POCT-related Infections*

- Discard finger-stick devices after each patient
  - Use autodisabling devices

- Assign POC devices to a single patient whenever possible

- Clean and disinfect POCT devices after every use

- Use proper hand-hygiene

*Safe and helps meet accreditation standards

Clinical Laboratory News (39):1
FDA Patient Safety News. Preventing infections while monitoring glucose.
Staff Safety

• Blood exposure and needlestick injuries are common
  – 23,908 injuries in 85 hospitals in 10 states (1995-2005)¹

• All healthcare staff involved in patient care are affected
  – Medical technologists, Physicians, Respiratory Therapists, and Nurses

²Adapted from http://www.cdc.gov/niosh/stopsticks/sharpsinjuries.html
Exposure Causes and Consequences

**Causes:**
- Unavailability of safety devices
- Lack of procedure for operator safety
- Procedures for safety not known or followed

**Consequences:**
- Needle-stick injury
- Anxiety
- Infection
- Medical treatment
Risk Reduction

• To avoid risks:
  – Use PPE
  – Use a safety device that limits contact with patient blood
  – Use a protection device for the safe removal of needles
  – Ensure procedure for operator safety is established and followed
SAMPLING

Patient Variation

Sampling

Transport

Processing
Sampling

• Potential Issues:
  – Site selection
  – Site preparation
  – Collection
Sampling: Arterial Puncture

• Label the syringe with patient ID

• Choose Wisely
  – Note location and direction of flow for IV fluids relative to draw site
  – Confirm Arterial vs. Venous collection
  – Adequate flushing of ports or lines

• Expel any air bubbles immediately after sampling

• Mix the sample thoroughly immediately after sampling
Poll

Contaminated sample

Type: Arterial
pH: 6.923
pCO2: 12.4
pO2: 49.3
HCO3: 4.5
BE: -27.7
sO2: 83.5

tHgb: 7.0
K: 1.6
Na: 143
Glucose: 145

Accurate sample

Type: Arterial
pH: 6.975
pCO2: 8.2
pO2: 187
HCO3: <1.0
BE: -28.2
sO2: 98.9

tHgb: 13.8
K: 3.0
Na: 142
Glucose: 290

If unrecognized, what are the potential consequences of this error?

A). Unnecessary blood transfusion
B). Excess potassium supplementation
C). Confusion & concern for misidentification
D). Lack of appropriate insulin therapy
Blood Gas Sampling

To avoid errors:

• Check the specific catheter package for the exact volume of dead space

• Rule of thumb: discard at least three times the dead space
  – (CLSI recommends 6x)

• Draw the blood gas sample with a dedicated blood gas syringe containing dry electrolyte-balanced heparin

• If in doubt, consider resampling
Air bubbles

- Any air bubbles in the sample must be expelled as soon as possible after the sample has been drawn — before mixing the sample with heparin

- Even small air bubbles may seriously affect the $pO_2$ value of the sample

- An air bubble whose relative volume is 0.5 to 1.0 % of the blood in the syringe is a potential source of a significant error
Air bubble Effects depend on:

- Size of bubble
- Number of bubbles
- Initial oxygen status of sample
- Longer time
- Lower temperature
- Increased agitation
Effect of Air Bubbles

Sample was transferred between collection devices to inject low sample volume
Hemolysis

• Hemolysis releases intracellular components
• Is not visible in a whole blood sample
  – All POC samples!

After 5 % hemolysis
(≈ 0.8 g/dL free hemoglobin)
Hemolysis

• Hemolysis of the sample can lead to:
  – Biased results
  – Possible misdiagnosis
  – Possible erroneous patient treatment/lack of treatment

• To avoid errors:
  – Do not milk or massage the tissue during sampling
  – Use self-filling syringes
  – Use recommended procedures for mixing of samples
PROCESSING

1. Patient Variation
2. Sampling
3. Transport
4. Processing
Mixing and Clots

- Samples must be mixed after expelling air
- Before analyzing the sample, make a visual check of the blood
- Inspect for air bubbles
- Expel a few drops of blood from the syringe to inspect for clots
What Happens to the Instrument If a Clotted Sample is Analyzed?

**POLL QUESTION**

- A). No effect, ABG instruments have a hemolyzer
- B). Instrument will be unusable until clot is removed
- C). Electrolyte results will decrease
- D). Electrolyte results will increase
What Happens to the Instrument If a Clotted Sample is Analyzed?

Error!!
Summary

- We’re all in this together → Help the patient!

- Pre-analytical errors can lead to harm

- POC Testing has unique challenges

- A bad sample is worse than no sample
Thank you and Questions?
Additional Resources

- [www.acutecaretesting.org](http://www.acutecaretesting.org)
- A discard volumes arterial blood gas sampling. Critical Care Medicine: June 2003 - Volume 31 - Issue 6 - pp 1654-1658
- [http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6006a5.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6006a5.htm)
List of Potential Preanalytical Errors

- Missing or wrong patient/sample identification
- Use of the wrong type or amount of anticoagulant
  - dilution due to the use of liquid heparin
  - insufficient amount of heparin
  - binding of electrolytes to heparin
- Inadequate stabilization of the respiratory condition of the patient
- Inadequate removal of flush solution in a-lines prior to blood collection
- Mixture of venous and arterial blood during puncturing
- Air bubbles in the sample
- Insufficient mixing with heparin
- Incorrect storage
- Hemolysis of red blood cells
- Not visually inspecting the sample for clots
- Inadequate mixing of sample before analysis
- Failure to identify the sample upon analysis