Reducing Pre-analytical Errors

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Objectives

• List the 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
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
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
Parts of the Pre-analytical Phase

- Safety
  - Patient
    - Sampling
    - Transport
    - Processing
  - Patient stability
    - Patient identification
  - Tube/syringe labeling
    - Site preparation
    - Sample collection
  - Specimen delivery to laboratory/storage
  - Specimen receipt
    - Order/requisition processing
    - Mixing
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
  – Testing personnel
  – Clinicians interpreting the results
Understanding Pre-analytical Issues

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

% of Time Spent
- 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
  - Specimen delivery to laboratory/storage

- Processing
  - Specimen receipt
  - Order/requisition processing
  - Mixing
POC-Specific Pre-analytical Challenges

• Non-lab staff
  – Limited Training & Experience
  – Divided Focus
  – Patient complexity
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

• Risk of patient harm
  – May harm two patients if results are switched
  – Over or under treatment/diagnosis/followup
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
- Ensure user competency
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: Patients

- 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

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
POC Testing and Safety: Staff

• 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

\(^2\)Adapted 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
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

<table>
<thead>
<tr>
<th>Contaminated sample</th>
<th>Accurate sample</th>
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<tbody>
<tr>
<td><strong>Type:</strong> Arterial</td>
<td><strong>Type:</strong> Arterial</td>
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<td><strong>pH:</strong> 6.923</td>
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<td><strong>pCO2:</strong> 12.4</td>
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<td><strong>pO2:</strong> 49.3</td>
<td><strong>pO2:</strong> 187</td>
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<td><strong>HCO3:</strong> 4.5</td>
<td><strong>HCO3:</strong> &lt;1.0</td>
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<td><strong>BE:</strong> -27.7</td>
<td><strong>BE:</strong> -28.2</td>
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<td><strong>sO2:</strong> 83.5</td>
<td><strong>sO2:</strong> 98.9</td>
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<td><strong>tHgb:</strong> 7.0</td>
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<td><strong>K:</strong> 1.6</td>
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<td><strong>Na:</strong> 143</td>
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<tr>
<td><strong>Glucose:</strong> 145</td>
<td><strong>Glucose:</strong> 290</td>
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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

#### Air Contaminated sample

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<tr>
<td>sO2:</td>
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#### Accurate sample

<table>
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<th>Not specified</th>
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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
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?

- 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!

• POC testing is not free from re-analytical errors

• POC Testing has unique challenges

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


• 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
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