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?

POLL QUESTION

- 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

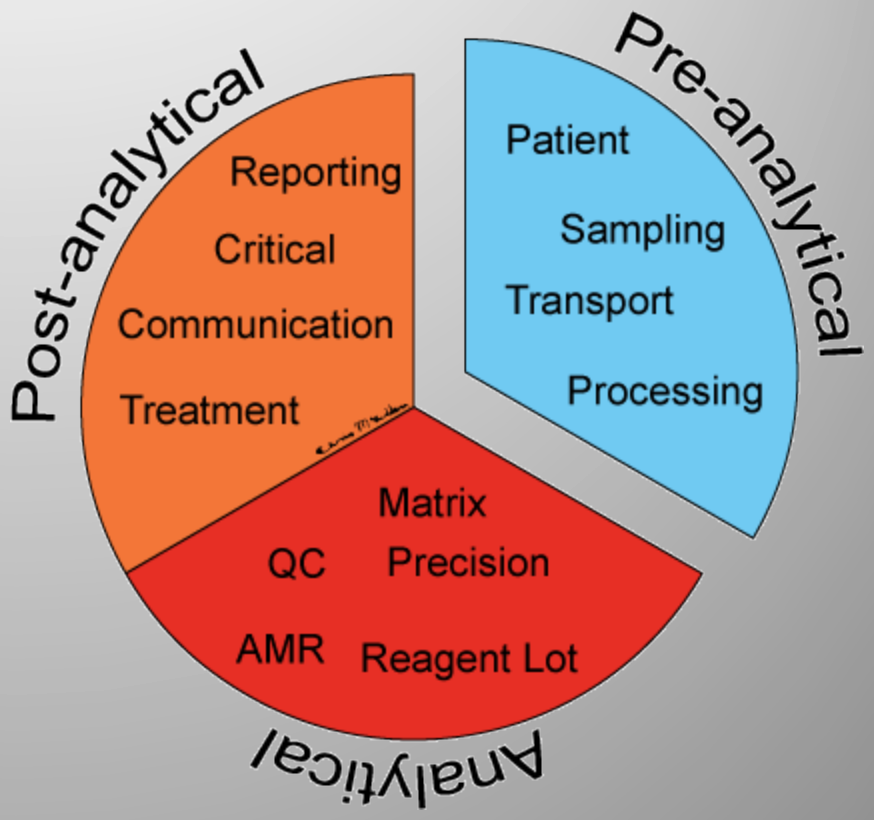
- Introduction
- Pre-analytical Phase:
  - Patient
  - Sampling
  - Transportation, Storage, and Mixing

Safety

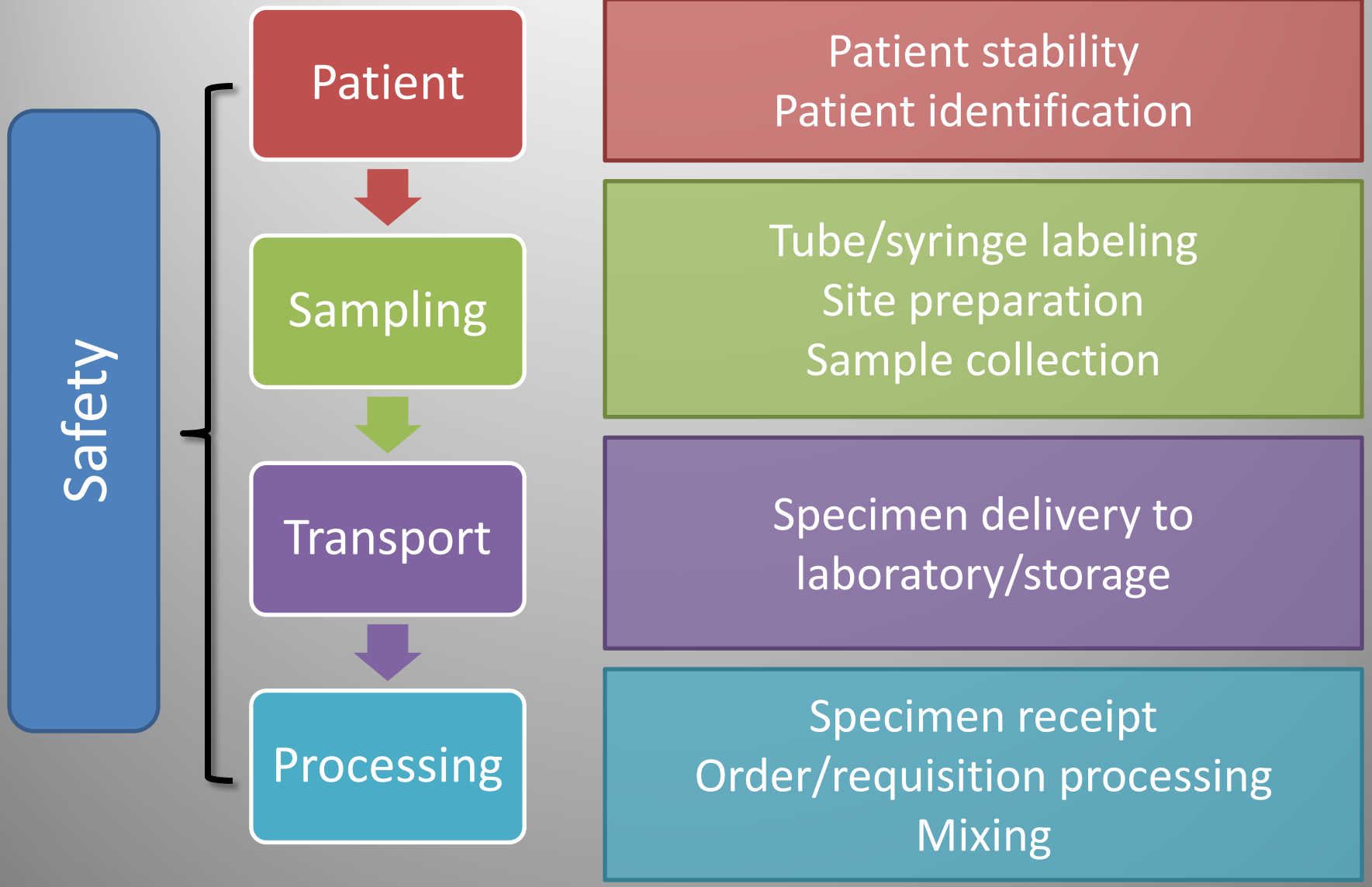
- Summary and Key Points

The Pre-analytical Phase

- Processes that occur <u>before</u> 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

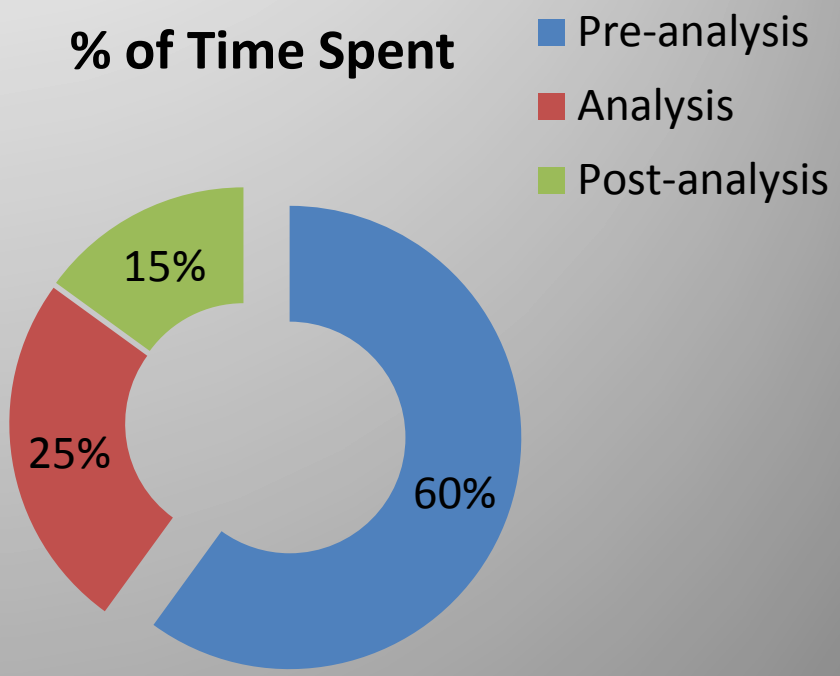


Pre-analytical Challenges

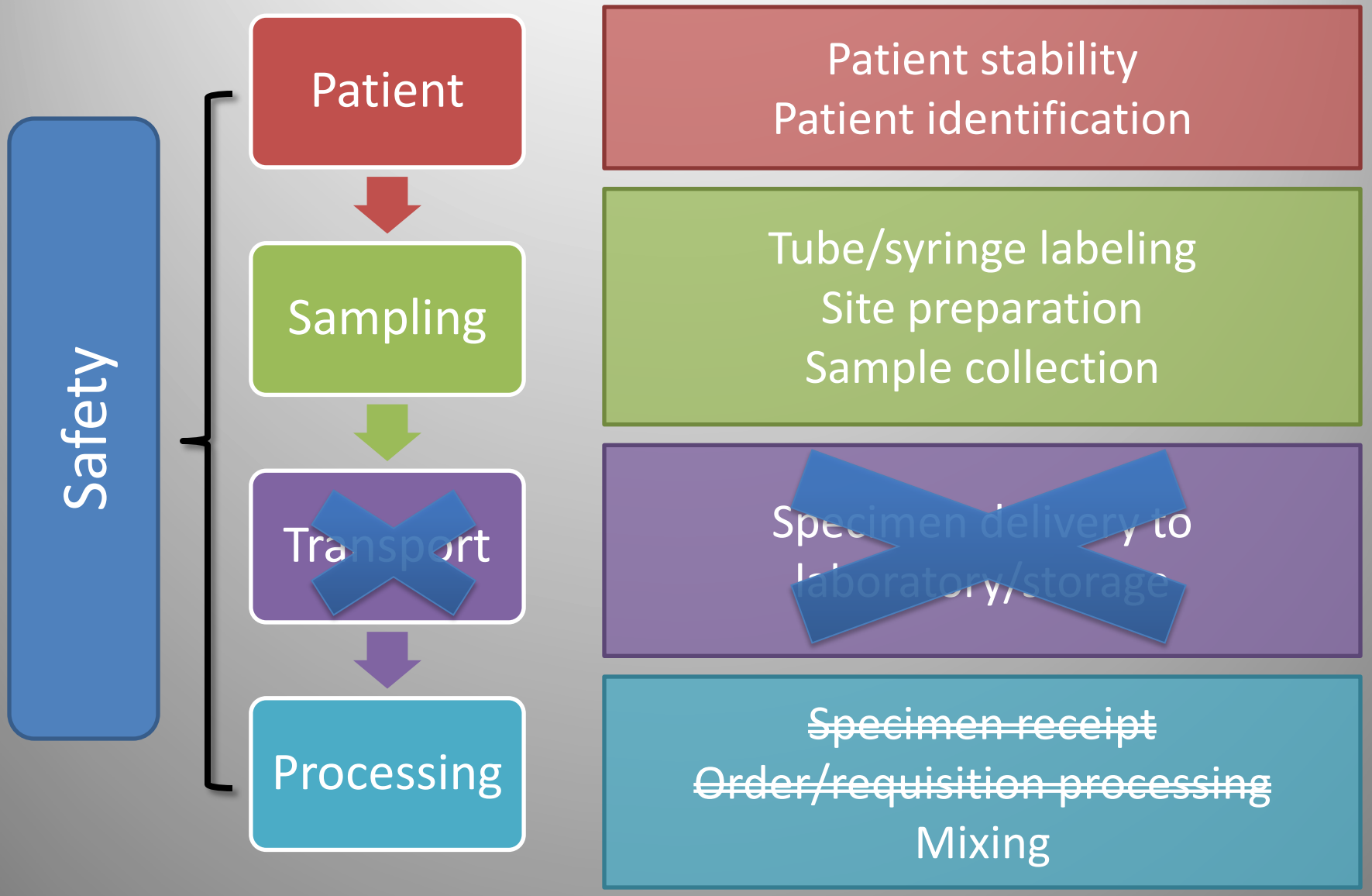
- Many people involved:
  - Physicians: writing orders, instructing patients/staff
  - Nurses/Phlebotomists/RTs: patient ID, specimen collection
  - Runners: transport
  - Lab staff: receipt and processing
- More challenging in a teaching hospital
- Pre-analytical variables/errors are often unknown
  - 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



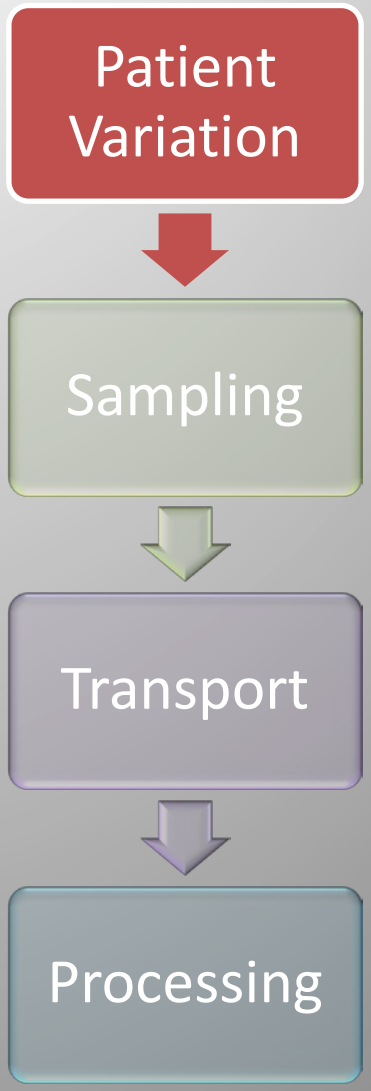
The Pre-analytical Process: POC



POC-Specific Pre-analytical Challenges

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

THE PATIENT



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

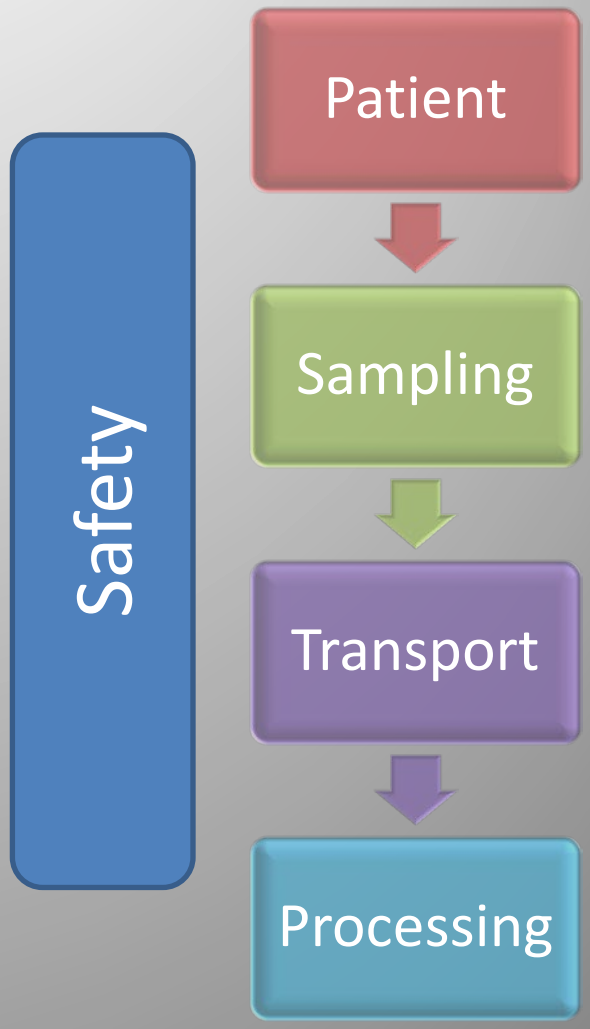
Avoiding Identification Errors

- 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

CDC Morb Mortal Wkly Rep 2011;60:182.
http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6006a5.htm

Reducing the Risk of POCT-related Infections*

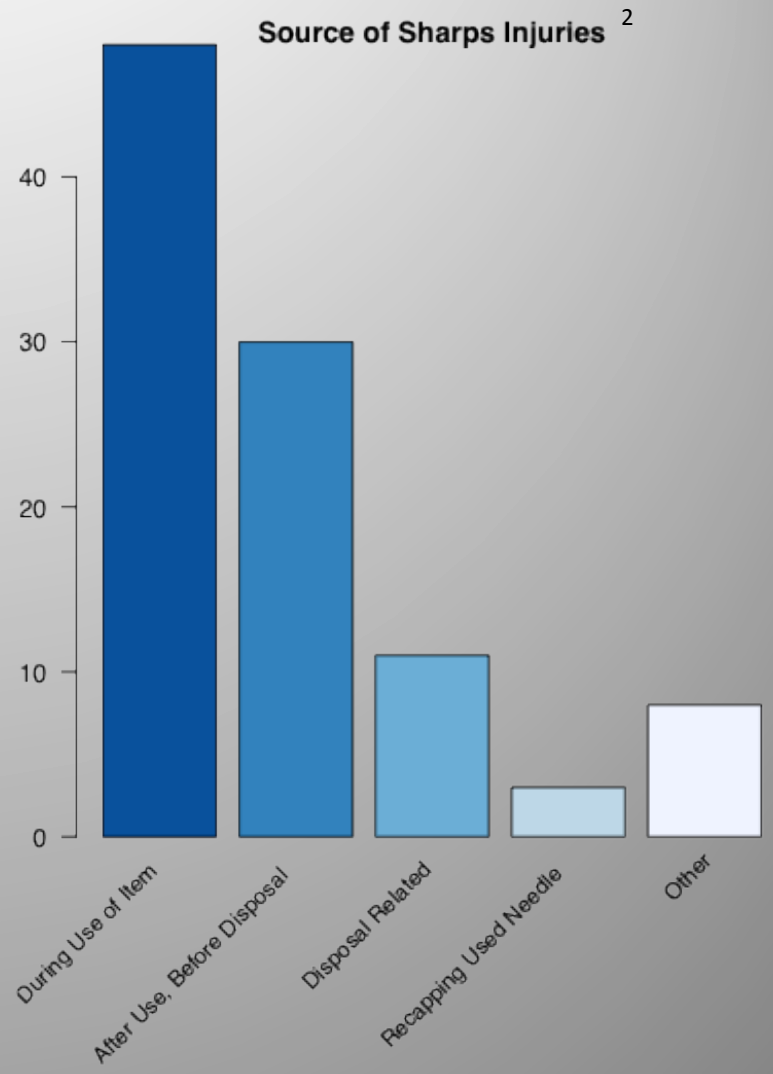
- Discard finger-stick devices after each patient
  - Use autodisabling devices
- Assign POC devices to a single patient whenever possible
- Clean and disinfect POCT devices after every use
- Use proper hand-hygiene

Safe and helps meet accreditation standards

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

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



[1]Percutaneous Injuries before and after the Needlestick Safety and Prevention Act. N Engl J Med 2012; 366:670-67
[2]Adapted from http://www.cdc.gov/niosh/stopsticks/sharpsinjuries.html

Exposure Causes and Consequences

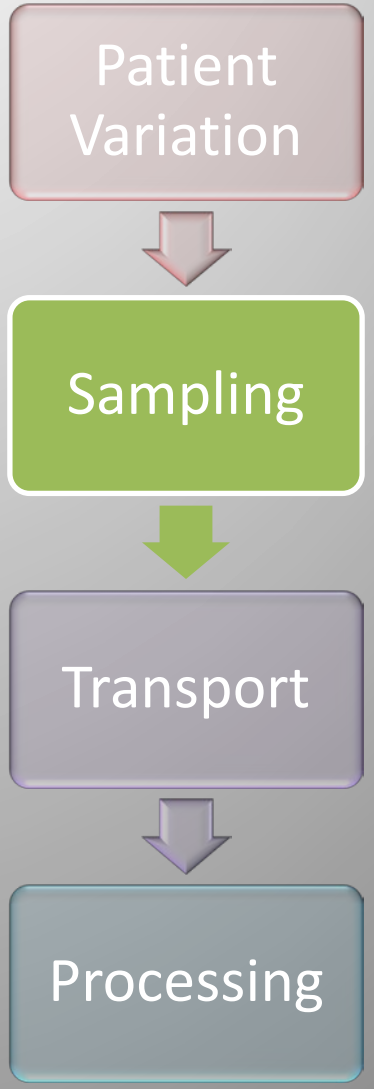
- **Causes:**
  - Unavailability of safety devices
  - Lack of procedure for operator safety
  - Procedures for safety not known or followed

- **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



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

POLL QUESTION

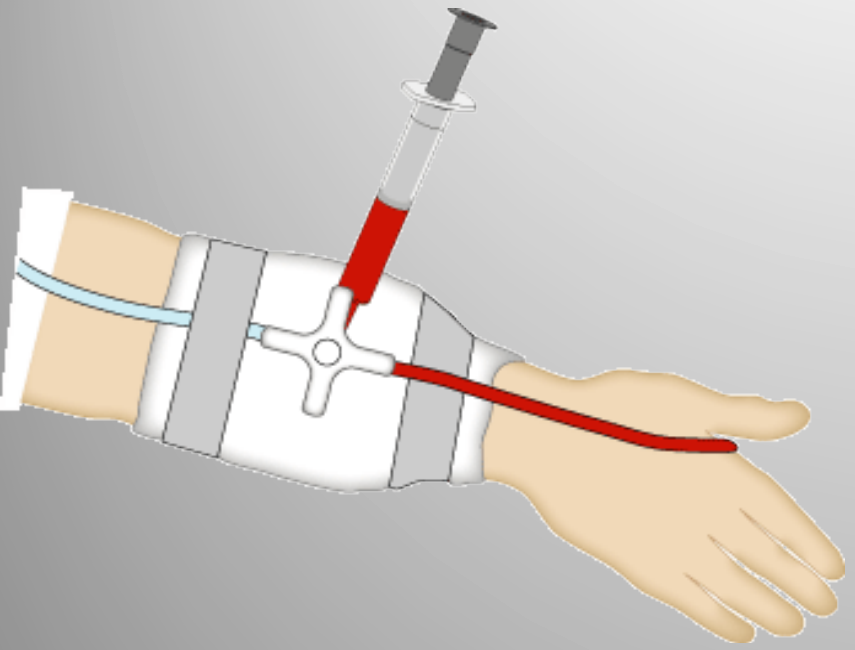
Contaminated sample	
Type:	Arterial
pH:	6.923
pCO2:	12.4
pO2:	49.3
HCO3:	4.5
BE:	-27.7
sO2:	83.5
tHgb:	**7.0**
K:	**1.6**
Na:	**143**
Glucose:	**145**

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

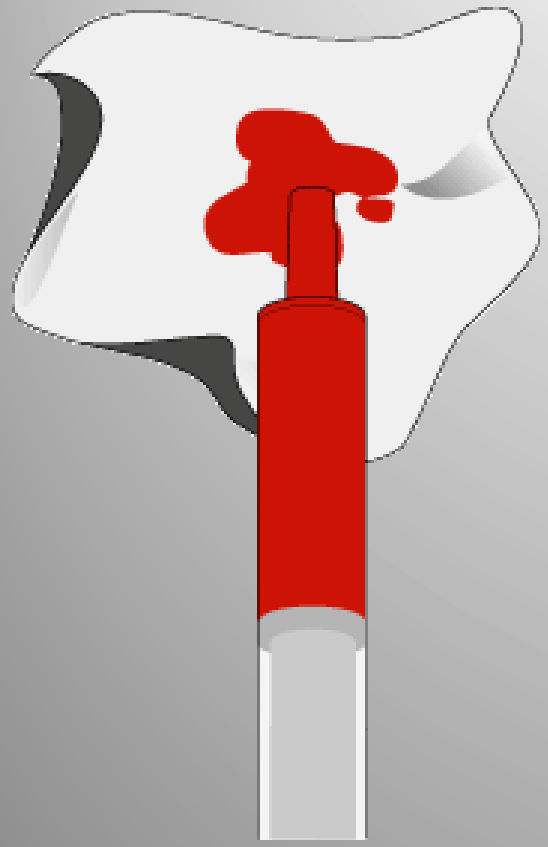
Blood Gas Sampling



To avoid errors:

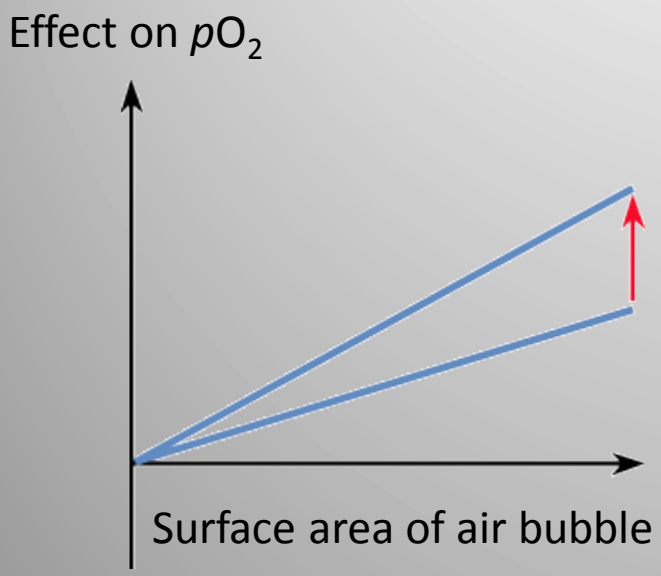
- Check the specific catheter package for the exact volume of dead space
- Rule of thumb: discard at least three times the dead space
  - (CLSI recommends 6x)
- Draw the blood gas sample with a dedicated blood gas syringe containing dry electrolyte-balanced heparin
- If in doubt, consider resampling

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

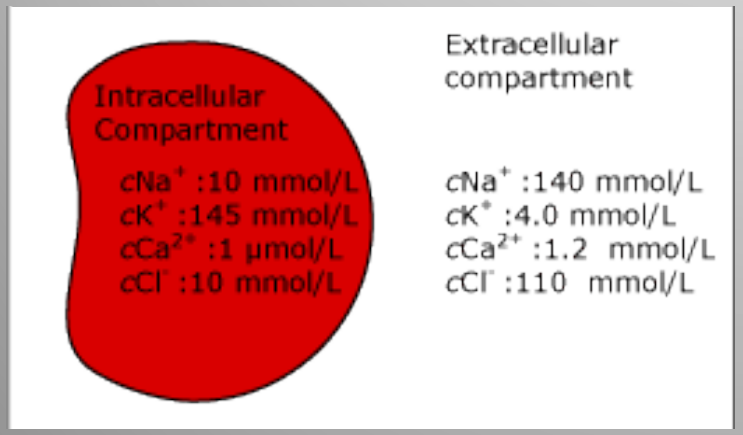
Air Contaminated sample	
Type:	Not specified
pH:	**7.50**
pCO2:	**37.1**
pO2:	**163**
HCO3:	28.9
BE:	5.6
sO2:	99.0

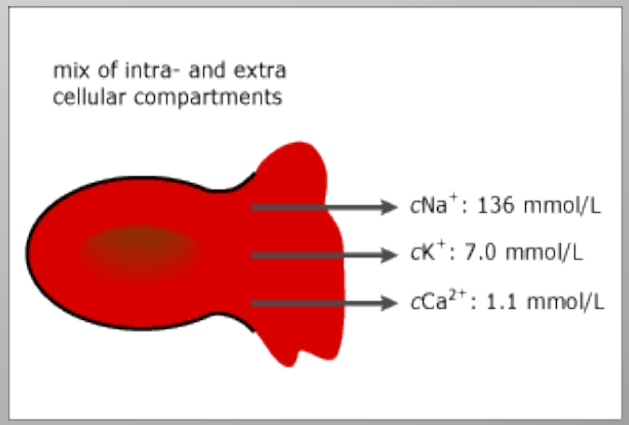
Accurate sample	
Type:	Not specified
pH:	**7.37**
pCO2:	**56.7**
pO2:	**43.8**
HCO3:	31.9
BE:	6.7
sO2:	81.1

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!





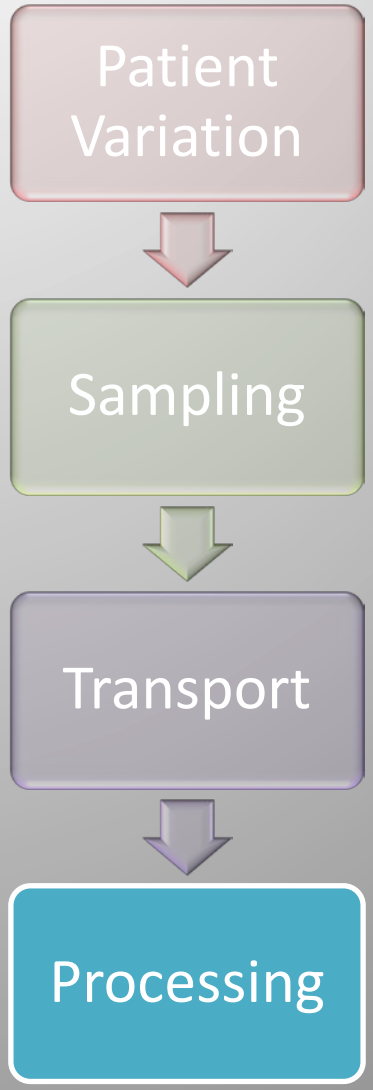
After 5 % hemolysis
(~ 0.8 g/dL free hemoglobin)

Hemolysis

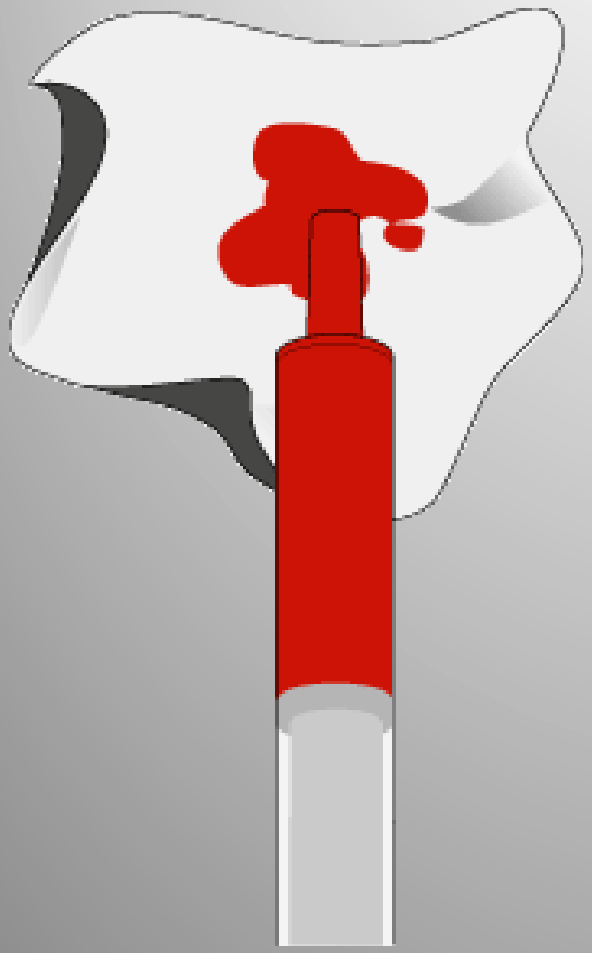
- **Hemolysis of the sample can lead to:**
  - Biased results
  - Possible misdiagnosis
  - Possible erroneous patient treatment/lack of treatment

- **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



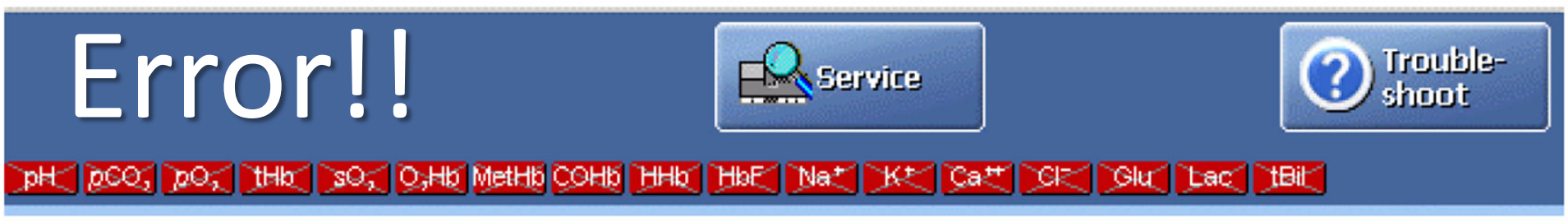
- Samples must be mixed *after* expelling air
- Before analyzing the sample, make a visual check of the blood
- Inspect for air bubbles
- Expel a few drops of blood from the syringe to inspect for clots

What Happens to the Instrument If a Clotted Sample is Analyzed?

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?



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

- Howanitz PJ, Howanitz JH. Quality control for the clinical laboratory. Clin Lab Med. 1983;3:541-551.
- Bonini P, Plebani M, Ceriotti F, et al. Errors in laboratory medicine. Clin Chem. 2002;48(5):691-698.
- Grenache DG and Parker CM. Integrated and automatic mixing of whole blood: evaluation of a novel blood gas analyzer. Clinica Chimica Acta, 2007
- CLSI. Procedures for the Collection of Arterial Blood Specimens; Approved Standard—Fourth Edition. CLSI document H11-A4. Wayne, PA: Clinical and Laboratory Standards Institute 2004
- www.acutecaretesting.org
- Percutaneous Injuries before and after the Needlestick Safety and Prevention Act. N Engl J Med 2012; 366:670-67
- 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