Pre-analytical error in arterial specimen collection is a major potential source of erroneous results. All potential hazards to the patient and the personnel obtaining the specimen must be reduced while maintaining the integrity of the specimen. NCCLS (The National Committee for Clinical Laboratory Standards) published the first approved standard on arterial blood collection in 1985. Nearly 15 years later, the third edition of this standard has been published, H11-A3, “Procedures for the Collection of Arterial Blood Specimens.” In the interim, the American Association for Respiratory Care also published the clinical practice guideline for arterial sampling. The recent NCCLS standard references the AARC document.

Over the years, a significant amount of research by respiratory therapists and clinical laboratorians has continued to expand our knowledge in arterial blood collection. The 1999 NCCLS document incorporates the research that has lead to changes in the standard. The document is organized along the laboratory “path of workflow”; therefore, it covers the pre-analytical components. Arterial puncture is the primary focus with a detailed discussion of arterial cannulation.

This article focuses on specific changes in the standard and other areas of significance.

Hazards
Several hazards have been described related to arterial puncture, including vasovagal response, arteriospasm, hematoma, thrombosis, embolism, and damage to the artery or nerve. The danger of hematoma is greater in older patients due to the loss of elastic tissue. Patients with serious coagulopathies or those receiving anticoagulants are at higher risk for developing hematomas. The size of a cannula and the duration of cannulation have a direct relationship with the obstruction of an artery by a thrombus. The presence of collateral circulation is also related to the safety of the procedure and should be considered when selecting the puncture site.

Choice of anticoagulant
The specific type of heparin selected will be dependent on the analytes and applications. The addition of electrolytes
The new standard recommends that specimens be kept at room temperature and analyzed within 30 minutes.

to the specimen changes the anticoagulant requirements. NCCLS document C46-P, “Blood Gas and pH Analysis and Related Measurements,” provides guidance in the selection of the anticoagulant.

Storage considerations

The impact of storage time and temperature on arterial specimen results has been extensively debated and researched based on the specific collection device and analytes. The central issue is whether to ice or not to ice the specimen. Multiple variables impact this decision. They include the collection device, the storage time, the initial oxygen level in the blood sample, and the analytes requested.

Leukocytes in shed blood continue to consume oxygen at a rate depending on the storage temperature, storage time, and the level of the initial oxygen in the blood. Prior to plastic syringes, the procedure with glass syringes included collecting the specimen and immediately placing it in ice slurry. The purpose of the ice slurry is to slow the metabolic rate of the leukocytes and, therefore, decrease the reduction in oxygen levels. The change to plastic syringes required a reassessment of this issue. Glass is impermeable to gases, unlike plastic. The initial studies confirmed that plastic syringes did produce clinically significant changes in oxygen. Further studies identified those changes that exacerbate the problem. These include the initial oxygen level, the degree of oxygen-hemoglobin binding, the amount of total hemoglobin, and the time and temperature during storage.

The use of plastic versus glass syringes was evaluated in a 1997 study by Smeenk et al. They concluded that when performing 100 percent oxygen studies, regardless of collection in glass or plastic syringes, and storage in ice water or room temperature, deterioration of the oxygen tension (PO$_2$) occurs over time. The authors recommended the use of glass syringes and immediate cooling, regardless of the storage time. This data confirmed similar conclusions from an earlier study in 1994. In a 1999 study, Beaulieu et al examined the effects of temperature, 22 degrees Celsius or in ice slurry, on PO$_2$, arterial carbon dioxide tension (PCO$_2$), and pH when the specimen was collected in a plastic syringe with low heparin. They concluded that specimens with a PO$_2$ initially between 50 and 250 and stored on ice, should be analyzed within 30 minutes. PCO$_2$ and pH did not exhibit clinically significant changes for 60 minutes.

Based on the current research and use of plastic syringes, the standard recommends that specimens collected for blood gas and/or electrolyte analysis should be kept at room temperature and analyzed within 30 minutes. If the anticipated storage time will exceed 30 minutes, glass syringes and ice slurry should be used. There are circumstances that require analysis immediately or within five minutes. These include elevated platelet count, elevated leukocytes, shunt studies, and other special studies.

The procedure for icing or not icing specimens in each setting must be based on a thorough understanding of the study performed, collection device, pre-existing variables, anticipated storage time, and analytes measured. Immediate analysis of the specimen carries
the greatest potential for limiting deterioration of the results. This understanding and controlling the pre-analytical variables will impact accurate results in each situation.

**Patient preparation, site selection, and collection**

An addition to H11-A3 is the recommendation for patient assessment and verification of clinical indication prior to specimen collection. This is a direct reflection of changes prompted by respiratory therapists and the establishment of the laboratory path of workflow. The criteria for selection of the site has not changed over time but deserves continued emphasis. One must always evaluate collateral blood flow, accessibility and size of the artery, and the periarterial tissue. The preferred site is the radial artery, generally followed by the brachial and femoral arteries. The standard also addresses capillaries, scalp arteries, dorsalis pedis arteries, and umbilical arteries. Detailed instructions are provided for specimen collection from each of these sites. An addition to the standard is the detailed description and associated illustrations for arterial cannulation for sampling and monitoring. Respiratory therapists whose scope of practice includes arterial catheter insertion must undergo additional training and competence assessment. This document provides a valuable reference for the training.

**Specimen transport**

As always, the specimen must be properly labeled and transported according to institutional procedure. The specimen should be transported to the laboratory immediately and specimen receipt procedures followed. Rejection criteria for specimens should be outlined in the procedure.

**Summary**

Arterial sampling, analysis, and interpretation are core competencies for respiratory therapists. The NCCLS document should serve as a primary reference in the development of arterial collection procedures. It is also an essential document for training and competence assessment. Many of the regulatory and accrediting agencies also use NCCLS documents as a reference source. The analytical and post-analytical portions of the “path of workflow” are covered in the proposed document, C-46P, “Blood Gas and pH Analysis and Related Measurements.”

**References**


**Additional reading**


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