CLINICAL AND LABORATORY STANDARDS INSTITUTE®

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# C29-A2

## Standardization of Sodium and Potassium Ion-Selective Electrode Systems to the Flame Photometric Reference Method; Approved Standard—Second Edition



This document contains recommendations on the expression of the results of ion-selective electrode measurement of sodium and potassium ion activities in undiluted serum, plasma, or whole blood in clinical practice.

A standard for global application developed through the Clinical and Laboratory Standards Institute consensus process.

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# Standardization of Sodium and Potassium Ion-Selective Electrode Systems to the Flame Photometric Reference Method; Approved Standard—Second Edition

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## Abstract

*Standardization of Sodium and Potassium Ion-Selective Electrode Systems to the Flame Photometric Reference Method; Approved Standard—Second Edition* (CLSI document C29-A2) offers a protocol for standardizing instruments that contain direct ion-selective electrodes to give results in concentration terms that are verifiable to the reference method (flame photometry) for specimens with normal plasma water (i.e., lipids and proteins). The document describes the preparation of serum pools to carry out the procedure. Laboratories without the resources, equipment, or personnel to prepare the pools can purchase them from the National Institute of Standards and Technology (Gaithersburg, MD). It is recommended in C29-A2 that the accuracy of each new direct potentiometric instrument be verified with these standard pools, together with the flame photometer, if it is also used to report patient results.

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## Contents

## Foreword

Analysis of electrolytes in whole blood is becoming increasingly common, and instruments that perform these analyses (ion-selective electrodes that do not require diluted samples, i.e., direct ISE) are available from a number of manufacturers. In many clinical laboratories, instruments that use a diluted specimen [flame photometry or indirect ion-selective electrodes (ISEs)] are also still in use. Direct ISE results are not equivalent to those results obtained by the technology employing dilution for a number of reasons, foremost of which are those relating to the variation in plasma water. To avoid confusion, we recommend that results obtained by direct potentiometry be adjusted to resemble those obtained by procedures that measure concentration in plasma. Most instruments using direct ISEs have built-in conversion algorithms that can be utilized by putting the instrument in "flame" mode. However, it is clear from work performed at the National Institute of Standards and Technology (NIST) that a number of direct potentiometric systems from a variety of manufacturers do not give identical results when assaying identical specimens even in the "flame" mode.[1]

The results of determinations of sodium and potassium ions in physiological fluids have been expressed in terms of (substance) concentration (mmol/L) for many years. The use of concentrations of both sodium and potassium and their reference intervals is firmly established in clinical interpretation and practice. Analytical systems that report concentration, such as flame atomic emission spectrometry (FAES) and ion-selective electrode systems using diluted samples, will continue to be used alongside direct ion-selective electrode determinations in the foreseeable future. Consequently, to introduce a new system of reporting results of sodium and potassium determinations by ion-selective electrodes in terms of ion activity carries significant risks of confusing clinical interpretation.[2,3]

A more fundamental problem also exists. Ion-selective electrodes respond to the thermodynamic activity of ions in solution. By theory, they do not sense concentration which, in fluids such as plasma, is related in a complex way to activity.[4, 2] Therefore, results should be expressed in terms of ion activity. Many practical difficulties exist with this approach, however. Because the activity of these ions cannot, at present, be determined with certainty, particularly in a fluid as complex as plasma, the accuracy of any determination of activity cannot be verified.

The convention recommended in this standard represents a pragmatic compromise that facilitates the introduction of ion-selective electrode determinations of sodium and potassium ion concentrations in whole blood or undiluted plasma into routine clinical practice, while minimizing the risk of clinical misinterpretation.

### Key Words

Direct potentiometry, flame photometry, ion-selective electrode (ISE), potassium, sodium

# Standardization of Sodium and Potassium Ion-Selective Electrode Systems to the Flame Photometric Reference Method; Approved Standard—Second Edition

## 1 Introduction

The objective of this standard is to describe a method to standardize direct ion-selective electrode analyzers for determination of sodium and potassium in blood plasma to units of concentration (mmoI/L) in "normal" plasma, as reported by flame atomic emission spectrometry (flame photometry). This standardized method will allow clinical laboratories to use the same reference intervals, regardless of instrumentation or principle of the methodology.

## 2 Scope

This document addresses the determination of sodium and potassium in undiluted plasma in routine clinical practice using ion-selective electrodes.

## 3 Definitions/Terminology[a]

**Calibration material//Calibrator,** *n* - A material or device of known, or assigned quantitative characteristics (e.g., concentration, activity, intensity, reactivity, responsiveness) used to adjust the output of a measurement procedure or to compare the response obtained with the response of a test specimen and/or sample.

**Direct analysis,** *n* **-** Measurement made directly on an undiluted specimen, e.g., whole blood, plasma, or sweat.

**Flame mode,** *n* - In the flame mode, a factor can be applied to results generated by direct ISE systems that makes the results comparable to those generated by indirect systems for patient specimens normal in protein and lipid content.

**Heparinized,** *adj* - Specimens anticoagulated with a heparin salt(s).

**Indirect analysis,** *n* - Systems that require dilution of the sample; **NOTE:** These include some ion-selective, electrode-based systems, as well as flame emission photometry and atomic absorption.

**Plasma,** *n* - The liquid part {of whole blood} remaining after the separation of the cellular elements ... in a receptacle containing an anticoagulant, or separated by continuous filtration or centrifugation of anticoagulated blood in an apheresis procedure.

**Primary standard,** *n* - A standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity.

[a] Some of these definitions are found in NCCLS document NRSCL8—*Terminology and Definitions for Use in NCCLS Documents.* For complete definitions and detailed source information, please refer to the most current edition of that document.

### 3.1 Abbreviations

| | | Section[b] |
|---|---|---|
| ACD | Acid citrate dextrose | A2.1 |
| CRM/SRM | Certified reference material/standard reference material | 7.1/App. A |
| CV | Coefficient of variation | 7.2.2 |
| EP-BGpH/IFCC | Expert Panel on Blood Gas/pH of the IFCC | A3 |
| FAAS | Flame atomic absorption spectrometry | A2.3 |
| FAES | Flame atomic emission spectroscopy | A2.1(4) |
| FP | Flame photometer | 6.2.2 |
| HIV | Human immunodeficiency virus | A2.1 |
| IFCC | International Federation of Clinical Chemistry | A3 |
| ISE | Ion-selective electrode | 3 |
| NIST | National Institute of Standards and Technology | 7.1 |
| NRSCL | National Reference System for the Clinical Laboratory | A1.3 |

## 4 Standard Precautions

Because it is often impossible to know what might be infectious, all human blood specimens are to be treated as infectious and handled according to "standard precautions." Standard precautions are new guidelines that combine the major features of "universal precautions and body substance isolation" practices. Standard precautions cover the transmission of any pathogen and thus are more comprehensive than universal precautions which are intended to apply only to transmission of blood-borne pathogens. Standard precaution and universal precaution guidelines are available from the U.S. Centers for Disease Control and Prevention (*Guideline for Isolation Precautions in Hospitals*. Infection Control and Hospital Epidemiology. CDC. 1996;Vol 17;1:53-80.), [MMWR 1987;36(suppl 2S):2S-18S] and (MMWR 1988;37:377-382, 387-388). For specific precautions for preventing the laboratory transmission of blood-borne infection from laboratory instruments and materials; and recommendations for the management of blood-borne exposure, refer to NCCLS document M29—*Protection of Laboratory Workers from Instrument Biohazards and Infectious Disease Transmitted by Blood, Body Fluids, and Tissue*.

## 5 Purpose

The purpose of this standard is to recommend a procedure for the standardization of reported, direct ion-selective electrode determination of sodium and potassium in serum, plasma, or whole blood.

[b] Section where abbreviation first appears in text.

## Related NCCLS Publications*

**C46-P** **Blood Gas and pH Analysis and Related Measurements; Proposed Guideline (2000).** This document provides clear definitions of the several quantities in current use, and provides a single source of information on appropriate specimen collection, preanalytical variables, calibration, and quality control for blood pH and gas analysis and related measurements.

**EP9-A** **Method Comparison and Bias Estimation Using Patient Samples; Approved Guideline (1995).** This guideline provides background information and procedures for characterizing the effects of interfering substances on test results.

**H1-A4** **Evacuated Tubes and Additives for Blood Specimen Collection—Fourth Edition; Approved Standard (1996)**. *American National Standard*. This standard contains requirements for blood collection tubes and additives including heparin, EDTA, and sodium citrate.

**H3-A4** **Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture—Third Edition; Approved Standard (1998)**. This standard provides detailed descriptions and explanations of proper collection techniques, as well as hazards to patients from a inappropriate specimen collection by skin puncture procedures. (See related publications H18-A in this section, LA4-A3 in the Immunology and Ligand Assay section, and M29-A in the Microbiology section.)

**NRSCL8-A** **Terminology and Definitions For Use in NCCLS Documents; Approved Standard (1998).** This document provides standard definitions for use in NCCLS standards and guidelines, and for submitting candidate reference methods and materials to the National Reference System for the Clinical Laboratory (NRSCL).

**RS7-P** **Sodium; Proposed Summary of Methods and Materials Credentialed by the NRSCL Council (1988).**

**RS8-P** **Potassium; Proposed Summary of Methods and Materials Credentialed by the NRSCL Council (1988).**



* Proposed- and tentative-level documents are being advanced through the NCCLS consensus process; therefore, readers should refer to the most recent editions.

 

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