SYNCHRON® System(s)
Chemistry Information Sheet

K
Potassium
REF & 467915 467935
REF & A28945 A28937

For *In Vitro* Diagnostic Use

ANNUAL REVIEW

Reviewed by:		Reviewed by:	Date
Refer to coversheet in front of method			

PRINCIPLE

INTENDED USE

ISE Electrolyte Buffer reagent and ISE Electrolyte Reference reagent, when used in conjunction with SYNCHRON LX® System(s), UniCel® DxC 600/800 System(s) and SYNCHRON® Systems AQUA CAL 1, 2 and 3, are intended for the quantitative determination of potassium concentration in human serum, plasma or urine.

CLINICAL SIGNIFICANCE

Potassium measurements are used in the diagnosis and treatment of hypokalemia (metabolic alkalosis, metabolic acidosis or the absence of acid-base disturbances), hyperkalemia (overadministration of potassium, acidosis, or crush injuries), renal failure, Addison's disease or other diseases involving electrolyte imbalance.

METHODOLOGY

The SYNCHRON® System(s) determines potassium ion concentration by indirect potentiometry utilizing a potassium ion selective electrode in conjunction with a sodium reference electrode.

To measure potassium concentrations, a precise volume of sample (40 microliters) is mixed with a buffered solution. The ratio used is one part sample to 33 parts buffer. The high molar strength buffer is used to establish a constant activity coefficient for potassium ions, calibrating the electrode to concentration values.

CHEMICAL REACTION SCHEME

The potassium ion selective electrode consists of a valinomycin PVC membrane cast on a solid support. The physical structure of the valinomycin ionophore is such that its cavity is nearly equal to the diameter of the potassium ion, thus allowing potassium ions to complex with valinomycin. When sample buffer mixture contacts the electrode, changes in electrode potential occur as potassium ions react with valinomycin. These changes in potential are referenced to the sodium reference electrode. The "referenced potential" follows the Nernst equation and allows the calculation of potassium concentration in sample:

$$E = \text{Constant} + (\text{slope})(\log[K^+])$$

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For more accurate measurement, the reference reagent containing potassium ions is introduced into the flow cell after the sample cycle, and the same complexation takes place. The differential potential (voltage) between sample and reference reagent cycles is used for the calculation.[1]

Under ideal conditions, the electrode imparts a selectivity of 1000:1 over sodium ions and is insensitive to hydrogen ions in solutions buffered from pH 3 to 9.

SPECIMEN

TYPE OF SPECIMEN

Biological fluid samples should be collected in the same manner routinely used for any laboratory test.[2] Freshly drawn serum, plasma or properly collected urine (random/timed) are the preferred specimens. Acceptable anticoagulants are listed in the PROCEDURAL NOTES section of this chemistry information sheet. Whole blood is not recommended for use as a sample.

SPECIMEN STORAGE AND STABILITY

1. Tubes of blood are to be kept closed at all times and in a vertical position. It is recommended that the serum or plasma be physically separated from contact with cells within two hours from the time of collection.[3]
2. Separated serum or plasma should not remain at room temperature longer than 8 hours. If assays are not completed within 8 hours, serum or plasma should be stored at +2°C to +8°C. If assays are not completed within 48 hours, or the separated sample is to be stored beyond 48 hours, samples should be frozen at -15°C to -20°C. Frozen samples should be thawed only once. Analyte deterioration may occur in samples that are repeatedly frozen and thawed.[3]
3. It is recommended that urine assays be performed within 2 hours of collection. For timed specimens, the collection container should be kept in the refrigerator or on ice during the timed period. No preservative is required.[4]

ADDITIONAL SPECIMEN STORAGE AND STABILITY CONDITIONS AS DESIGNATED BY THIS LABORATORY:

Refer to “Sample Integrity in Chemistry” write up in “Policies and Procedures” manual

SAMPLE VOLUME

A filled 0.5 mL sample cup is the optimum volume. For optimum primary sample tube volumes in primary tube samples and minimum volumes, refer to the Primary Tube Sample Template for your system.

CRITERIA FOR UNACCEPTABLE SPECIMENS

Refer to the PROCEDURAL NOTES section of this chemistry information sheet for information on unacceptable specimens.

CRITERIA FOR SAMPLE REJECTION AS DESIGNATED BY THIS LABORATORY:

Refer to “Sample Integrity in Chemistry” write up in “Policies and Procedures” manual

PATIENT PREPARATION

SPECIAL INSTRUCTIONS FOR PATIENT PREPARATION AS DESIGNATED BY THIS LABORATORY:

Refer to “Sample Integrity in Chemistry” write up in “Policies and Procedures” manual

SPECIMEN HANDLING

SPECIAL INSTRUCTIONS FOR SPECIMEN HANDLING AS DESIGNATED BY THIS LABORATORY:

Refer to “Sample Integrity in Chemistry” write up in “Policies and Procedures” manual

REAGENTS

CONTENTS

Each kit contains the following items:

ISE ELECTROLYTE BUFFER REAGENT:
Two Electrolyte Buffer Reagent Bottles (2 x 2 L)
ISE ELECTROLYTE REFERENCE REAGENT:
Two Electrolyte Reference Reagent Bottles (2 x 2 L)

VOLUMES PER TEST

Sample Volume	40 µL
Reagent Volume	
ISE Electrolyte Buffer	1.27 mL
ISE Electrolyte Reference	3.23 mL

REACTIVE INGREDIENTS

REAGENT CONSTITUENTS

ISE ELECTROLYTE BUFFER REAGENT:	
Tris	230 mmol/L
ISE ELECTROLYTE REFERENCE REAGENT:	
Sodium	7 mmol/L
Potassium	0.2 mmol/L
Chloride	5 mmol/L
Carbon Dioxide	1.5 mmol/L

REAGENT CONSTITUENTS

Calcium	0.1 mmol/L

Also non-reactive chemicals necessary for optimal system performance.

Avoid skin contact with reagent. Use water to wash reagent from skin.

MATERIALS NEEDED BUT NOT SUPPLIED WITH REAGENT KIT

SYNCHRON® Systems AQUA CAL 1, 2 and 3
At least two levels of control material

REAGENT PREPARATION

No preparation is required.

ACCEPTABLE REAGENT PERFORMANCE

The acceptability of a reagent is determined by successful calibration and by ensuring that quality control results are within your facility's acceptance criteria.

REAGENT STORAGE AND STABILITY

1. ISE Electrolyte Reference reagent stored unopened at room temperature is stable until the expiration date printed on the bottle label. Once opened, the reagent is stable at room temperature for 30 days, unless the expiration date is exceeded.
2. ISE Electrolyte Buffer reagent stored unopened at room temperature is stable until the expiration date printed on the bottle label. Once opened, the reagent is stable at room temperature for 30 days, unless the expiration date is exceeded.
3. For any electrolyte reagents frozen in transit, completely warm to room temperature and mix thoroughly by gently inverting bottle at least 20 times to redissolve salts into solution.

ISE ELECTROLYTE BUFFER REAGENT AND ISE ELECTROLYTE REFERENCE REAGENT STORAGE LOCATION:

Chemistry department, room L568. Stored on open shelves kept at room temperature (monitored daily.)

CALIBRATION

CALIBRATOR REQUIRED

SYNCHRON® Systems AQUA CAL 1, 2 and 3

CALIBRATOR PREPARATION

No preparation is required.

CALIBRATOR STORAGE AND STABILITY

1. If unopened, the calibrators should be stored at +2°C to +8°C until the expiration date printed on the calibrator bottle. Once opened, the calibrators are stable at room temperature for 30 days.
2. Repetitive refrigeration of the aqueous calibrators may facilitate crystal formation. Once removed from refrigerated storage, these calibrators should remain at room temperature.

CALIBRATOR STORAGE LOCATION:

Opened Aqua Cal bottles kept at room temperature (monitored daily) in Chemistry department room L568.
Unopened Aqua Cal bottles kept in Chemistry refrigerator #6 in Chemistry department room L568.

CALIBRATION INFORMATION

1. The system must have a valid calibration in memory before controls or patient samples can be run.
2. Under typical operating conditions the K assay must be calibrated every 24 hours or with each new bottle of reagent and also with certain parts replacement or maintenance procedures, as defined in the SYNCHRON LX *Maintenance Manual and Instrument Log*, or the UniCel DxC 600/800 System *Instructions for Use* (IFU) manual.
3. For detailed calibration instructions, refer to the SYNCHRON LX *Operations Manual*, or the UniCel DxC 600/800 System *Instructions For Use* (IFU) manual.
4. The system will automatically perform checks on the calibration and produce data at the end of calibration. In the event of a failed calibration, the data will be printed with error codes and the system will alert the operator of the failure. For information on error codes, refer to the SYNCHRON LX *Diagnostics and Troubleshooting Manual*, or the UniCel DxC 600/800 System *Instructions For Use* (IFU) manual.

TRACEABILITY

For Traceability information refer to the Calibrator instructions for use.

QUALITY CONTROL

At least two levels of control material should be analyzed daily. In addition, these controls should be run with each new calibration, with each new bottle of reagent, and after specific maintenance or troubleshooting procedures as detailed in the appropriate system manual. More frequent use of controls or the use of additional controls is left to the discretion of the user based on good laboratory practices or laboratory accreditation requirements and applicable laws.

The following controls should be prepared and used in accordance with the package inserts. Discrepant quality control results should be evaluated by your facility.

NOTICE

Do not use controls containing diethylamine HCl.

TABLE 1 QUALITY CONTROL MATERIAL

CONTROL NAME	SAMPLE TYPE	STORAGE
Monitrol levels 1 and 2 vials in use kept refrigerated after thawing. Unopened Monitrol kept frozen until just before use. Refer to “DXC 800 Control Analysis” in DXC 800 procedure manual for other control material used and storage. Control preparations and acceptance of QC results are in “Policies and Procedures” manual		

TESTING PROCEDURE(S)

1. If necessary, load the reagent onto the system.
2. After reagent load is completed, calibration is required.
3. Program samples and controls for analysis.
4. After loading samples and controls onto the system, follow the protocols for system operations.

For detailed testing procedures, refer to the SYNCHRON LX *Operations Manual*, or the UniCel DxC 600/800 System *Instructions For Use* (IFU) manual.

CALCULATIONS

The SYNCHRON® System(s) performs all calculations internally to produce the final reported result. The system will calculate the final result for sample dilutions made by the operator when the dilution factor is entered into the system during sample programming.

REPORTING RESULTS

Equivalency between the SYNCHRON LX and UniCel DxC 600/800 Systems has been established. Chemistry results between these systems are in agreement and data from representative systems may be shown.

REFERENCE INTERVALS

Each laboratory should establish its own reference intervals based upon its patient population. The following reference intervals were taken from literature and a study performed on SYNCHRON Systems.[5]

TABLE 2 REFERENCE INTERVALS

INTERVALS	SAMPLE TYPE	CONVENTIONAL UNITS	S.I. UNITS
Literature	Serum or Plasma	3.5 – 5.1 mmol/L	3.5 – 5.1 mmol/L
	Urine (timed)	25 – 125 mmol/24 hrs	25 – 125 mmol/24 hrs
SYNCHRON	Serum or Plasma	3.6 – 5.1 mmol/L	3.6 – 5.1 mmol/L

INTERVALS	SAMPLE TYPE	AGE	CONVENTIONAL UNITS	S.I. UNITS
Laboratory	Serum or Plasma	<1 year	3.2 – 6.0 mmol/L	n/a
		≥ 1year	3.8 – 5.1 mmol/L	n/a
	Urine (timed)			n/a

Refer to References (5,6,7) for guidelines on establishing laboratory-specific reference intervals.

1. Normal range for infants 0 to <1 year adopted from Soldin, Steven J., "Pediatric Reference Intervals", 6th edition, AACC Press, 2007, method 4.
2. Adult range used for children ≥1 year old.
3. Normal range for adults was determined by testing 271 male and female healthy blood donors at UCSF.

ADDITIONAL REPORTING INFORMATION AS DESIGNATED BY THIS LABORATORY:

Refer to "DXC800 Linearity and Reportable Range" chart in Technical notes section of DXC800 Procedure manual

PROCEDURAL NOTES

ANTICOAGULANT TEST RESULTS

1. If plasma is the sample of choice, the following anticoagulants were found to be compatible with this method:

TABLE 3 COMPATIBLE ANTICOAGULANTS

ANTICOAGULANT	LEVEL TESTED FOR IN VITRO INTERFERENCE	AVERAGE PLASMA-SERUM BIAS (mmol/L)[a]
Ammonium Heparin	14 Units/mL	NSI[b]
Lithium Heparin	14 Units/mL	NSI
Sodium Heparin	14 Units/mL	NSI

2. The following anticoagulants were found to be incompatible with this method:

TABLE 4 INCOMPATIBLE ANTICOAGULANTS

ANTICOAGULANT	LEVEL TESTED FOR IN VITRO INTERFERENCE	AVERAGE PLASMA-SERUM BIAS (mmol/L)[c]
Potassium Oxalate/Sodium Fluoride	2.0 / 2.5 mg/mL	-0.61

LIMITATIONS

If urine samples are cloudy or turbid, it is recommended that they be centrifuged before transfer to a sample cup.

INTERFERENCES

1. The following substances were tested for interference with this methodology:

TABLE 5 INTERFERENCES

SUBSTANCE	SOURCE	LEVEL TESTED	OBSERVED EFFECT[d]
Bilirubin (unconjugated)	Bovine	30 mg/dL	NSI[e]
Hemoglobin	RBC hemolysate	50 mg/dL	+0.2 mmol/L
Lipemia	Intralipid[f]	500 mg/dL	NSI
Ammonium Nitrate	NA[g]	5 mmol/L	+0.16 mmol/L
Benzalkonium chloride	NA	1 mg/dL	-0.15 mmol/L
Cesium Chloride	NA	0.5 mg/dL	+0.15 mmol/L

2. Benzalkonium heparin demonstrates a positive interference with the potassium assay.

3. Lipemic samples with visual turbidity >3+, or with a Lipemia Serum Index >10, should be ultracentrifuged and the analysis performed on the infranate.
4. Refer to References (8,9,10) for other interferences caused by drugs, disease and preanalytical variables.

PERFORMANCE CHARACTERISTICS

Analytic Range

The SYNCHRON® System(s) method for the determination of this analyte provides the following analytical ranges:

TABLE 6 ANALYTICAL RANGE

SAMPLE TYPE	CONVENTIONAL UNITS	S.I. UNITS
Serum or Plasma	1.0 – 15.0 mmol/L	1.0 – 15.0 mmol/L
Urine	2 – 300 mmol/L	2 – 300 mmol/L

Samples with concentrations exceeding the high end of the analytical range should be diluted with deionized water and reanalyzed.

REPORTABLE RANGE (as determined on site):

TABLE 7 REPORTABLE RANGE

SAMPLE TYPE	CONVENTIONAL UNITS	S.I. UNITS
Serum or Plasma	1.0 – 15.0 mmol/L	1.0 – 15.0 mmol/L
Urine	2 – 300 mmol/L	2 – 300 mmol/L

SENSITIVITY

Sensitivity is defined as the lowest measurable concentration which can be distinguished from zero with 95% confidence. Sensitivity for K determination is 1.0 mmol/L for serum or plasma, and 2.0 mmol/L for urine.

EQUIVALENCY

Equivalency was assessed by Deming regression analysis of patient samples to accepted clinical methods.

Serum or Plasma (in the range of 1.31 to 14.6 mmol/L):

Y (SYNCHRON LX Systems)	= 1.000X + 0.015
N	= 239
MEAN (SYNCHRON LX Systems)	= 4.44
MEAN (SYNCHRON CX Systems)	= 4.46
CORRELATION COEFFICIENT (r)	= 0.999

Urine (in the range of 7.97 to 294.4 mmol/L):

Y (SYNCHRON LX Systems)	= 0.960X + 0.339

Urine (in the range of 7.97 to 294.4 mmol/L):

N	= 100
MEAN (SYNCHRON LX Systems)	= 66.41
MEAN (SYNCHRON CX Systems)	= 68.83
CORRELATION COEFFICIENT (r)	= 1.000

Serum or Plasma (in the range of 1.2 to 15 mmol/L):

Y (UniCel DxC Systems)	= 0.994X -0.00
N	= 160
MEAN (UniCel DxC Systems)	= 7.6
MEAN (SYNCHRON LX Systems)	= 7.7
CORRELATION COEFFICIENT (r)	= 0.998

Urine (in the range of 7.6 to 261.3 mmol/L):

Y (UniCel DxC Systems)	= 0.972X + 2.31
N	= 148
MEAN (UniCel DxC Systems)	= 84.8
MEAN (SYNCHRON LX Systems)	= 84.8
CORRELATION COEFFICIENT (r)	= 0.999

Refer to References (11) for guidelines on performing equivalency testing.

PRECISION

A properly operating SYNCHRON® System(s) should exhibit imprecision values less than or equal to the maximum performance limits in the table below. Maximum performance limits were derived by an examination of the imprecision of various methods, proficiency test summaries, and literature sources.

TABLE 8 MAXIMUM PERFORMANCE LIMITS

TYPE OF PRECISION	SAMPLE TYPE	1 SD	CHANGEOVER VALUE[h]	% CV
		mmol/L	mmol/L	
Within-run	Serum/Plasma	0.10	5.0	2.0
	Urine	2.0	50.0	4.0
Total	Serum/Plasma	0.20	6.67	3.0
	Urine	3.0	50.0	6.0

Comparative performance data for the SYNCHRON LX System evaluated using the NCCLS Approved Guideline EP5-A appears in the table below.[12] Each laboratory should characterize their own instrument performance for comparison purposes.

TABLE 9 NCCLS EP5-A PRECISION ESTIMATE METHOD

TYPE OF IMPRECISION	SAMPLE TYPE		No. Systems	No. Data Points[i]	Test Mean Value (mmol/L)	EP5-A Calculated Point Estimates	
						SD	%CV
Within-run	Serum	Control 1	1	80	2.47	0.02	0.9
	Serum	Control 2	1	80	7.66	0.06	1.0
	Urine	Control 1	1	80	28.81	0.18	0.6
	Urine	Control 2	1	80	77.84	0.36	0.5
Total	Serum	Control 1	1	80	2.47	0.03	1.4

TYPE OF IMPRECISION	SAMPLE TYPE		No. Systems	No. Data Points[i]	Test Mean Value (mmol/L)	EP5-A Calculated Point Estimates	
						SD	%CV
	Serum	Control 2	1	80	7.66	0.07	1.0
	Urine	Control 1	1	80	28.81	0.26	0.9
	Urine	Control 2	1	80	77.84	1.09	1.4

NOTICE

These degrees of precision and equivalency were obtained in typical testing procedures on a SYNCHRON LX® System and are not intended to represent the performance specifications for this reagent.

ADDITIONAL INFORMATION

For more detailed information on SYNCHRON LX Systems or UniCel DxC Systems, refer to the appropriate system manual.

SHIPPING DAMAGE

If damaged product is received, notify your Beckman Coulter Clinical Support Center.

REFERENCES

1. Stefanac, Z., Simon, W., "Highly Selective Cation Electrode Systems Based on In-Vitro Behavior of Macrotetrolides in Membranes", *Chimica*, 20:436-440 (1966).

2. Tietz, N. W., "Specimen Collection and Processing; Sources of Biological Variation", *Textbook of Clinical Chemistry*, 2nd Edition, W. B. Saunders, Philadelphia, PA (1994).

3. National Committee for Clinical Laboratory Standards, *Procedures for the Handling and Processing of Blood Specimens*, Approved Guideline, NCCLS publication H18-A, Villanova, PA (1990).

4. National Committee for Clinical Laboratory Standards, *Routine Urinalysis and Collection, Transportation and Preservation of Urine Specimens*, Tentative Guideline, NCCLS publication GP16-T, Villanova, PA (1992).

5. Tietz, N. W., *Clinical Guide to Laboratory Tests*, 3rd Edition, W. B. Saunders, Philadelphia, PA (1995).

6. National Committee for Clinical Laboratory Standards, *How to Define, Determine, and Utilize Reference Intervals in the Clinical Laboratory*, Approved Guideline, NCCLS publication C28-A, Villanova, PA (1995).

7. Henry, J. B., *Clinical Diagnosis and Management by Laboratory Methods*, 18th Edition, W. B. Saunders Company, Philadelphia, PA (1991).

8. Young, D. S., *Effects of Drugs on Clinical Laboratory Tests*, 4th Edition, AACC Press, Washington, D. C. (1995).

9. Friedman, R. B., Young, D. S.,*Effects of Disease on Clinical Laboratory Tests*, 3rd Edition, AACC Press, Washington, D.C. (1997).

10. Young, D. S., *Effects of Preanalytical Variables on Clinical Laboratory Tests*, 2nd Edition, AACC Press, Washington, D. C. (1997).

11. National Committee for Clinical Laboratory Standards, *Method Comparison and Bias Estimation Using Patient Samples*, Approved Guideline, NCCLS publication EP9-A, Villanova, PA (1995).

12. National Committee for Clinical Laboratory Standards, *Evaluation of Precision Performance of Clinical Chemistry Devices*, Approved Guideline, Vol. 19, No. 2, NCCLS publication EP5-A, Villanova, PA (1999).

EC REP Beckman Coulter Ireland Inc., Mervue Business Park, Mervue, Galway, Ireland (353 91 774068)

Beckman Coulter, Inc., 250 South Kraemer Blvd., Brea, CA 92821

ENDNOTES

a Bias is based on worst case instead of average.

b NSI = No Significant Interference (within ±0.2 mmol/L or 4%).

c Bias is based on worst case instead of average. Plus (+) or minus (-) signs in this column signify positive or negative bias.

d Plus (+) or minus (-) signs in this column signify positive or negative interference.

e NSI = No Significant Interference (within ±0.2 mmol/L or 4%).

f Intralipid is a registered trademark of KabiVitrum, Inc., Clayton, NC 27250.

g NA = Not applicable.

h When the mean of the test precision data is less than or equal to the changeover value, compare the test SD to the SD guideline given above to determine the acceptability of the precision testing. When the mean of the test precision data is greater than the changeover value, compare the test % CV to the guideline given above to determine acceptability. Changeover value = (SD guideline/CV guideline) x 100.

i The point estimate is based on the pooled data from one system, run for twenty days, two runs per day, two observations per run on an instrument operated and maintained according to the manufacturer's instructions.