

Piccolo[®] Renal Function Panel

For In Vitro Diagnostic Use and Healthcare Professional Use Only
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Applicable to US customers only
CLIA Waived: Use lithium heparin whole blood, only
Moderate Complexity: Use lithium heparin whole blood, lithium heparin plasma, or serum



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1. Intended Use

The Piccolo[®] Renal Function Panel, used with the Piccolo Xpress[®] chemistry analyzer is intended to be used for the *in vitro* quantitative determination of albumin, calcium, chloride, creatinine, glucose, phosphorus, potassium, sodium, total carbon dioxide and blood urea nitrogen (BUN) in heparinized whole blood, heparinized plasma, or serum in a clinical laboratory setting or point-of-care location/ near-patient testing.

For US Customers Only

The tests on this panel are waived under CLIA '88 regulations. If a laboratory modifies the test system instructions, then the tests are considered high complexity and subject to all CLIA requirements. For CLIA waived labs, only lithium heparin whole blood may be tested. For use in moderate complexity labs, lithium heparinized whole blood, lithium heparinized plasma, or serum may be used.

A CLIA Certificate of Waiver is needed to perform CLIA waived testing. A Certificate of Waiver can be obtained from the Centers for Medicare & Medicaid Services (CMS).

2. Summary and Explanation of Tests

The Piccolo Renal Function Panel reagent disc and the Piccolo Xpress chemistry analyzer comprise an *in vitro* diagnostic system that aids the physician in diagnosing the following disorders in adults:

Albumin:	General Renal and hepatic processes, and general nutritional/ health status, for example, Dehydration, renal disease, liver insufficiency with decreased albumin synthesis, severe malnutrition, acute inflammation, chronic inflammation, malignancy, and burns.
Calcium:	General metabolic disease, for example, Parathyroid, bone and chronic renal diseases; tetany.
Chloride:	General metabolic disease, for example, Dehydration, prolonged diarrhea and vomiting, renal tubular disease, hyperparathyroidism, burns, salt-losing renal diseases, overhydration and thiazide therapy.
Creatinine:	Renal diseases and renal dialysis.
Glucose:	Carbohydrate metabolism disorders, for example, adult and juvenile diabetes mellitus and hypoglycemia.
Phosphorus:	General metabolic disorders, for example, Dehydration, diabetes, parathyroidism, and renal disease.
Potassium:	Renal, endocrine, and metabolic disease as well as iatrogenic causes, for example, Renal glomerular or tubular disease, adrenocortical insufficiency, diabetic ketacidosis, excessive intravenous potassium therapy, sepsis, panhypopituitarism, <i>in vitro</i> hemolysis, hyperaldosteronism, malnutrition, hyperinsulinism, metabolic alkalosis and gastrointestinal loss.

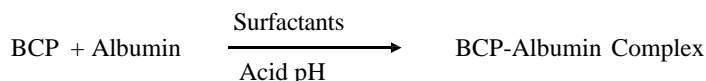
Sodium:	Metabolic diseases, for example, Dehydration, diabetes insipidus, loss of hypotonic gastrointestinal fluids, salt poisoning, selective depression of the sense of thirst, skin loss, burns, sweating, hyperaldosteronism, CNS disorders, dilutional, depletion and delusional hyponatremia and ADH secretion syndrome.
Total Carbon Dioxide:	Metabolic disorders, for example, metabolic alkalosis and acidosis and primary respiratory alkalosis and acidosis.
Blood urea nitrogen (BUN):	Renal diseases.

As with any diagnostic test procedure, all other test procedures including the clinical status of the patient, should be considered prior to final diagnosis.

3. Principle of Method

Albumin (ALB)

Early methods used to measure albumin include fractionation techniques and tryptophan content of globulins.¹⁻⁵ These methods were unwieldy to perform and did not have a high specificity. Two immunochemical techniques are considered as reference methods but are expensive and time consuming.⁶ Dye binding techniques are the most frequently used methods for measuring albumin. Bromocresol green (BCG) is the most commonly used of the dye binding methods but may over-estimate albumin concentration, especially at the low end of the normal range.⁷ Bromocresol purple (BCP) is the most specific of the dyes in use.^{8,9}



Bound albumin is proportional to the concentration of albumin in the sample. This is an endpoint reaction that is measured as the difference in absorbance between 600 nm and 550 nm.

Calcium (CA)

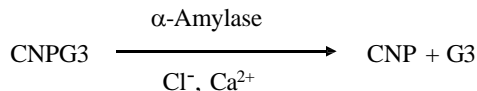
The reference method for calcium is atomic absorption spectroscopy; however, this method is not suited for routine use.¹⁰ Spectrophotometric methods using either *o*-cresolphthalein complexone (CPC) or arsenazo III metallochromic indicators are most commonly used.^{11,12,13} Arsenazo III has a high affinity for calcium and is not temperature dependent as is CPC. Calcium in the patient sample binds with arsenazo III to form a calcium-dye complex.



The endpoint reaction is monitored at 405 nm, 467 nm, and 600 nm. The amount of total calcium in the sample is proportional to the absorbance.

Chloride (CL⁻)

The Abaxis chloride method is based on the determination of chloride-dependent activation of α -amylase activity. Deactivated α -amylase is reactivated by addition of the chloride ion, allowing the calcium to re-associate with the enzyme. The reactivation of α -amylase activity is proportional to the concentration of chloride ions in the sample. The reactivated α -amylase converts the substrate, 2-chloro-*p*-nitrophenyl- α -D-maltotriose (CNPG3) to 2-chloro-*p*-nitrophenyl (CNP) producing color and α -maltotriose (G3). The reaction is measured bichromatically and the increase absorbance is directly proportional to the reactivated α -amylase activity and the concentration of chloride in the sample.¹⁴

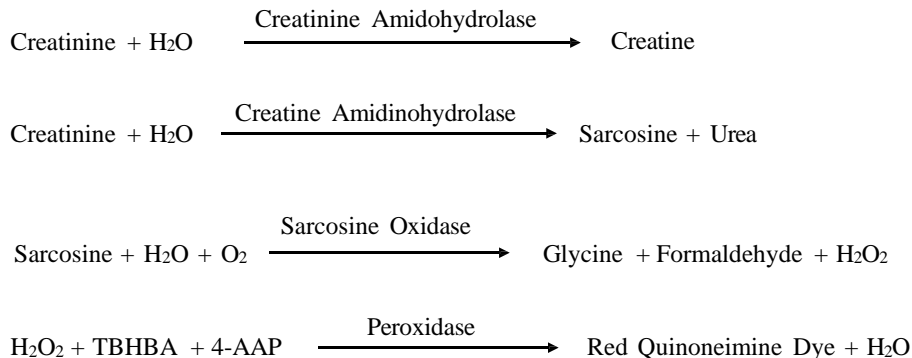


Creatinine (CRE)

The Jaffe method, first introduced in 1886, is still a commonly used method of determining creatinine levels in blood. The current reference method combines the use of Fuller's earth (floridin) with the Jaffe technique to increase the specificity of the reaction.^{15,16} Enzymatic methods have been developed that are more specific for creatinine than the various modifications of the Jaffe technique.^{17,18,19,20} Methods using the enzyme creatinine amidohydrolase eliminate the problem of ammonium ion interference found in techniques using creatinine iminohydrolase.²¹

In the coupled enzyme reactions, creatinine amidohydrolase hydrolyzes creatinine to creatine. A second enzyme, creatine amidinohydrolase, catalyzes the formation of sarcosine from creatine. Sarcosine oxidase causes the oxidation of sarcosine to

glycine, formaldehyde and hydrogen peroxide (H₂O₂). In a Trinder reaction, peroxidase catalyzes the reaction among the hydrogen peroxide, 2,4,6-tribromo-3-hydroxybenzoic acid (TBHBA) and 4-aminoantipyrine (4-AAP) into a red quinoneimine dye. Potassium ferrocyanide and ascorbate oxidase are added to the reaction mixture to minimize the potential interference of bilirubin and ascorbic acid, respectively.



Two cuvettes are used to determine the concentration of creatinine in the sample. Endogenous creatine is measured in the blank cuvette, which is subtracted from the combined endogenous creatine and the creatine formed from the enzyme reactions in the test cuvette. Once the endogenous creatine is eliminated from the calculations, the concentration of creatinine is proportional to the intensity of the red color produced. The endpoint reaction is measured as the difference in absorbance between 550 nm and 600 nm.

eGFR (calculated)

Serum creatinine is routinely measured as an indicator of renal function. Because creatinine is influenced by age, gender and race, chronic kidney disease (CKD) may not be detected using serum creatinine alone. Thus, the National Kidney Disease Education Program strongly recommends that laboratories routinely report an estimated Glomerular Filtration Rate (eGFR) when serum creatinine is measured for patients 18 and older. Routinely reporting the eGFR with all serum creatinine determinations allows laboratories to help identify individuals with reduced kidney function and help facilitate the detection of CKD. Calculated eGFR values of <60 ml/min are generally associated with increased risk of adverse outcomes of CKD.

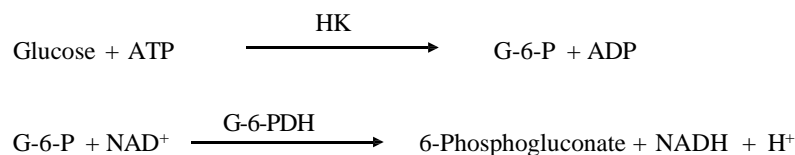
Calculation of the eGFR is performed by the Piccolo using the patient's age, gender and race. The Piccolo method for creatinine is traceable to the IDMS reference method for creatinine so that the following form of the MDRD equation for calculating the eGFR can be used.

$$\text{GFR (mL/min/1.73 m}^2) = 175 \times (\text{S}_{\text{cr}})^{-1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female}) \times (1.212 \text{ if African American})$$

Glucose (GLU)

Measurements of glucose concentration were first performed using copper-reduction methods (such as Folin-Wu²² and Somogyi-Nelson^{23,24}). The lack of specificity in copper-reduction techniques led to the development of quantitative procedures using the enzymes hexokinase and glucose oxidase. The glucose test incorporated into the Piccolo Renal Function Panel reagent disc is a modified version of the hexokinase method, which has been proposed as the basis of the glucose reference method.²⁵

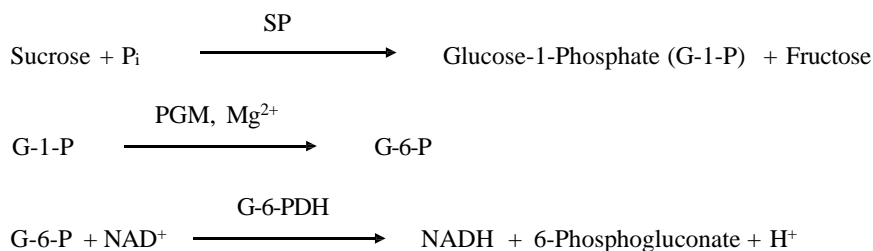
The reaction of glucose with adenosine triphosphate (ATP), catalyzed by hexokinase (HK), produces glucose -6-phosphate (G-6-P) and adenosine diphosphate (ADP). Glucose-6-phosphate dehydrogenase (G-6-PDH) catalyzes the reaction of G-6-P into 6-phosphogluconate and the reduction of nicotinamide adenine dinucleotide (NAD⁺) to NADH.



The absorbance is measured bichromatically at 340 nm and 850 nm. The production of NADH is directly proportional to the amount of glucose present in the sample.

Phosphorus (PHOS)

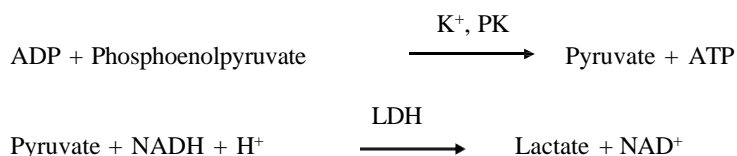
The most applicable enzymatic method for the Abaxis system uses sucrose phosphorylase (SP) coupled through phosphoglucomutase (PGM) and glucose-6-phosphate dehydrogenase (G6PDH).^{26,27} Using the enzymatic system for each mole of phosphorus present in the sample, one mole of NADH is formed. The amount of NADH formed can be measured as an endpoint at 340 nm.



Potassium (K⁺)

Spectrophotometric methods have been developed that allow the measurement of potassium concentration on standard clinical chemistry instrumentation. An enzymatic method based on the activation of pyruvate kinase with potassium show excellent linearity and negligible susceptibility to endogenous substances.^{28,29,30} Interference from sodium and ammonium ions are minimized with the addition of Kryptofix and glutamine synthetase, respectively.²⁸

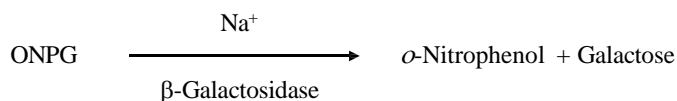
In the coupled-enzyme reaction, pyruvate kinase (PK) dephosphorylates phosphoenolpyruvate to form pyruvate. Lactate dehydrogenase (LDH) catalyzes conversion of pyruvate to lactate. Concomitantly, NADH is oxidized to NAD⁺.



The rate of change in absorbance difference between 340 nm and 405 nm is due to the conversion of NADH to NAD⁺ and is directly proportional to the amount of potassium in the sample.

Sodium (NA⁺)

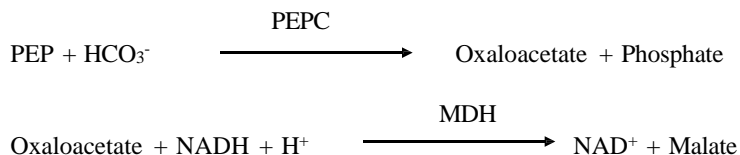
Colorimetric and enzymatic methods have been developed that allow the measurement of sodium concentration on standard clinical chemistry instrumentation.^{31,32,33} In the Abaxis enzymatic reaction, β -galactosidase is activated by the sodium in the sample. The activated enzyme catalyses the reaction o-nitrophenyl- β -galactopyranoside (ONPG) to o-nitrophenyl and galactose.



Total Carbon Dioxide (tCO₂)

Total carbon dioxide in serum or plasma exists as dissolved carbon dioxide, carbamino derivatives of proteins, bicarbonate and carbonate ions and carbonic acid. Total carbon dioxide can be measured by pH indicator, CO₂ electrode and spectrophotometric enzymatic methods, which all produce accurate and precise results.^{34,35} The enzymatic method is well suited for use on a routine blood chemistry analyzer without adding complexity.

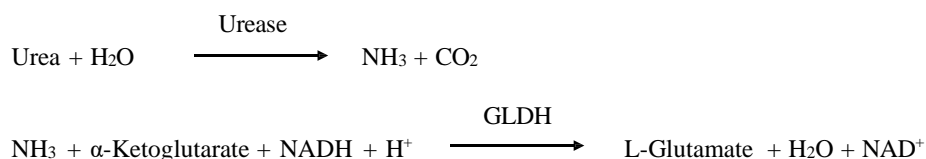
In the enzymatic method, the specimen is first made alkaline to convert all forms of carbon dioxide (CO₂) to bicarbonate (HCO₃⁻). Phosphoenolpyruvate (PEP) and HCO₃⁻ then react to form oxaloacetate and phosphate in the presence of phosphoenolpyruvate carboxylase (PEPC). Malate dehydrogenase (MDH) catalyzes the reaction of oxaloacetate and reduced nicotinamide adenine dinucleotide (NADH) to NAD⁺ and malate. The rate of change in absorbance due to the conversion of NADH to NAD⁺ is directly proportional to the amount of tCO₂ in the sample.



Blood Urea Nitrogen (BUN)

Urea can be measured both directly and indirectly. The diacetyl monoxime reaction, the only direct method to measure urea, is commonly used but employs dangerous reagents.³⁶ Indirect methods measure ammonia created from the urea; the use of the enzyme urease has increased the specificity of these tests.³⁷ The ammonia is quantitated by a variety of methods, including nesslerization (acid titration), the Berthelot technique^{38,39} and coupled enzymatic reactions.^{40,41} Catalyzed Berthelot procedures, however, are erratic when measuring ammonia.⁴² Coupled-enzyme reactions are rapid, have a high specificity for ammonia, and are commonly used. One such reaction has been proposed as a candidate reference method.⁴³

In the coupled-enzyme reaction, urease hydrolyzes urea into ammonia and carbon dioxide. Upon combining ammonia with α -ketoglutarate and reduced nicotinamide adenine dinucleotide (NADH), the enzyme glutamate dehydrogenase (GLDH) oxidizes NADH to NAD⁺.



The rate of change of the absorbance difference between 340 nm and 405 nm is caused by the conversion of NADH to NAD⁺ and is directly proportional to the amount of urea present in the sample.

4. Principle of Operation

Refer to the Piccolo Xpress chemistry analyzer Operator's Manual, for the Principles and Limitations of the Procedure.

5. Description of Reagents

Reagents

Each Piccolo Renal Panel reagent disc contains dry test-specific reagent beads (described below). A dry sample blank reagent (comprised of buffer, surfactants, excipients, and preservatives) is included in each disc for use in calculating concentrations of albumin (ALB), chloride (CL⁻), calcium (CA), glucose (GLU), phosphorus (PHOS), potassium(K⁺), sodium (NA⁺), total carbon dioxide (tCO₂) and blood urea nitrogen (BUN). A dedicated sample blank is included in the disc to calculate concentrations of creatinine (CRE). Each disc also contains a diluent consisting of surfactants and preservatives.

Table 1: Reagents

Components	Quantity/Disc
N-Acetyl cysteine	23 μ g
Adenosine 5'-diphosphate	4 μ g
Adenosine 5'-diphosphate, trilithium salt	3.7 μ g
Adenosine 5'-triphosphate, disodium salt	12 μ g
4-Aminoantipyrine	5.4 μ g
α -Ketoglutaric acid	18 μ g
4-Aminoantipyrine hydrochloride	27 μ g
Amylase	0.036 U
Arsenazo III, sodium salt	3.5 μ g
Ascorbate oxidase	0.3 U
Brij	39 μ g
Bromocresol purple, sodium salt	2.3 μ g
Calcium acetate	25 μ g
Citric acid, trisodium salt	567 μ g
2-Chloro-4-nitrophenyl- α -maltotrioxide (CNPG3)	53 μ g
Creatine amidinohydrolase	3 U
Creatinine amidohydrolase	1 U
3,5-Dichloro-2-hydroxybenzenesulfonic acid, Sodium salt (DHBSA)	34.8 μ g
Ethylenediaminetetraacetic acid (EDTA)	15 μ g
Ethylenediaminetetraacetic acid (EDTA), disodium salt	356 μ g
Ethylenediaminetetraacetic acid (EDTA), Tetrasodium salt	180 μ g

Table 1: Reagents (continued)

Components	Quantity/Disc
Ethylene glycol-bis(β -aminoethyl ether)-N,N,N',N'-tetraacetic acid (EGTA)	4 μ g
Glucose-6-phosphate dehydrogenase (G6PDH)	0.1 U
β -Galactosidase	0.005 U
Glucose-1,6-diphosphate	1 μ g
L-Glutamic acid	9.2 μ g
Glutamate dehydrogenase	0.1 U
Glutamine synthetase	0.17 U
Hexokinase	0.1 U
Imidazole	57 μ g
Lactate dehydrogenase	0 U
Lactate dehydrogenase (LDH)	0.1 U
Lactate dehydrogenase	0.13 U
Lithium hydroxide, monohydrate	102 μ g
Magnesium acetate, tetrahydrate	29 μ g
Magnesium sulfate, heptahydrate	122 μ g
Malate dehydrogenase	0.1 U
Manganese chloride	10 μ g
D-Mannitol	3802 μ g
2-Methyl-4-isothiazolin-3-one hydrochloride (MIT)	0 μ g
β -Nicotinamide adenine dinucleotide (NAD)	62 μ g
β -Nicotinamide adenine dinucleotide, reduced (NADH)	34 μ g
<i>o</i> -Nitrophenyl- β -D-galactopyranoside (ONPG)	44 μ g
4,7,13,16,21-Pentaoxa-1,10-diazabicyclo[8.8.5]tricosane	139 μ g
Peroxidase	1 U
Phosphoenol pyruvate	14 μ g
Phosphoenol pyruvate carboxylase	0.002 U
Phosphoglucomutase	0.141 U
Pluronic F68	18 μ g
Polyethylene glycol, 8000	883 μ g
Potassium ferrocyanide	0.4 μ g
Pyruvate kinase	0.01 U
Sarcosine oxidase	1 U
Sucrose	11 μ g
Sucrose phosphorylase	0.28 U
Sodium chloride	772 μ g
2,4,6-Tribromo-3-hydroxybenzoic acid	188 μ g
Triethanolamine hydrochloride	314 μ g
Triton X-100	280 μ g
Urease	0.05 U
Uricase	0 U
Buffers, surfactants, excipients and preservatives	

Warnings and Precautions

- For *in vitro* Diagnostic Use
- The diluent container in the reagent disc is automatically opened when the analyzer drawer closes. A disc with an opened diluent container cannot be re-used. Ensure that the sample or control has been placed into the disc before closing the drawer.

- Used reagent discs contain human body fluids. Follow good laboratory safety practices when handling and disposing of used discs.⁴⁴ See the Piccolo Xpress chemistry analyzer Operator's Manual for instructions on cleaning biohazardous spills.
- The reagent discs are plastic and may crack or chip if dropped. Never use a dropped disc as it may spray biohazardous material throughout the interior of the analyzer.
- Reagent beads may contain acids or caustic substances. The operator does not come into contact with the reagent beads when following the recommended procedures. In the event that the beads are handled (e.g., cleaning up after dropping and cracking a reagent disc), avoid ingestion, skin contact, or inhalation of the reagent beads.
- This mixture does not contain substances assessed to be vPvB / PBT according to Regulation (EC) No 1907/2006, Annex XIII. This product contains components considered to have endocrine disrupting properties for environment, according to REACH Article 57(f), Regulation (EU) 2018/605 or Regulation (EU) 2017/2100. Refer to the Safety Data Sheet (SDS) for specific details.
- Materials incorporated into the device may consist of substances derived from other microbial and animal sourced materials.

Instructions for Reagent Handling

Reagent discs may be used directly from the refrigerator without warming. Do not allow discs to remain at room temperature at 20-25°C (68-77°F) longer than 48 hours prior to use. Open the sealed foil pouch and remove the disc, being careful not to touch the bar code ring located on the top of the disc. Use according to the instructions provided in Piccolo Xpress chemistry analyzer Operator's Manual. A disc not used within 20 minutes of opening the pouch should be discarded.

Storage

Store reagent discs in their sealed pouches at 2-8 °C (36-46 °F). Do not expose opened or unopened discs to direct sunlight or temperatures above 32 °C (90 °F). Reagent discs may be used until the expiration date included on the package. The expiration date is also encoded in the bar code printed on the bar code ring. An error message will appear on the Piccolo Xpress chemistry analyzer display if the reagents have expired.

Indications of Reagent Disc Instability/Deterioration

A torn or otherwise damaged pouch may allow moisture to reach the unused rotor and adversely affect reagent performance. Do not use a rotor from a damaged pouch.

6. Instrument

See Piccolo Xpress chemistry analyzer Operator's Manual for complete information on use of the analyzer.

7. Sample Collection and Preparation

Sample collection techniques are described in the "Sample Collection" section of the Piccolo Xpress chemistry analyzer Operator's Manual.

- The minimum required sample size is ~100 µL of heparinized whole blood, heparinized plasma, serum, or control material. The reagent disc sample chamber can contain up to 120 µL of sample.
- Whole blood samples obtained by venipuncture must be homogeneous before transferring a sample to the reagent disc. Gently invert the collection tube several times just prior to sample transfer. Do not shake the collection tube; shaking may cause hemolysis.
- Whole blood samples should only be obtained via venipuncture, not from capillary blood.
- Hemolysis may cause erroneously high results in **potassium** assays. This problem may go undetected when analyzing whole blood (release of potassium from as few as 0.5% of the erythrocytes can increase the potassium serum level by 0.5 mmol/L). In addition, even unhemolyzed specimens that are not promptly processed may have increased potassium levels due to intracellular leakage.⁴⁵
- Whole blood venipuncture samples should be run within 60 minutes of collection.^{46,61} **Glucose** concentrations are affected by the length of time since the patient has eaten and by the type of sample collected from the patient. To accurately determine glucose results, samples should be obtained from a patient who has been fasting for at least 12 hours. The glucose concentration decreases approximately 0.28-0.67 mmol/L in 1 hour in uncentrifuged samples stored at room temperature.⁴⁷

- Refrigerating whole blood samples can cause significant changes in concentrations of **creatinine** and **glucose**.⁴⁸ The sample may be separated into plasma or serum and stored in capped sample tubes at 2-8 °C (36-46 °F) if the sample cannot be run within 60 minutes.
- Use only lithium heparin evacuated specimen collection tubes for whole blood or plasma samples. Use no-additive evacuated specimen collection tubes or serum separator tubes for serum samples.
- The concentration of **total carbon dioxide** is most accurately determined when the assay is done immediately after opening the tube and as promptly as possible after collection and processing of the blood in the unopened tube. Ambient air contains far less carbon dioxide than does plasma and gaseous dissolved carbon dioxide will escape from the specimen into the air, with a consequent decrease in carbon dioxide value of up to 6 mmol/L in the course of 1 hour.⁴⁹
- Start the test within 10 minutes of transferring the sample into the reagent disc.

8. Procedure

Materials Provided

- One Piccolo Renal Function Panel PN: 400-1027 (a box of discs PN 400-0027)

Materials Required but Not Provided

- Piccolo Xpress chemistry analyzer
- Sample transfer pipettes (fixed volume approximately 100 µL) and tips are provided with each Piccolo Xpress chemistry analyzer and may be reordered from Abaxis.
- Commercially available control reagents recommended by Abaxis (contact Abaxis Technical Support for approved control materials and expected values).
- Timer

Test Parameters

The Piccolo Xpress chemistry analyzer operates at ambient temperatures between 15°C and 32 °C (59-90 °F). The analysis time for each Piccolo Renal Function Panel is less than 14 minutes. The analyzer maintains the reagent disc at a temperature of 37 °C (98.6 °F) over the measurement interval.

Test Procedure

The complete sample collection and step-by-step operating procedures are detailed in the Piccolo Xpress chemistry analyzer Operator's Manual.

Calibration

The Piccolo Xpress chemistry analyzer is calibrated by the manufacturer before shipment. The bar code printed on the reagent disc bar code ring provides the analyzer with disc-specific calibration data. See the Piccolo Xpress chemistry analyzer Operator's Manual.

The Piccolo Xpress chemistry analyzer is calibrated using internal calibrators or reference materials. The methods and materials used in the procedures for the calibration and control value assignments are traceable either to the comparative method and/or to the standards listed below:

- IFCC – International Federation of Clinical Chemistry
- NIST – National Institute of Standards and Technology
- CRMLN – Cholesterol Reference Method Laboratory Network
- SRM – Standard Reference Material
- CRM – Certified Reference Material

The calibration and value assignment processes are in compliance with EN ISO 17511, Metrological Traceability of Values Assigned to Calibrators and Control Materials.

The measured analytes in the Renal Function Panel are traceable to the following reference materials or methods. The Piccolo Xpress Analysis System controls and calibration verification materials are validated for use only with the Piccolo Xpress Analysis System and assigned values may not be commutable with other methods. For specific analyte reference standard methods, refer to Section 3. Principles of Method.

Analyte	Calibration Standard	Method
ALB (BCP)	Correlation to Beckman LX-20 / DX-20	Dye Binding Bromocresol Purple
CA	Correlation to Beckman LX-20 / DX-20	Arsenazo III Dye
CL	Correlation to Beckman LX-20 / DX-20	Enzymatic
CRE	NIST SRM #967	Enzymatic
GLU	NIST SRM #909	Enzymatic
PHOS	SRM #3186	Enzymatic
K+	NIST SRM #909	Enzymatic
NA+	Correlation to Beckman LX-20 / DX-20	Enzymatic
tCO ₂	Correlation to Beckman LX-20 / DX-20	Enzymatic
BUN	NIST SRM #912A	Enzymatic

Quality Control

See Section 6 (Calibration and Quality Control) of the Piccolo Xpress chemistry analyzer Operator's Manual. Performance of the Piccolo Xpress chemistry analyzer can be verified by running controls. For a list of approved quality control materials with acceptance ranges, please contact Abaxis Technical Support. Other human serum or plasma-based controls may not be compatible. Quality control materials should be stored as per the package-insert included with the controls.

If control results are out of range, repeat one time. If still out of range, call Technical Support. Do not report results if controls are outside their labeled limits. See the Piccolo Xpress chemistry analyzer Operator's Manual for a detailed discussion on running, recording, interpreting, and plotting control results.

Waived Laboratories (US only): Abaxis recommends control testing as follows:

- at least every 30 days
- whenever the laboratory conditions have changed significantly, e.g. Piccolo moved to a new location or changes in temperature control
- when training or retraining of personnel is indicated
- with each new lot (CLIA waived tests in waived status labs)

Non-Waived Laboratories (US only): Abaxis recommends control testing to follow federal, state, and local guidelines.

And the non-waived ones will use the below:

- Performance of the Piccolo Xpress chemistry analyzer can be verified by running controls. For a list of approved quality control materials with acceptance ranges, please contact Abaxis Technical Support. Other human serum or plasma-based controls may not be compatible. Quality control materials should be stored as per the package-insert included with the controls.
- If control results are out of range, repeat one time. If still out of range, call Technical Support. Do not report results if controls are outside their labeled limits. See the Piccolo Xpress chemistry analyzer Operator's Manual for a detailed discussion on running, recording, interpreting, and plotting control results.

9. Results

The Piccolo Xpress chemistry analyzer automatically calculates and prints the analyte concentrations in the sample. Details of the endpoint and rate reaction calculations are found in the Piccolo Xpress chemistry analyzer Operator's Manual.

Interpretation of results is detailed in the analyzer Operator's Manual. Results are printed onto result cards or paper rolls supplied by Abaxis. The result cards or paper rolls have an adhesive backing for easy placement in the patient's files.

The reaction for each analyte occurs at 37°C (98.6°F).

10. Limitations of Procedure

General procedural limitations are discussed in the Piccolo Xpress chemistry analyzer Operator's Manual.

- The only anticoagulant **recommended for use** with the Piccolo Xpress chemistry analyzer is **lithium heparin**. Abaxis has performed studies demonstrating that EDTA, fluoride, oxalate, and any anticoagulant containing ammonium ions will interfere with at least one chemistry contained in the Piccolo Renal Function Panel reagent disc. Do not use sodium heparin.
- Samples with hematocrits in excess of 62% packed red cell volume (a volume fraction of 0.62) may give inaccurate results. Samples with high hematocrits may be reported as hemolyzed. These samples may be spun down to get plasma. The plasma can then be re-run in a new reagent disc.
- **Any result for a particular test that exceeds the assay range should be analyzed by another approved test method or sent to a referral laboratory. Do not dilute the sample and run it again on the Piccolo Xpress chemistry analyzer.**

Warning: Extensive testing of the Piccolo Xpress chemistry analyzer has shown that, in very rare instances, sample dispensed into the reagent disc may not flow smoothly into the sample chamber. Due to the uneven flow, an inadequate quantity of sample may be analyzed and several results may fall outside the reference ranges. The sample may be re-run using a new reagent disc.

Note: Operators shall report any serious incident that has occurred in relation to the device to the manufacturer.

Interference

Substances were tested as interferents with the analytes. Human serum pools were prepared. The concentration at which each potential interferent was tested was based on the testing levels in CLSI (formerly NCCLS) EP7-P.⁵⁰

Effects of Endogenous Substances

- Physiological interferents (hemolysis, icterus and lipemia) cause changes in the reported concentrations of some analytes. The sample indices are printed on the bottom of each printout to inform the operator about the levels of interferents present in each sample.
- The Piccolo Xpress chemistry analyzer suppresses any results that are affected by >10% interference from hemolysis, lipemia or icterus. "HEM", "LIP", or "ICT" respectively, is printed on the printout in place of the result.
- Extremely elevated amylase levels (>9,000 U/L) will have a significant effect, >10% increase, on the **chloride** result. The concentration of amylase is not evaluated by the Piccolo system for each specimen.
- The potassium assay in the Piccolo system is a coupled pyruvate kinase (PK) / lactate dehydrogenase (LDH) assay. Therefore, in cases of extreme muscle trauma or highly elevated levels of creatine kinase (CK), the Piccolo may recover a falsely elevated potassium(K+) value. In such cases, unexpected high potassium recoveries need to be confirmed utilizing a different methodology.
- For maximum levels of endogenous substances contact Abaxis Technical Support.

Effects of Exogenous and Therapeutic Substances

Thirty-five exogenous and therapeutic substances were selected as potential interferents for Abaxis test methods based on recommendations by Young.⁵¹ Significant interference is defined as greater than $\pm 10\%$ shift in the result for a normal range specimen. Human serum pools were supplemented with known concentrations of the drugs or chemicals and then analyzed. **Please see Table 2 for a list of exogenous and therapeutic substances evaluated. Please see Table 3 for a list of analytes where interference was observed.**

Table 2: Exogenous and Therapeutic Substances Evaluated

Potential Interferent	Highest Concentration Tested (mg/dL unless otherwise specified)
Acetaminophen	100
Acetoacetate	102
Acetylsalicylic Acid	50
Ampicillin	30
Ascorbic acid	20
Caffeine	10
Calcium Chloride	20
Cephalothin (Keflin)	400
Chloramphenicol	100
Cimetidine	16
Dopamine	19
Epinephrine	1
Erythromycin	10
Glutathione	30
Hydrochlorothiazide	7.5
Ibuprofen	50
Isoniazide	4
α -Ketoglutarate	5
Ketoprofen	50
L-dopa	5
Lidocaine	1
Lithium Lactate	84
Methicillin	100
Methotrexate	0.5
Metronidazole	5
Nafcillin	1
Nitrofurantoin	20
Oxacillin	1
Oxaloacetate	132
Penicillin G	100
Phenytoin (5,5-Diphenylhydantion)	3
Proline	4
Pyruvate	44
Rifampin	0.5
Salicylic Acid	50
Sulfasalazine	150
Sulfanilamide	50
Theophylline	20

Please see Table 3 for a list of analytes where interference was observed.

Table 3: The following substances showed greater than $\pm 10\%$ shift in the result for a normal range specimen.

	Concentration Which Produces > 10% Interference
Albumin	
Acetoacetate	102
Ampicillin	30
Caffeine	10
Calcium chloride	20
Cephalothin (Keflin)	400
Ibuprofen	50
α -Ketoglutarate	5
Nitrofurantoin	20
Proline	4
Sulfasalazine	10
Sulfanilamide	50
Theophylline	20
Creatinine	
Ascorbic acid	20
Dopamine	19
L-dopa	5
Epinephrine	1
Glutathione	30
Glucose	
Oxaloacetate	132
Pyruvate	44
Phosphorus	
Nitrofurantoin	20
Oxaloacetate	132
Potassium	
Penicillin G	100
Sulfasalazine	150
Sodium	
Cephalothin	400
Methotrexate	0.5
Penicillin G	100
Total Carbon Dioxide	
Acetaminophen	100
Ascorbic Acid	20
Cephalothin	400
Cimetidine	16
Erythromycin	10
Lidocaine	1
Methotrexate	0.5
Nitrofurantoin	20
Salicylic Acid	50
Sulfasalazine	150

- For the Chloride assay, bromide at toxic levels (≥ 15 mmol/L) can cause a significant effect ($> 10\%$ increase), on the chloride result. Iodide at very high concentrations (30 mmol/L, highest level tested) has no effect. Normal physiological levels of bromide and iodide do not interfere with the Piccolo Chloride Test System.

11. Expected Values

Samples from approximately 90 – 140 adult males and females were analyzed to determine the reference intervals for the following assays. These intervals are provided as a guideline only. It is recommended that your office or institution establish normal ranges for your particular patient population.⁵²

Table 4: Piccolo Reference Intervals**

Analyte	Common Units	SI Units
Albumin	3.3-5.5 g/dL	33-55 g/L
Calcium	8.0-10.3 mg/dL	2.0-2.58 mmol/L
Chloride	98-108 mmol/L	98-108 mmol/L
Creatinine	0.6-1.2 mg/dL	53-106 µmol/L
Glucose	73-118 mg/dL	4.1-6.6 mmol/L
Phosphorus (plasma)	2.2-4.1 mg/dL	0.71-1.32 mmol/L
Phosphorus (serum)	2.5-4.4 mg/dL*	0.81-1.42 mmol/L*
Potassium	3.6-5.1 mmol/L	3.6-5.1 mmol/L
Sodium	128-145 mmol/L	128-145 mmol/L
Total Carbon Dioxide	18-33 mmol/L	18-33 mmol/L
Blood Urea Nitrogen (BUN)	7-22 mg/dL	2.5-7.9 mmol urea/L

* There is no observed difference between the concentration of Phosphorus measured in heparinized whole blood and heparinized plasma. However, a small increase (0.3 mg/dL) was observed in serum when compared to heparinized whole blood and heparinized plasma. This increase is consistent with the difference between Phosphorus in serum and plasma as described in the literature.^{53, 54, 55, 56}

**Data was generated using equivalence device Piccolo Blood Chemistry Analyzer.

12. Performance Characteristics

Linearity

The chemistry for each analyte is linear over the dynamic range listed below when the Piccolo Xpress chemistry analyzer is operated according to the recommended procedure (refer to the Piccolo Xpress chemistry analyzer Operator's Manual).

Table 5: Piccolo Xpress chemistry analyzer Dynamic Ranges

Analyte	Common Units	SI Units
Albumin	1-6.5 g/dL	10-65 g/L
Calcium	4.0-16.0 mg/dL	1.0-4.0 mmol/L
Chloride	80-135 mmol/L	80-135 mmol/L
Creatinine	0.2-20 mg/dL	18-1768 µmol/L
Glucose	10-700 mg/dL	0.6-38.9 mmol/L
Phosphorus	0.2-20 mg/dL	0.06-6.5 mmol/L
Potassium	1.5-8.5 mmol/L	1.5-8.5 mmol/L
Sodium	110-170 mmol/L	110-170 mmol/L
Total Carbon Dioxide	5-40 mmol/L	5-40 mmol/L
Blood Urea Nitrogen (BUN)	2-180 mg/dL	0.7-64.3 mmol urea/L

If the analyte concentration is above the measuring range (dynamic range), but less than the system range, the printout will indicate a ">" sign at the upper limit and an asterisk after the number, e.g. ALT >2000* U/L. If lower than the dynamic range, a "<" will be printed with an asterisk, e.g. ALT <5* U/L. For values that are grossly beyond the measurement range (system range), "~~~~" will be printed instead of a result. Any time "~~~~" appears on a printout, collect a new sample and rerun the test. If results for the second sample are suppressed again, please call Abaxis Customer Service.

Sensitivity (Limits of Detection)

The lower limit of the reportable (dynamic) range for each analyte is: albumin 1 g/dL (10 g/L); calcium 4.0 mg/dL (1.0 mmol/L); chloride 80 mmol/L; creatinine 0.2 mg/dL (18 µmol/L); glucose 10 mg/dL (0.56 mmol/L); phosphorus 0.2 mg/dL (0.06 mmol/L); potassium 1.5 mmol/L; sodium 110 mmol/L; total carbon dioxide 5 mmol/L; and blood urea nitrogen 2.0 mg/dL (0.7 mmol urea/L).

Precision

Precision studies were conducted using CLSI (formerly NCCLS) EP5-A guidelines, with modifications based on CLSI (formerly NCCLS) EP18-P for unit-use devices.^{57,58} Results for within-run and total precision were determined by testing levels of commercially available control materials and in case of potassium two levels of plasma pools. The studies made use of multiple instruments. Precision for albumin, calcium, creatinine, glucose, sodium and urea nitrogen was performed at one site; potassium and total carbon dioxide testing was performed at two sites over 20 days; and chloride and phosphorus testing was conducted at two sites over a period of 5 days. Potassium testing was conducted at a CLIA waived site making use of three analyzers, one lot of reagent discs, and two operators over five days.

Results of the precision studies are shown in Table 6.

Table 6: Precision

Analyte	Sample Size	Within-Run	Total
Albumin (g/dL)	N = 80		
<u>Control 1</u>			
Mean		5.6	5.6
SD		0.09	0.11
%CV		1.7	2.1
<u>Control 2</u>			
Mean		3.7	3.7
SD		0.07	0.11
%CV		2.0	2.9
Calcium (mg/dL)	N = 80		
<u>Control 1</u>			
Mean		8.6	8.6
SD		0.21	0.25
%CV		2.4	2.9
<u>Control 2</u>			
Mean		11.8	11.8
SD		0.39	0.40
%CV		3.3	3.4
Chloride (mmol/L)	N = 160		
<u>Control 1</u>			
Mean		97.8	97.8
SD		1.63	1.74
%CV		1.7	1.7
<u>Control 2</u>			
Mean		113.6	113.6
SD		1.97	2.22
%CV		1.7	2.0
Creatinine (mg/dL)	N = 80		
<u>Control 1</u>			
Mean		1.1	1.1

Table 6: Precision (continued)

Analyte	Sample Size	Within-Run	Total
SD		0.14	0.14
%CV		12.5	13.1
<u>Control 2</u>			
Mean		5.2	5.2
SD		0.23	0.27
%CV		4.4	5.2
Glucose (mg/dL)	N = 80		
<u>Control 1</u>			
Mean		66	66
SD		0.76	1.03
%CV		1.1	1.6
<u>Control 2</u>			
Mean		278	278
SD		2.47	3.84
%CV		0.9	1.4
Phosphorus (mg/dL)	N = 80		
<u>Control 1</u>			
Mean		3.1	3.1
SD		0.12	0.14
%CV		3.7	4.7
<u>Control 2</u>			
Mean		7.3	7.3
SD		0.09	0.15
%CV		1.3	2.0
Potassium (mmol/L)	N = 150		
<u>Control 1</u>			
Mean		3.2	3.2
SD		0.09	0.11
%CV		2.8	3.3
<u>Control 2</u>	N = 149		
Mean		6.2	6.2
SD		0.09	0.11
%CV		2.8	3.3
<u>Plasma Pool 1</u>	N = 150		
Mean		3.2	3.2
SD		0.07	0.09
CV		2.3	2.9
<u>Plasma Pool 2</u>	N = 150		

Table 6: Precision (continued)

Analyte	Sample Size	Within-Run	Total
Mean		5.4	5.4
SD		0.09	0.10
CV		1.6	1.9
Sodium (mmol/L)	N = 80		
<u>Control 1</u>			
Mean		143.5	143.5
SD		2.28	2.28
%CV		1.6	1.6
<u>Control 2</u>			
Mean		120.0	120.0
SD		2.13	2.13
%CV		1.8	1.8
Total Carbon			
Dioxide (mmol/L)	N = 120		
<u>Control 1</u>			
Mean		21.4	21.4
SD		2.29	2.29
%CV		10.7	10.7
<u>Control 2</u>			
Mean		10.5	10.5
SD		0.90	0.90
%CV		8.6	8.6
Urea Nitrogen (mg/dL)	N = 80		
<u>Control 1</u>			
Mean		19	19
SD		0.35	0.40
%CV		1.9	2.1
<u>Control 2</u>			
Mean		65	65
SD		1.06	1.18

Whole Blood Precision for Potassium

Whole blood precision was tested at a CLIA waived site by two CLIA waiver operators. The study used four Piccolo Xpress Analyzers with 16 replicates per sample for four (4) fresh, lithium heparin whole blood samples.

Table 7: Whole Blood Precision for Potassium

Potassium (mmol/L)	Sample Size	Within-Run	Total
Whole Blood 1	N = 16		
Mean		3.9	3.9
SD		0.06	0.11
CV		1.6	2.8
Whole Blood 2	N = 16		
Mean		4.0	4.0
SD		0.11	0.14
CV		2.9	3.4
Whole Blood 3	N = 16		
Mean		4.0	4.0
SD		0.11	0.15
CV		2.8	3.9
Whole Blood 4	N = 16		
Mean		4.0	4.0
SD		0.11	0.13
CV		2.7	3.4

Correlation

Serum samples were collected and assayed by a comparative method.

Table 8: Correlation with Comparative Method (s)**

	Correlation Coefficient	Slope	Intercept	SEE	N	Sample Range	Comparative Method
Albumin (g/dL)	0.854	1.001	-0.3	0.22	261	1.1-5.3	Paramax®
	0.896	0.877	-0.1	0.21	100	1.5-5.0	Beckman
Calcium (mg/dL)	0.991*	0.990	-0.44	0.17	25	5.2-11.9	Paramax®
	0.673	0.742	1.8	0.22	81	8.1-9.9	Beckman
Chloride (mmol/L)	0.978	0.982	-1.1	1.84	120	71-118	Vitros® 950
Creatinine (mg/dL)	0.993	0.926	0.0	0.15	260	0.4-14.7	Paramax®
	0.987	0.866	0.1	0.16	107	0.4-7.5	Beckman
Glucose (mg/dL)	0.987	1.009	-2.8	3.89	251	72-422	Paramax®
	0.997	0.943	1.2	4.69	91	56-646	Beckman
Phosphorus (mg/dL)	0.993	1.017	-0.2	0.236	90	0.8 – 11.7	Vitros® 950
Potassium (mmol/L) Whole Blood (waived laboratory)	0.984	0.99	0.13	0.10	130	1.3-9.5	Siemens VISTA Plasma
Potassium (mmol/L) Whole Blood (moderately Complex laboratory)	0.984	0.98	0.12	0.18	178	1.5-8.6	Siemens VISTA Plasma

Table 8: Correlation with Comparative Method (s) (continued)**

	Correlation Coefficient	Slope	Intercept	SEE	N	Sample Range	Comparative Method
Potassium (mmol/L) Serum (moderately Complex laboratory)	0.99	0.98	0.06	0.14	178	1.4-8.5	Siemens VISTA Serum
Sodium (mmol/L)	0.937	0.782	27.7	3.79	113	116-154	Radiometer KNA® 2
Total Carbon Dioxide (mmol/L)	0.947	0.903	2.4	0.84	60	6-39	Cobas® Fara
Blood Urea Nitrogen (mg/dL)	0.964 0.983	0.923 0.946	0.5 0.0	1.08 0.66	251 92	6-52 6-38	Paramax Beckman

* Serum samples from hospitalized patients provided a broader, and possibly more useful, sample range than did venous whole blood samples from out-patients. Correlation statistics for the Piccolo calcium test are from these serum samples.

**Data was generated using equivalence device Piccolo Blood Chemistry Analyzer.

It should be noted that serum will typically give higher results for K+ compared to whole blood or plasma for physiological reasons. The variation can range from approximately 0.2 to 0.9mmol/L and is dependent on a number of factors. The primary effect is dependent upon the number of blood cells present in the patient sample.⁶⁰

Results of Untrained User Study

An “untrained user” study was conducted in which participants were given only the test instructions and asked to perform testing of 3 discs with blinded randomized samples. The samples consisted of serum pools prepared at three levels for each of the ten analytes, albumin, calcium, chloride, creatinine, glucose, phosphorus, potassium, sodium, total carbon dioxide, and blood urea nitrogen (BUN). The participants were not given any training on the use of the test or instrument. A total of 62 participants were enrolled from 3 sites, representing a diverse demographic (educational, age, gender, etc) population.

Tables below present the summary of the performance for each analyte.

Albumin

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	30	34	40
Mean value By Piccolo (g/L)	30	35	42
SD	11.59	13.04	10.15
%CV	2.7%	2.5%	1.8%
Observed Range	29 – 32	33 – 37	40 – 44

Calcium (CA)

	Level 1	Level 2	Level 3
Number	62	62	62
Target concentration	2.02	2.62	3.29
Mean value By Piccolo (mmol/L)	2.0	2.62	3.26
SD	0.14	0.15	0.18
%CV	1.7%	1.4%	1.4%
Observed Range	1.92 – 2.1	2.52 – 2.74	3.14 – 3.34

Chloride (CL⁻)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	93	105	115
Mean value By Piccolo (mmol/L)	94.6	106	115.5
SD	1.66	1.5	1.74
%CV	1.8	1.4	1.5
Observed Range	90 – 100	102 - 108	110 - 119

Creatinine (CRE)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	79.56	185.64	609.96
Mean value By Piccolo (μmol/L)	78.68	182.99	609.08
SD	8.84	8.84	9.72
%CV	11.2%	4.8%	1.6%
Observed Range	61.88 – 106.08	159.12 – 203.32	574.6 – 636.48

Glucose

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	5.33	7.21	20.15
Mean value By Piccolo (mmol/L)	5.28	7.23	20.31
SD	0.06	0.07	0.16
%CV	1.1%	1.0%	0.8%
Observed Range	5.16 – 5.44	6.94 – 7.38	19.48 – 20.71

Phosphorus (PHOS)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	0.71	1.36	2.36
Mean value By Piccolo (mmol/L)	0.71	1.36	2.36
SD	0.03	0.04	0.03
%CV	4.5	2.6	1.2
Observed Range	0.65 – 0.81	1.29 – 1.45	2.29 – 2.42

Potassium (K⁺)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	3.4	5.6	7.2
Mean value By Piccolo (mmol/L)	3.42	5.66	7.19
SD	0.11	0.14	0.14
%CV	3.3	2.5	1.9
Observed Range	3.2 – 3.7	5.2 – 5.9	6.7 – 7.5

Sodium (NA⁺)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	122	141	158
Mean value By Piccolo (mmol/L)	122.1	140.8	157.5
SD	1.25	1.15	1.63
%CV	1.0	0.8	1.0
Observed Range	118 - 127	138 - 143	154 - 162

Total Carbon Dioxide (tCO₂)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	21	28	33
Mean value By Piccolo (mmol/L)	20.3	27.6	34.4
SD	1.03	1.26	1.27
%CV	5.1	4.6	3.7
Observed Range	18 - 23	23 - 30	32 - 38

Blood Urea Nitrogen (BUN)

	Level 1	Level 2	Level 3
Number	62	62	62
Target Concentration	5.36	14.99	25.7
Mean value By Piccolo (mmol/L)	5.39	14.64	25.78
SD	0.12	0.36	1.3
%CV	2.3%	2.5%	1.8%
Observed Range	5.0 - 5.72	13.21 - 15.35	68 - 75

13. Symbols



Use By



Catalog Number



Batch Code



In Vitro Diagnostic
Medical Device



Consult Instructions
for Use



Manufacturer



Do Not Reuse



X Number of Test
Devices In Kit



Manufacturing
Sequence



Serial Number



Authorized
Representative
in the European
Community



Temperature
Limitation



Caution

PN:
Part Number



denotes conformity to specified
European directives

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