510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY ONLY TEMPLATE

A. 510(k) Number:

k180428

B. Purpose for Submission:

New device

C. Measurands:

Sodium (Na), Potassium (K), Chloride (Cl), Ionized Calcium (iCa) and Ionized Magnesium (iMg)

D. Type of Test:

Quantitative, potentiometric, ion selective electrode

E. Applicant:

Nova Biomedical Corporation

F. Proprietary and Established Names:

Stat Profile® Prime Plus Analyzer System

G. Regulatory Information:

Regulation section	Classification	Product code	Panel
21 CFR § 862.1665 (Sodium test system)	Class II	JGS	Chemistry (75)
21 CFR § 862.1600 (Potassium test system)	Class II	CEM	
21 CFR § 862.1170 (Chloride test system)	Class II	CGZ	
21 CFR § 862.1145 (Calcium test system)	Class II	JFP	
21 CFR § 862.1495 (Magnesium test system)	Class I, reserved	CFA	

H. Intended Use:

1. Intended use(s):

   See Indication(s) for Use below

2. Indication(s) for use:

   The Stat Profile® Prime Plus Analyzer System is intended for use by healthcare professionals in clinical laboratory settings for the quantitative determination of sodium, potassium, chloride, ionized calcium, and ionized magnesium in heparinized arterial and venous whole blood.

   Sodium measurements are used in the diagnosis and treatment of aldosteronism, diabetes insipidus, adrenal hypertension, Addison's disease, dehydration, or diseases involving electrolyte imbalance.

   Potassium measurements are used in the diagnosis and treatment of disease conditions characterized by low or high potassium levels.

   Chloride measurements are used in the diagnosis and treatment of electrolyte and metabolic disorders such as cystic fibrosis and diabetic acidosis.

   Ionized calcium measurements are used in the diagnosis and treatment of parathyroid disease, a variety of bone diseases, chronic renal disease and tetany (intermittent muscular contractions or spasms).

   Ionized magnesium measurements are used in the diagnosis and treatment of hypomagnesemia (abnormally low levels of magnesium) and hypermagnesemia (abnormally high levels of magnesium).

3. Special conditions for use statement(s):

   Not for point of care use.

4. Special instrument requirements:

   Stat Profile® Prime Plus Analyzer System

I. Device Description:

The Stat Profile® Prime Plus Analyzer System is designed to be used in a clinical laboratory setting. It consists of the analyzer, sensor cartridges, calibrator packs, auto-cartridge quality control packs (internal controls), ampuled quality control materials (external controls) and thermal paper for an onboard printer. Specimens are identified by scanning a barcode or by manually entering the information via the touchscreen.

The Stat Profile® Prime Plus Analyzer has slots to accommodate two sensor cartridges (primary and auxiliary). The analyzer will determine the configuration of the system by detecting which sensor cards are installed. The reporting of CO-Oximeter parameters (or not reporting them) will also be determined by the selection of the Sensor Cards, for which there are two options:

- Primary Sensor Card 1 reports the following analytes: pO_2, pCO_2, pH, Hct, tHb, Na, Cl, K, iCa, iMg, Glu, SO_2, O_2Hb, COHb, MetHb, HHb, tBil, and HbF
- Primary Sensor Card 2 reports the following analytes: pO_2, pCO_2, pH, Hct, tHb, Na, Cl, K, iCa, iMg, Glu, SO_2

J. Substantial Equivalence Information:

1. Predicate device name(s):

   Stat Profile pHOx Ultra Analyzer System

2. Predicate 510(k) number(s):

   k110648

3. Comparison with predicate:

Similarities		
Item	Candidate Device - Stat Profile® Prime Plus Analyzer (k180428)	Predicate Device - Stat Profile pHOx Ultra Analyzer (k110648)
Intended Use	For the quantitative determination of sodium, potassium, chloride, ionized calcium, and ionized magnesium in heparinized arterial and venous whole blood.	Same
Measuring range – Na	80 - 200 mmol/L	Same
Measuring range – K	1.0 - 20.0 mmol/L	Same
Measuring range – Cl	50 - 200 mmol/L	Same
Measuring range – iCa	0.1 - 2.7 mmol/L	Same
Measuring range – iMg	0.1 - 1.5 mmol/L	Same
Measurement Principle	Ion selective electrode	Same

Differences		
Item	Candidate Device - Stat Profile® Prime Plus Analyzer (k180428)	Predicate Device - Stat Profile pHOx Ultra Analyzer (k110648)
Matrices	Lithium heparin whole blood	Sodium or lithium heparinized whole blood, serum, or plasma
Sample Volume	135 µL	60 – 200 µL
Touch Screen	10.1” WXGA 1280 x 800 color touch screen	12.1" LCD, 1024x768 pixel, Resistive Touch

K. Standard/Guidance Document Referenced (if applicable):

- IEC 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: general requirements
- IEC 61010-2-101:2015 - Particular requirements for in vitro diagnostic (IVD) medical equipment

L. Test Principle:

The sodium, potassium, chloride, ionized calcium and ionized magnesium parameters are measured by an ion-selective electrode (ISE) that selectively measures the activity of ionic species. When the ISE is contacted with a sample, a potential is developed. The potential is proportional to the logarithm of the ionic activity and is measured versus a reference electrode, as described by the Nernst equation.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. Precision/Reproducibility:

Within-run and between-analyzer precision was evaluated by analyzing quality control (QC) materials and whole blood samples in replicates of 20 on each of three analyzers.

Internal Quality Control within-run results:
All three analyzers yielded similar results. The results of one representative analyzer are summarized in the table below.

Parameter	n = 20	Internal Control Level 1	Internal Control Level 2
Na+ (mmol/L)	Mean SD CV%	141.9 0.2 0.2	116.2 0.2 0.1
K+ (mmol/L)	Mean SD CV%	4.02 0.01 0.2	6.22 0.01 0.2
Cl- (mmol/L)	Mean SD CV%	127.0 0.3 0.2	98.1 0.1 0.1
iCa^{2+} (mmol/L)	Mean SD CV%	0.97 0.00 0.3	1.39 0.00 0.2
iMg^{2+} (mmol/L)	Mean SD CV%	0.64 0.00 0.5	1.17 0.01 0.5

External Quality Control within-run results:

All three analyzers yielded similar results. The results of one representative analyzer are summarized in the table below.

Parameter	n = 20	External Control Level 1	External Control Level 2
Na+ (mmol/L)	Mean	137.9	111.7
	SD	0.2	0.3
	CV%	0.2	0.2
K+ (mmol/L)	Mean	3.91	6.10
	SD	0.14	0.02
	CV%	3.7	0.3
Cl- (mmol/L)	Mean	127.0	97.5
	SD	0.0	0.6
	CV%	0.0	0.6
iCa^{2+} (mmol/L)	Mean	0.99	1.64
	SD	0.01	0.01
	CV%	0.9	0.6
iMg^{2+} (mmol/L)	Mean	0.66	1.06
	SD	0.02	0.03
	CV%	2.4	2.6

Within-run precision using whole blood:

All three analyzers yielded similar results. The results from one representative analyzer are summarized in the tables below. Note: the samples below were selected to evaluate a specific parameter over a specific range, so all parameters were not evaluated on all samples.

Na+ (mmol/L) (n=20)			
Sample	**Mean**	**SD**	**%CV**
Sample A	141.7	0.3	0.2
Sample B	142.4	0.4	0.3
Sample 1	160.3	0.7	0.4
Sample 2	120.3	0.4	0.4

K+ (mmol/L) (n=20)			
Sample	**Mean**	**SD**	**%CV**
Sample A	4.18	0.01	0.3
Sample B	3.86	0.03	0.8
Sample 1	6.50	0.07	1.0
Sample 6	2.58	0.04	1.5

Cl- (mmol/L) (n=20)			
Sample	**Mean**	**SD**	**%CV**
Sample A	103.3	0.2	0.2
Sample B	107.3	0.8	0.7
Sample 3	145.7	1.3	0.9
Sample 4	74.8	0.7	1.0

iCa^{2+} (mmol/L) (n=20)			
Sample	**Mean**	**SD**	**%CV**
Sample A	1.18	0.01	0.6
Sample B	1.13	0.01	0.5
Sample 1	1.66	0.01	0.9
Sample 5	0.75	0.01	1.1

iMg^{2+} (mmol/L) (n=20)			
Sample	**Mean**	**SD**	**%CV**
Sample A	0.64	0.00	0.7
Sample B	0.65	0.01	1.0
Sample 1	1.13	0.02	1.7
Sample 7	0.24	0.01	3.6

Run-to-run precision using QC material

Run-to-run precision was assessed by analyzing two levels of QC materials and whole blood in duplicate on each of three analyzers, with two runs per day over 20 days for a total of forty runs.

Sodium						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run % CV	Total imprecision SD (St)	Total Imprecision % CV
QC Level 4	141.7	240	0.2	0.2	0.3	0.2
QC Level 5	116.5	240	0.2	0.2	0.3	0.3

Potassium						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run % CV	Total imprecision SD (St)	Total Imprecision % CV
QC Level 4	4.02	240	0.01	0.2	0.01	0.2
QC Level 5	6.23	240	0.02	0.3	0.04	0.6

Chloride						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run % CV	Total imprecision SD (St)	Total Imprecision % CV
QC Level 4	126.4	240	0.4	0.3	1.3	1.0
QC Level 5	99.3	240	0.4	0.4	1.3	1.3

ionized Calcium						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run % CV	Total imprecision SD (St)	Total Imprecision % CV
QC Level 4	0.97	240	0.00	0.4	0.00	0.0
QC Level 5	1.4	240	0.01	0.7	0.01	0.7

ionized Magnesium						
Sample	Pooled Mean	N	Within run SD (Sr)	Within run % CV	Total imprecision SD (St)	Total Imprecision % CV
QC Level 4	0.61	240	0.01	1.6	0.02	3.3
QC Level 5	1.14	240	0.01	0.9	0.03	2.6

Run-to-run precision using whole blood

Estimates of the run-to-run precision were determined for the Stat Profile® Prime Plus analyzers for whole bloods that were sampled from a syringe. A ten day study was simulated by running samples followed by running a calibration and repeating the process ten times. All three analyzers yielded similar results. The results from one representative analyzer are summarized in the tables below. Note: the samples below were selected to evaluate a specific parameter over a specific range, so all parameters were not evaluated on all samples.

Parameter	n = 30	Venous Blood 1	Venous Blood 2	Venous Blood 3	Venous Blood 4
Na + (mmol/L)	Mean SD CV%	146.4 0.8 0.6	157.3 0.6 0.4	119.7 0.7 0.6	n/a
K + (mmol/L)	Mean SD CV%	3.49 0.08 2.26	4.85 0.05 1.0	n/a	2.53 0.03 1.4
Cl – (mmol/L)	Mean SD CV%	103.5 0.3 0.3	120.5 0.7 0.6	90.3 0.4 0.5	n/a
iCa2+ (mmol/L)	Mean SD CV%	1.19 0.01 0.51	1.60 0.01 0.6	n/a	0.96 0.01 0.6

Parameter	n = 30	Venous Blood 1	Venous Blood 2	Venous Blood 3	Venous Blood 4
iMg 2+ (mmol/L)	Mean SD CV%	0.64 0.00 0.6	0.87 0.01 1.6	n/a	0.42 0.01 1.2

b. Linearity/assay reportable range:

The sponsor performed a linearity study to evaluate the claimed analytical measurement range (AMR) for the sodium, potassium, chloride, ionized calcium, and ionized magnesium assays on the Stat Profile Prime® Plus Analyzer. The evaluation of the linear range included lower and upper limits of the AMR and various medical decision limits.

Low and high concentration pools were prepared from the whole bloods for each parameter. Nine to eleven different concentrations spanning the analytical range were made per analyte from these pools using serial dilutions. Each blood level was analyzed in triplicate in random order on three test analyzers and on the pHOx Ultra reference analyzer. The pHOx Ultra analyzers were used to establish the target value of each blood level for each parameter. All three analyzers yielded similar results. The results of the least squares linear regression analysis from one representative analyzer are summarized below.

Analyte	Claimed measurement range	Concentration range tested	Slope	Intercept	r
Na+ mmol/L	80 - 200	77.6 - 213.5	1.0076	-1.1382	0.9998
K+ mmol/L	1.0 - 20.0	0.57 - 21.7	1.0199	-0.2714	0.9993
Cl- mmol/L	50 - 200	45.6 - 225	0.9681	2.8399	0.9992
iCa mmol/L	0.1 - 2.7	0.06 - 2.76	1.0003	0.0015	0.9996
iMg mmol/L	0.1 - 1.5	0.12 - 1.56	0.9887	0.0356	0.9964

The results of the linearity study support the sponsor's claimed measuring ranges (as described in the table above).

c. *Traceability, Stability, Expected values (controls, calibrators, or methods):*

The sodium standards and reagents are traceable to NIST SRM 2201.

The potassium standards and reagents are traceable to NIST SRM 2202.

The chloride standards and reagents are traceable to NIST SRM 2201.

The ionized calcium standards and reagents are traceable to NIST SRM 91Sa.

The ionized magnesium standards and reagents are traceable to NIST SRM 929a.

d. *Detection limit:*

The sponsor performed a study to evaluate the limit of blank (LoB), limit of detection (LoD) and limit of quantification for ionized calcium and ionized magnesium using altered whole blood samples. Study samples were prepared from heparinized venous whole blood samples. Varying amounts of sodium citrate were added to some samples to bind the iCa and iMg and create blank samples and low level samples. All prepared samples were analyzed on the reference analyzer to obtain the target values.

Results for ionized calcium and ionized magnesium were as follows:

Analyte	units	LoB	LoD	TE	LoQ	Acceptance Criteria for TE (</=)	Claimed Measurement Range
iCa	**mmol/L**	0.04	0.05	0.02	0.05	0.2	0.1 - 2.7
iMg	**mmol/L**	0.05	0.1	0.1	0.1	0.11	0.1 - 1.5

The performance at the lower end of the measuring range for sodium, potassium, and chloride is supported by the linearity studies in section M.1.b.

e. *Analytical specificity:*

The sponsor performed a specificity study using whole blood collected in lithium heparin vacutainers. Samples were divided to create two separate pools of blood, one for control samples and the other for test samples. The potential interferents were tested at two analyte concentrations. For all analytes, the sponsor defined interference as > ± 10% bias from the test concentration. If interference was identified, a dose response study was performed to determine the concentration where the interfering substance may alter results.

The sponsor determined that the following substances did not cause interference at the concentrations listed below:

Sodium

Substance	Highest concentration tested that did not cause significant interference
Acetoacetate	2 mmol/L
Acetylsalicylic Acid	3.62 mmol/L
Ammonium Chloride	107 µmol/L
Benzalkonium Chloride	10 mg/L
Bilirubin	342 µmol /L
$CaCl_2$	2 mmol/L
Dobutamine	2 mg/dL
Hemoglobin	2 g/L
Ibuprofen	2.4 mmol/L
Intralipid	1.0%
Lithium Lactate	6.6 mmol/L
$MgCl_2$	15 mmol/L
Salicylic Acid	4.34 mmol/L
$ZnCl_2$	1.3 mg/dL

Potassium

Substance	Highest concentration tested that did not cause significant interference
Acetoacetate	2 mmol/L
Acetylsalicylic Acid	3.62 mmol/L
Ammonium Chloride	107 µmol /L
Benzalkonium Chloride	10 mg/L
Bilirubin	342 µmol /L
$CaCl_2$	2 mmol/L
Dobutamine	2 mg/dL
Hemoglobin	2 g/L
Ibuprofen	2.4 mmol/L
Intralipid	1.00%
Lithium Lactate	6.6 mmol/L
NaBr	37.5 mmol/L
Salicylic Acid	4.34 mmol/L
$ZnCl_2$	1.3 mg/dL

Chloride

Substance	Highest concentration tested that did not cause significant interference
Acetoacetate	2 mmol/L
Acetylsalicylic Acid	3.62 mmol/L
Ammonium Chloride	107 µmol /L
Ascorbic Acid	50 mg/dL
Benzalkonium Chloride	10 mg/L
Bilirubin	342 µmol /L

Substance	Highest concentration tested that did not cause significant interference
Hemoglobin	2 g/L
Ibuprofen	2.4 mmol/L
Intralipid	1.00%
Lithium Lactate	6.6 mmol/L
Perchlorate	1 mmol/L
Salicylic Acid	4.34 mmol/L
Sodium Citrate	12 mmol/L
Sodium Oxalate	500 mg/dL

Ionized Calcium

Substance	Highest concentration tested that did not cause significant interference
Acetoacetate	2 mmol/L
Ammonium Chloride	107 µmol /L
Benzalkonium Chloride	10 mg/L
Bilirubin	342 µmol /L
Dobutamine	2 mg/dL
Hemoglobin	2 g/L
Ibuprofen	2.4 mmol/L
Intralipid	1.00%
KCl	5 mmol/L
Lithium Lactate	6.6 mmol/L
NaBr	37.5 mmol/L
NaCl	10 mmol/L
Perchlorate	1 mmol/L
$ZnCl_2$	1.3 mg/dL

Ionized Magnesium

Substance	Highest concentration tested that did not cause significant interference
Acetoacetate	2 mmol/L
Ammonium Chloride	107 µmol /L
Benzalkonium Chloride	10 mg/L
Bilirubin	342 µmol /L
$CaCl_2$	2 mmol/L
Dobutamine	2 mg/dL
Hemoglobin	2 g/L
Ibuprofen	2.4 mmol/L
Intralipid	1.00%
KCl	5 mmol/L
Lithium Lactate	6.6 mmol/L
NaBr	37.5 mmol/L
NaCl	10 mmol/L

The sponsor lists the following interferents in the labeling:

Parameter	Interferent	Interference Observed at Concentrations Above:
Ionized Calcium	$MgCl_2$	3.75 mmol/L
Ionized Magnesium	Perchlorate Thiocyanate $ZnCl_2$	0.06 mmol/L 0.4 mmol/L 0.163 mg/dL
Chloride	Bromide Thiocyanate	2.5 mmol/L 3.4 mmol/L

f. Assay cut-off:

Not applicable

2. Comparison studies:

a. Method comparison with predicate device:

Method comparison studies were conducted by testing lithium heparinized arterial and venous whole blood specimens in singlet on the three Stat Profile® Prime Plus analyzers and two pHOx Ultra analyzers (predicate device). In order to evaluate the claimed measuring range, some venous whole blood specimens were tonometered, spiked or diluted to achieve the desired concentrations. The singlet result from each test analyzer was compared to the average of the results from each comparative method. Linear regression analysis of one representative analyzer is shown below.

Analyte	n	Sample concentration range	Slope	Intercept	r
Sodium (mmol/L)	217	84.8 – 190.6	1.002	-0.275	0.9950
Potassium (mmol/L)	219	1.30 – 18.37	1.012	-0.019	0.9991
Chloride (mmol/L)	219	69.7 – 181.9	1.015	-0.835	0.9967
Ionized Calcium (mmol/L)	222	0.25 – 2.47	0.997	-0.001	0.9928
Ionized Magnesium (mmol/L)	214	0.24 – 1.44	0.998	0.008	0.9751

b. Matrix comparison:

Not applicable. For use with lithium heparinized whole blood only.

3. Clinical studies:

   a. Clinical Sensitivity:

   Not applicable

   b. Clinical specificity:

   Not applicable

   c. Other clinical supportive data (when a. and b. are not applicable):

   Not applicable

4. Clinical cut-off:

   Not applicable

5. Expected values/Reference range:

   Reference ranges for sodium, potassium, chloride and ionized calcium are cited from the literature:

   Sodium: 136 - 146 mmol/L

   Potassium: 3.5 - 5.1 mmol/L

   Chloride: 98 - 106 mmol/L

   Ionized Calcium: 1.09 – 1.30 mmol/L

   References:

Statland, Bernard, Clinical Decision Levels for Lab Tests, Medical Economics Books, 1987.

Burtis, Carl A. and Ashwood, Edward R., ed. 1994. Tietz Textbook of Clinical Chemistry, W. B. Saunders Co. Philadelphia, PA.

Tietz, Norbert W., ed. 1983. Clinical Guide to Laboratory Tests, W. B. Saunders Co., Philadelphia, PA.

Kost, G.T., "The Significance of Ionized Calcium in Cardiac and Critical Care," Arch. Pathol. Lab Med. Vol. 117: pp 890-896. 1993.

Reference range for ionized magnesium was determined from reference ranges established in a dozen or so reporting institutions that have been working with Nova analyzers. The extremes of the reference ranges in these institutions were 0.43 - 0.57 to 0.46 - 0.62, with most being 0.45 - 0.60 mmol/L.

Ionized Magnesium: 0.45 – 0.60 mmol/L

N. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Parts 801 and 809, as applicable.

O. Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.