510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY AND INSTRUMENT

I Background Information:

A 510(k) Number

K203549

B Applicant

Nova Biomedical Corporation

C Proprietary and Established Names

Nova Primary Glucose Analyzer System

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
CGA	Class II	21 CFR 862.1345 - Glucose Test System	CH - Clinical Chemistry

II Submission/Device Overview:

A Purpose for Submission:

New Device

B Measurand:

Glucose

C Type of Test:

Quantitative amperometric

III Intended Use/Indications for Use:

A Intended Use(s):

Please see indication(s) for use.

B Indication(s) for Use:

The Nova Primary Glucose Analyzer System is indicated for in vitro diagnostic use by healthcare professionals in clinical laboratory settings for the quantitative determination of Glucose in lithium heparinized venous whole blood and plasma.

The measurement of Glucose is used in the diagnosis and treatment of carbohydrate metabolism disturbances including diabetes mellitus, neonatal hypoglycemia, and idiopathic hypoglycemia, and pancreatic islet cell carcinoma.

C Special Conditions for Use Statement(s):

Rx - For Prescription Use Only

Not for point-of-care use.

D Special Instrument Requirements:

Nova Primary Glucose Analyzer

IV Device/System Characteristics:

A Device Description:

The Nova Primary Glucose Analyzer System is a benchtop laboratory glucose analyzer that measures blood glucose levels in lithium heparinized venous whole blood or plasma and utilizes a glucose-oxidase-based sensor and membrane/cap assembly. The system is comprised of the following: the analyzer, a wireless keyboard, a glucose sensor, a glucose sensor membrane cap, a calibrator pack, thermal paper for an onboard printer, and an optional barcode scanner.

The Nova Primary Glucose Analyzer utilizes an integrated calibrator pack with an RFID data management tag to monitor pack expiration date and number of samples remaining. All calibrator lot information is programmed into the RFID tags.

B Principle of Operation:

Glucose measurement is based on the level of H_2O_2 produced during the enzymatic reaction between glucose and oxygen molecules in the presence of the glucose oxidase enzyme. At a constant potential of 0.70 volts, electroactive H_2O_2 is oxidized at the surface of the platinum anode. The current generated by the flow of electrons at the surface of the platinum electrode is proportional to the glucose concentration of the sample.

C Instrument Description Information:

1. Instrument Name:

   Nova Primary Glucose Analyzer

2. Specimen Identification:

   When running a sample, an operator enters a sample ID of up to 40 alpha-numeric characters using either (or a combination of) the keyboard or the optional wireless scanner, if desired. Previously analyzed sample and quality control results are retained indefinitely in the analyzer's database and can be recalled for review, printed, and exported to a USB device as a .csv file for use in an offline spreadsheet.

3. Specimen Sampling and Handling:

   The device is intended to be used with lithium heparin venous whole blood and plasma samples from syringes using a port on a venous line, blood collection tubes, or small cups. Once an analysis sequence has been initiated by the user, the device extends the sample probe to aspirate a volume of sample (minimum sample volume for analysis is 25 µL) from one of the appropriate containers listed above into the analyzer's flow path. The sample probe then retracts into the device and the analysis starts. Once the sample measurement is complete, the device aspirates calibrator pack reagents through the sample probe to flush/wash the sample probe between sample analyses. The device then conducts a 1-point sensor calibration prior to each sample analysis to ensure no carry over between samples.

   If using blood collection tubes, samples should be collected with minimal stasis, without the exercise of the arm. Samples should be well mixed before introduction into the analyzer and should be analyzed within 15 minutes of collection for glucose to minimize the clinical impact of glycolysis on the measured glucose result. Measurement delays greater than 15 minutes may impact the clinical accuracy of the glucose measurement. Plasma samples should be separated from contact with cells as soon as possible to a maximum time limit of 2 hours from the time of collection.

4. Calibration:

   Automatic two-point calibration every 2 hours, automatic one-point calibration with samples.

5. Quality Control:

   Two levels of quality control material can be monitored on the Nova Primary Glucose Analyzer System. Results that exceed the entered ranges are flagged for identification. Laboratories should perform the following minimum QC procedures (External Ampule QC) on each analyzer: (1) During every 24 hours of testing one normal and one abnormal level of control, (2) After performing system maintenance, follow good laboratory practice guideline for performing quality control analysis.

V Substantial Equivalence Information:

A Predicate Device Name(s):
YSI Model 2300 Stat Glucose And L-lactate Analyzer

B Predicate 510(k) Number(s):
K891480

C Comparison with Predicate(s):

Device & Predicate Device(s):	K203549	K891480
Device Trade Name	Nova Primary Glucose Analyzer	YSI 2300 STAT PLUS Glucose and Lactate Analyzer
General Device Characteristic Similarities		
Intended Use/Indications For Use	The Nova Primary Glucose Analyzer System is indicated for the determination of glucose in venous whole blood and plasma.	Same
Intended Users	Trained laboratory personnel	Same
Enzyme	Glucose Oxidase	Same
Sample size requirement	25 µL	Same
General Device Characteristic Differences		
Measured Tests	Glucose	Glucose and Lactate
Acceptable Sample Types	Lithium Heparin Venous Whole Blood and Plasma	Whole Blood, Plasma, Serum
Physical Dimensions	19.0 x 19.0 x 6.0 inches	10.0 x 14.0 x 14.0 inches
Automatic Whole Blood Hematocrit Correction	Yes – Contains an impedance-based Conductivity Detector. Whole blood samples are automatically adjusted to provide plasma equivalent glucose values based on the conductivity of the sample.	No – Hematocrit is independently measured on the whole blood specimen then manually entered into YSI 2300 to calculate equivalent plasma glucose value.

VI Standards/Guidance Documents Referenced:

- IEC 61010-1:2010+AMD1:2016 Safety Requirements For Electrical Equipment For Measurement, Control, And Laboratory Use - Part 1: General Requirements
- IEC 60601-1-2:2014 Medical Electrical Equipment - Part 1-2: General Requirements For Basic Safety And Essential Performance - Collateral Standard: Electromagnetic Disturbances - Requirements And Tests

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

1. Precision/Reproducibility:

Within-Run Precision:
Within-run precision testing was performed using two levels of quality control (QC) samples, venous whole blood (WB) samples, and plasma samples and analyzed in one run, with 20 replicates per run on 3 different analyzers. Seven different levels of samples concentrations were used to cover the measuring range of the device. Two lots of Nova Primary Calibrator Cartridges and two lots of glucose membranes were used over the course of the study. The results of one representative analyzer are shown below:

Within-Run Precision Results using QC Samples:

n = 20	QC Level 1	QC Level 2
Mean (mg/dL)	73	181
SD	1.9	1.4
%CV	2.5	0.8

Within-Run Precision Results using Venous Whole Blood Samples:

n= 20	Mean (mg/dL)	SD	%CV
Level 1	34	1.0	2.9
Level 2	78	2.1	2.7
Level 3	178	2.9	1.6
Level 4	308	3.2	1.0
Level 5	512	7.3	1.4
Level 6	675	12.4	1.8
Level 7	762	14.2	1.9

Within-Run Precision Results using Plasma Samples:

n = 20	Mean (mg/dL)	SD	%CV
Level 1	36	0.7	1.9
Level 2	122	1.5	1.2
Level 3	183	1.2	0.7
Level 4	400	1.8	0.4
Level 5	558	4.5	0.8
Level 6	692	6.4	0.9
Level 7	841	6.6	0.8

Run-to-Run Precision:

Run-to-Run Precision Results using QC Samples:
Run-to-run precision testing was performed using QC samples tested in duplicate, two runs per day for 20 days for a total of 40 runs. The summary results for the QC samples collected on 3 difference analyzers are shown below:

QC Sample	Pooled Mean	N	Run-to-Run SD (Sr)	Run-to-Run %CV	Total imprecision SD (St)	Total imprecision %CV
Level 1	74	240	1.3	1.8	2.0	2.7
Level 2	198	240	2.3	1.2	3.9	2.0

Run-to-Run Precision Results using Venous Whole Blood Samples:
Venous whole blood samples were run in triplicate in 10 runs during a single day. Plasma samples were run in duplicate, two runs per day for 20 days for a total of 40 runs. Six different levels of samples concentrations were used to cover the measuring range of the device. Two lots of Nova Primary Calibrator Cartridges and two lots of glucose membranes were used over the course of the study. The results of one representative analyzer are shown below for whole blood samples:

n = 30	Mean (mg/dL)	SD	%CV
Level 1	37	1.2	3.3
Level 2	80	1.6	2.0
Level 3	190	3.1	1.6

n = 30	Mean (mg/dL)	SD	%CV
Level 4	370	7.2	1.9
Level 5	547	14.2	2.6
Level 6	656	13.3	2.0

Run-to-Run Precision Results using Plasma Samples:
The results of one representative analyzer are shown below for plasma samples:

n = 80	Mean (mg/dL)	SD	%CV
Level 1	40	1.3	3.2
Level 2	93	2.9	3.1
Level 3	198	6.1	3.1
Level 4	408	13.4	3.3
Level 5	576	19.2	3.3
Level 6	781	26.2	3.4

2. Linearity:

Linearity of the Nova Primary Glucose Analyzer was evaluated using three (3) Nova Primary Glucose Analyzers and two (3) YSI 2300 Stat Plus Glucose and L-Lactate Analyzers (K891480). Two (2) lots of Nova Primary Calibrator Cartridges, and two (2) lots of glucose membranes were used over the course of the study.

Venous Whole Blood
Low and high pools were prepared from the pooled whole blood with glucose concentrations outside of the analytical measurement range. Samples of 10 different concentrations spanning beyond the claimed analytical range were made from the low and high pools using serial dilutions. Each blood level was analyzed in triplicate in random order on three (3) Nova Primary test analyzers and on the YSI 2300 analyzers. The results from each test analyzer were compared to the average of the test results from the YSI 2300 analyzers.

Plasma
Previously prepared whole blood samples were spun down to plasma. Each plasma level was analyzed in triplicate in random order on three (3) Nova Primary test analyzers and on the YSI 2300 analyzers. The results from each test analyzer were compared to the average of the test results from the YSI 2300 analyzers.

The results of the least squares linear regression analyses are shown below:

Nova Primary Linearity – Whole Blood						
Claimed Measurement Range (mg/dL)	**Analyzer**	**Total # of Levels**	**Specimen Range**	**Slope**	**Intercept**	**r**
20 – 900	1	10	0-976	1.0018	-0.4476	0.9982
	2	10	0-967	0.9955	-0.4923	0.9989
	3	10	0-970	0.9972	2.7854	0.9984

Nova Primary Linearity – Plasma						
Claimed Measurement Range (mg/dL)	**Analyzer**	**Total # of Levels**	**Specimen Range**	**Slope**	**Intercept**	**r**
20 – 900	1	10	0-998	1.0188	2.0841	0.9989
	2	10	0-1097	1.0026	1.9626	0.9944
	3	10	0-1016	1.0096	4.3566	0.9976

3. Analytical Specificity/Interference:

An interference study was performed using venous whole blood and plasma samples. The possible interfering substances were tested at two glucose concentrations (~ 80-100 mg/dL and ~ 200 mg/dL) and compared to a control sample.

The test substance was considered an interfering substance if the difference between the mean test value and the mean control value exceeded ±10%. If the difference between the test and control means was greater than the allowed bias, a dose response was performed.

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

Nova Primary Whole Blood Interference	
Test Substance	**Highest concentration tested that did not cause significant interference**
Acetaminophen	20 mg/dL
Acetoacetate	20 mg/dL
Acetylsalicylic Acid	65 mg/dL
Ammonium Chloride	0.6 mg/dL
Ascorbic Acid	50 mg/dL
Bilirubin	20 mg/dL
Benzalkonium Chloride	10 mg /dL
B-hydroxybutyrate	21 mg/dL
Dobutamine	2 mg/dL
Dopamine Hydrochloride	0.1 mg/dL
Ethanol	400 mg/dL

Nova Primary Whole Blood Interference	
Test Substance	**Highest concentration tested that did not cause significant interference**
Fluoride	0.4 mg/dL
D-Galactose	18 mg/dL
Glucosamine	0.5 mg/dL
Glycolic Acid	7.6 mg/dL
Hemoglobin	200 mg/dL
High Hematocrit	68%
Hydroxyurea	0.8 mg/dL
Ibuprofen	50 mg/dL
Intralipid	1.0 % solution
Lactate	60 mg/dL
Low Hematocrit	18%
Maltose	445 mg/dL
Mannose	18 mg/dL
Pyruvate	2.7 mg/dL
Salicylic Acid	60 mg/dL
Sodium Citrate	310 mg/dL
Sodium Oxalate	500 mg/dL
Thiocyanate	97.3 mg/dL
Xylose	25 mg/dL
N-Acetylcysteine	167 mg/dL
Glutathione	92 mg/dL
Creatinine	15 mg/dL
Cholesterol	500 mg/dL
Methyl-DOPA	2 mg/dL

Nova Primary Plasma Interference	
Test Substance	**Highest concentration tested that did not cause significant interference**
Acetaminophen	20 mg/dL
Acetoacetate	20 mg/dL
Acetylsalicylic Acid	65 mg/dL
Ammonium Chloride	0.6 mg/dL
Ascorbic Acid	50 mg/dL
Bilirubin	20 mg/dL
Benzalkonium Chloride	10 mg /dL
B-hydroxybutyrate	21 mg/dL
Dobutamine	2 mg/dL
Dopamine Hydrochloride	0.1 mg/dL
Ethanol	400 mg/dL
Fluoride	0.4 mg/dL
D-Galactose	18 mg/dL
Glucosamine	0.5 mg/dL

Nova Primary Plasma Interference	
Test Substance	**Highest concentration tested that did not cause significant interference**
Glycolic Acid	7.6 mg/dL
Hemoglobin	200 mg/dL
Hydroxyurea	0.8 mg/dL
Ibuprofen	50 mg/dL
Intralipid	1.0 % solution
Lactate	60 mg/dL
Maltose	445 mg/dL
Mannose	18 mg/dL
Pyruvate	2.7 mg/dL
Salicylic Acid	60 mg/dL
Sodium Citrate	310 mg/dL
Sodium Oxalate	500 mg/dL
Thiocyanate	97.3 mg/dL
Xylose	25 mg/dL
N-Acetylcysteine	167 mg/dL
Glutathione	92 mg/dL
Creatinine	15 mg/dL
Cholesterol	500 mg/dL
Methyl-DOPA	2 mg/dL

To mitigate the risk of false test results due to the presence of excess anticoagulant, the sponsor demonstrated no significant interference for samples containing up to 100 IU/mL lithium heparin.

4. Assay Reportable Range:

   Glucose measuring range = 20 – 900 mg/dL

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):

   The Glucose Calibrators, Controls, and Standards are traceable to the National Institute of Standards and Technology (NIST) Standard SRM-917.

6. Detection Limit:

   Detection capability studies of limit of blank, limit of detection, and limit of quantitation for glucose on the Nova Primary Glucose Analyzer System were conducted following the recommendations in CLSI EP17-A2. These studies supported the claim of 20 mg/dL as the lower end of the reportable range.

7. Assay Cut-Off:

   Not applicable.

8. Accuracy (Instrument):

Please see section B.1. Method Comparison with Predicate Device for a discussion of the instrument's accuracy.

9. Carry-Over:

Not applicable.

B Comparison Studies:

1. Method Comparison with Predicate Device:

Venous Whole Blood
174 discarded lithium heparinized venous whole blood specimens (15 of which were altered) from hospital patients were analyzed in singlet on three Nova Primary Glucose Analyzers and two YSI 2300 Stat Plus Glucose and L-Lactate Analyzers (comparative method – K891480). Two lots of Nova Primary Calibrator Cartridges, and two lots of glucose membranes were used over the course of the study. The singlet result from the test analyzers was compared to the average of the test results from the comparative method.

Whole Blood Method Comparison Summary – Nova Primary vs CM					
Analyzer	**N**	**Range (mg/dL)**	**Slope**	**Intercept**	**r**
1	174	34-871	0.9927	0.3878	0.9992
2	174	34-871	1.0017	-1.5404	0.9990
3	174	34-871	1.0083	-3.7425	0.9989

Plasma
170 discarded lithium heparinized venous plasma specimens (15 of which were altered) from hospital patients were analyzed in singlet on three Nova Primary Glucose Analyzers (test analyzers) and two YSI 2300 Stat Plus Glucose and L-Lactate Analyzers (comparative method). Two lots of Nova Primary Calibrator Cartridges, and two lots of glucose membranes were used over the course of the study. The singlet result from the test analyzers was compared to the average of the test results from the comparative method.

Plasma Method Comparison Summary – Nova Primary vs CM					
Analyzer	**N**	**Range (mg/dL)**	**Slope**	**Intercept**	**r**
1	170	30-835	1.0088	1.1364	0.9992
2	170	30-835	0.9935	1.0018	0.9991
3	170	30-835	1.0002	-0.2388	0.991

2. Matrix Comparison:

Not applicable. For use with lithium heparinized venous whole blood or plasma only.

C Clinical Studies:

1. Clinical Sensitivity:

Not applicable.

2. Clinical Specificity:

Not applicable.

3. Other Clinical Supportive Data (When 1. and 2. Are Not Applicable):

Not applicable.

D Clinical Cut-Off:

Not applicable.

E Expected Values/Reference Range:

Glucose (Serum, Fasting, Adult): 74 – 100 mg/dL

Reference cited:
Curtis, Carl A. and Bruns, David E., ed. 2015. Tietz Fundamentals of Clinical Chemistry, Saunders St. Louis, MO.

F Other Supportive Instrument Performance Characteristics Data:

The sponsor provided information to demonstrate they have mitigated risks associated with changes in sample volume and operating conditions.

The sponsor provided information to demonstrate they have validated use of the device up to 10,000 ft.

VIII Proposed Labeling:

The labeling supports the finding of substantial equivalence for this device.

IX Conclusion:

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