510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY ONLY

I Background Information:

A 510(k) Number

K223755

B Applicant

Abbott Point of Care Inc.

C Proprietary and Established Names

i-STAT G cartridge with the i-STAT 1 System

D Regulatory Information

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

II Submission/Device Overview:

A Purpose for Submission:

Modified device

B Measurand:

Glucose

C Type of Test:

Quantitative amperometric

III Intended Use/Indications for Use:

A Intended Use(s):

See Indications for Use below.

B Indication(s) for Use:

The i-STAT G cartridge with the i-STAT 1 System is intended for use in the in vitro quantification of glucose in arterial, venous or capillary whole blood in point of care or clinical laboratory settings.

Glucose measurements are used in the diagnosis, monitoring, and treatment of carbohydrate metabolism disorders including, but not limited to, diabetes mellitus, neonatal hypoglycemia, idiopathic hypoglycemia, and pancreatic islet cell carcinoma.

C Special Conditions for Use Statement(s):

Rx – For Prescription Use Only

For Point-of-care use or clinical laboratory setting.

Capillary whole blood specimens (e.g., obtained by fingerstick) should not be used in patients receiving intensive medical intervention/therapy because of the potential for pre-analytical collection error and specifically in patients with decreased peripheral blood flow, as it may not reflect the true physiological state. Examples include, but are not limited to, severe hypotension, shock, hyperosmolar-hyperglycemia (with or without ketosis) and severe dehydration.

D Special Instrument Requirements:

i-STAT 1 Analyzer

IV Device/System Characteristics:

A Device Description:

The i-STAT G (white) cartridge with the i-STAT 1 System is a single-use and disposable unit that contains test reagents and sensors for the glucose measurement. Cartridges require two to three drops of whole blood, which are applied to the cartridge using a transfer device, by the trained user before the cartridge is placed within the analyzer. All the test steps and fluid movements occur within the i-STAT G cartridge (white). The test reagents and internal fluids do not contact the analyzer or user.

B Principle of Operation:

Glucose on the i-STAT G cartridge (white) is measured amperometrically. A voltage is applied to the cartridge electrodes with current generated by the reduction of hydrogen peroxide that was produced by catalytic oxidation of glucose present in the sample by glucose oxidase. The current is directly proportional to the concentration of the glucose in the sample.

V Substantial Equivalence Information:

A Predicate Device Name(s):
i-STAT CHEM8+ cartridge with the i-STAT 1 System

B Predicate 510(k) Number(s):
K210958

C Comparison with Predicate(s):

Device & Predicate Device(s):	K223755	K210958
Device Trade Name	i-STAT G cartridge with the i-STAT 1 system	i-STAT CHEM8+ cartridge with the i-STAT 1 system
General Device Characteristic Similarities		
Intended Use/Indications For Use	Intended for in vitro quantification of glucose in samples. Glucose measurements are used in the diagnosis, monitoring, and treatment of carbohydrate metabolism disorders including, but not limited to, diabetes mellitus, neonatal hypoglycemia, idiopathic hypoglycemia, and pancreatic islet cell carcinoma.	Same
Reportable Range	20 – 700 mg/dL	Same
Traceability	NIST SRM965	Same
General Device Characteristic Differences		
Sample Type	Arterial and venous whole blood with and without lithium heparin or EDTA anticoagulant. Lithium Heparin capillary whole blood.	Arterial or venous whole blood with and without lithium heparin anticoagulant

VI Standards/Guidance Documents Referenced:

Clinical Laboratory Standards Institute (CLSI) EP05-A3: Evaluation of Precision of Quantitative Measurement Procedures; Approved Guideline – Third Edition.

CLSI EP06: Evaluation of Linearity of Quantitative Measurement Procedures;2nd Edition.

CLSI EP07: Interference Testing in Clinical Chemistry; 3rd ed.

CLSI EP09c: Measurement Procedure Comparison and Bias Estimation using Patient Samples, 3rd ed.

CLSI EP17-A2: Evaluation of Detection Capability for Clinical Laboratory Measurement Procedures; 2nd ed.

CLSI EP35: Assessment of Equivalence or Suitability of Specimen Types for Medical Laboratory Measurement Procedures; 1st ed.

CLSI EP37: Supplement Tables for Interference Testing in Clinical Chemistry; 1st ed.

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

1. Precision/Reproducibility:

Internal Site Precision

i. 20-day Precision

A single-site precision study for the i-STAT Glucose test on the i-STAT G cartridge (white) with the i-STAT 1 System was conducted following the recommendations in the CLSI EP05-A3. Five (5) concentration levels of i-STAT Calibration Verification fluids were tested using one (1) i-STAT G cartridge lot and multiple analyzers. Each level of calibration verification fluid was measured in duplicates per run, with two runs per day for at least 20 non-consecutive days resulting in a total of 80 test results per level. The results are summarized below:

Sample	N	Mean (mg/dL)	Repeatability		Between-Run		Between-Day		Within-Laboratory	
			SD	%CV	SD	%CV	SD	%CV	SD	%CV
L1	80	25.0	0.43	1.71	0.06	0.23	0.34	1.36	0.55	2.19
L2	80	38.5	0.38	0.99	0.22	0.58	0.21	0.54	0.49	1.27
L3	80	119.1	0.69	0.58	0.21	0.18	0.31	0.26	0.78	0.66
L4	80	272.2	1.42	0.52	0.40	0.15	0.76	0.28	1.66	0.61

Sample	N	Mean (mg/dL)	Repeatability		Between-Run		Between-Day		Within-Laboratory	
			SD	%CV	SD	%CV	SD	%CV	SD	%CV
L5	80	565.5	4.33	0.77	2.71	0.48	1.78	0.32	5.41	0.96

ii. Between-Lot Precision

The between-lot precision study for the i-STAT Glucose test on the i-STAT G cartridge (white) with the i-STAT 1 System was conducted following the recommendations in the CLSI document EP05-A3. The study was conducted using three (3) lots of i-STAT G cartridges (white), each lot tested in five (5) replicates over five (5) non-consecutive days for each of the i-STAT Calibration Verification fluid levels using multiple analyzers. The results are summarized below:

Sample	N*	Mean (mg/dL)	Repeatability		Between-Lot		Between-Day		Within-Laboratory	
			SD	%CV	SD	%CV	SD	%CV	SD	%CV
L1	76	26.6	0.29	1.10	1.04	3.93	0.14	0.52	1.09	4.11
L2	75	40.1	0.46	1.14	0.83	2.08	0.18	0.45	0.97	2.41
L3	76	122.5	0.31	0.26	0.70	0.58	0.28	0.23	0.82	0.67
L4	75	275.2	0.78	0.28	0.28	0.10	0.11	0.04	0.83	0.30
L5	75	561.4	2.48	0.44	4.20	0.75	1.41	0.25	5.08	0.90

*The sample size for L1 and L3 was greater than 75 as there were additional cartridges inadvertently run.

Point of Care (Multi-Site) Precision (aqueous control material)

Multiple-day precision testing was performed at three (3) clinical sites using a panel of aqueous material, i.e., i-STAT TriControls Calibration Verification Set, containing five (5) level of glucose concentration. At each site, testing was performed once (1) per day by two (2) operators for five (5) days and each operator performed test using one (1) lot of i-STAT G cartridges (white) on three (3) i-STAT 1 Analyzers. The combined precision study results from all sites are summarized below:

Sample	N	Mean (mg/dL)	Repeatability		Between-Day		Between-Operator		Within-Site	
			SD	%CV	SD	%CV	SD	%CV	SD	%CV
L1	89	573.1	2.63	0.46	1.2	0.21	0.00	0.00	2.89	0.5
L2	90	266.3	0.71	0.27	0.37	0.14	0.16	0.06	0.82	0.31
L3	90	133.7	0.57	0.43	0.12	0.09	0.18	0.13	0.61	0.46
L4	90	46.1	0.33	0.72	0.31	0.67	0.04	0.09	0.46	0.99

Sample	N	Mean (mg/dL)	Repeatability		Between-Day		Between-Operator		Within-Site	
			SD	%CV	SD	%CV	SD	%CV	SD	%CV
L5	90	33.7	0.57	1.68	0.00	0.00	0.14	0.40	0.58	1.73

Sample	N	Mean (mg/dL)	Between-Site		Overall	
			SD	%CV	SD	%CV
L1	89	573.1	0.00	0.00	2.89	0.5
L2	90	266.3	0.05	0.02	0.82	0.31
L3	90	133.7	0.00	0.00	0.61	0.46
L4	90	46.1	0.15	0.32	0.48	1.04
L5	90	33.7	0.00	0.00	0.58	1.73

Point of Care Precision (Whole Blood)

Whole blood precision of the i-STAT Glucose test in the i-STAT G cartridge (white) on the i-STAT 1 System was evaluated using arterial, venous, and capillary whole blood specimens collected with lithium heparin. The whole blood precision was assessed using the duplicate test results collected across multiple point of care sites. For each sample type, samples were grouped into subintervals based on their mean values. The precision results between sites were similar. The combined results from all sites are summarized below:

Test (Unit)	Sample Type	Sample Range	N	Mean	Pooled SD	%CV
Glucose (mg/dL)	Venous Whole Blood	20-90	38	75.0	0.32	0.43
		>90-150	67	109.6	0.39	0.35
		>150-250	32	195.8	0.73	0.37
		>250-400	15	315.0	1.17	0.37
		>400-700	12	559.0	2.01	0.36
	Arterial Whole blood	20-90	9	82.4	0.33	0.40
		>90-150	94	125.0	0.57	0.46
		>150-250	64	182.0	0.54	0.30
		>250-700	6	357.0	0.91	0.26
	Capillary Whole blood	20-90	33	70.9	1.91	2.71
		>90-150	53	116.0	2.44	2.10
		>150-250	37	196.6	4.40	2.24
		>250-400	16	297.1	4.09	1.38

2. Linearity:

The linearity study was designed based on the CLSI EP06 2nd ed guideline. The linearity of the i-STAT Glucose test in the i-STAT G cartridge (white) with the i-STAT 1 System was evaluated by preparing a total 11 samples with concentrations spanning the claimed measuring range. Each level was tested in replicates of two per cartridge lot for a total of 10 results per level. An assessment of linearity was performed using weighted least squares linear regression. At each concentration level, the deviation from linearity was within ± 3%. The regression parameters for the linearity study are summarized below:

Total of levels	Specimen Range (mg/dL)	Claimed Measurement Range (mg/dL)	Slope	Intercept	R^2
11	15.3 – 793.3	20 – 700	1.002	-1.258	0.999

The linearity data supported the claimed reportable range of 20 to 700 mg/dL.

3. Analytical Specificity/Interference:

The analytical specificity of the i-STAT Glucose assay on the i-STAT G cartridge (white) was established by conducting interference testing following the recommendations from CLSI EP07-3rd ed guideline. Interference from certain exogenous and endogenous substances was assessed using lithium heparin whole blood samples at two glucose concentrations: low (30 - 50 mg/dL) and high (210-230 mg/dL). The samples with high and low analyte levels were further divided into two groups: i.e., test sample (with added interferent) and control sample (without interferent). Each sample level was tested in duplicates for each of the five (5) i-STAT G cartridge lots (for a total of 10 results per level) on multiple i-STAT 1 analyzers.

The effect of each substance at each analyte level was evaluated by comparing the test results of a control sample, i.e., spiked with blank solvent solution, with the test results from a sample spiked with the potentially interfering substance at the toxic or pathological concentration based on CLSI EP37.

The sponsor defines that interference is considered non-significant if the bias between the test and control sample are within ± 10% for all test interferences. The following table lists the concentrations of each substance at which no significant interference was found.

Substance	Highest concentration at which no interference was observed
Acetaldehyde	0.2 mg/dL
Acetaminophen	15.6 mg/dL
Acetoacetate (lithium Acetoacetate)	20.0 mg/dL
Acetyl Cysteine (N-Acetyl-Cysteine)	15.0 mg/dL
Ammonium (Ammonium Chloride)	10.7 mg/dL

Substance	Highest concentration at which no interference was observed
Ascorbic Acid (L-Ascorbic Acid)	5.25 mg/dL
β – Hydroxybutyric Acid	62.46 mg/dL
Bilirubin	40 mg/dL
Bromide	21.7 mg/dL (2.5mmol/L)
Cholesterol	400 mg/dL
Creatinine	15 mg/dL
Dopamine (Dopamine Hydrochloride)	0.0621mg/dL
Ethanol	600 mg/dL
Fluoride (Lithium Fluoride)	0.12 mg/dL
Formaldehyde	0.399 mg/dL
Fructose	18 mg/dL
Galactose	60 mg/dL
Gentisic Acid	1.5 mg/dL
Gentamicin	3 mg/dL
Glucosamine (Glucosamine Hydrochloride)	0.647 mg/dL
Glutathione, reduced	3 mEq/L
Glycolic Acid	76.05 mg/dL
Guaifenesin	0.45 mg/dL
Hemoglobin	1000 mg/dL
Heparin (sodium heparin)	330 U/dL
Ibuprofen	21.9 mg/dL
Intralipid 20%	3151 mg/dL
Lactate (lithium lactate)	90 mg/dL
Maltose	360 mg/dL
Mannose	18.02 mg/dL
Nithiodote (sodium thiosulfate)	264.04 mg/dL
pH	8.0 pH units
Pyruvate (lithium pyruvate)	5 mg/dL
Salicylate (lithium salicylate)	2.86 mg/dL
Thiocyanate (lithium thiocyanate)	5.22 mg/dL
Triglyceride	1500 mg/dL
Uric Acid	23.5 mg/dL
Xylose	45.04 mg/dL

For those substances that on initial screening were found to interfere with the glucose results, dose response testing was conducted to establish the concentration limit below which no significant interference is expected. The results are given in the table below:

Substance	Interference Concentration Resulting in the Shift in the Glucose Test Concentration	Glucose Results Shift Direction
Lithium bromide	≥ 15.88 mmol/L	Decreased glucose results
Hydroxyurea	≥ 0.08 mmol/L	Increased glucose results
Isoniazid*	≥ 0.29 mmol/L	Increased glucose results

*Isoniazid interferes at low glucose concentration.

The sponsor included the following statements in the labeling:

- Bromide at 2.5 mmol/L is the peak plasma concentration associated with halothane anesthesia, in which bromide is released.

- Hydroxyurea is a DNA synthesis inhibitor used in the treatment of sickle cell anemia, HIV infection, and various types of cancer. The malignancies that it is used to treat include melanoma, metastatic ovarian cancer, and chronic myelogenous leukemia. It is also used in the treatment of polycythemia vera, thrombocythemia, and psoriasis. At typical doses ranging from 500 mg to 2 g/day, concentrations of hydroxyurea in a patient's blood may be sustained at approximately 0.1 to 0.5 mmol/L (100 to 500 µmol/L). Higher concentrations may be observed soon after dosing or at higher therapeutic doses.

The sponsor conducted studies to assess the effect of oxygen on the i-STAT G cartridge (white) on the i-STAT 1 System. Protocols and results were reviewed and found acceptable to support that the test is insensitive to oxygen levels between 21 and 515 mmHg.

The sponsor conducted studies to assess the effect of hematocrit on the i-STAT G cartridge (white) on the i-STAT 1 System. Protocols and results were reviewed and found acceptable to support that the test is insensitive to hematocrit levels between 15% to 75%.

The sponsor conducted studies to assess the effect of altitude on the i-STAT G cartridge (white) on the i-STAT 1 System. Protocols and results were reviewed and found acceptable to support that the test yields accurate results up to approximately 10,000 feet above sea level.

4. Assay Reportable Range:

   See section A.2 Linearity.

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

   Traceability
   The glucose assay on the i-STAT G cartridge is traceable to the U.S. National Institute of Standards and Technology (NIST) standard reference material SRM965.

Sample Stability
A study was conducted to verify the whole blood sample stability after sample collection with and without anticoagulants for the i-STAT G cartridge (white) on the i-STAT 1 Analyzer. The results support the sponsor's sample stability claims.

6. Detection Limit:

Detection capability studies of limit of blank (LoB), limit of detection (LoD), and limit of quantification (LoQ) for i-STAT G Glucose test on the i-STAT G cartridge (white) with the i-STAT 1 analyzer were conducted following the recommendations in CLSI EP17-A2.

The LoB was evaluated for the i-STAT G cartridge (white) using lithium heparin whole blood samples altered to create blank samples. The samples were tested across three days using two lots of the i-STAT G cartridge (white). The LoB for each lot was calculated following the EP17-A2 guideline. The higher of the two LoB values from each lot is reported as the LoB.

The LoD was evaluated using lithium heparin venous whole blood samples that were altered to create four (4) samples with low concentrations of glucose. Each of the low samples was measured using 20 i-STAT G cartridges (white) from each of two (2) cartridge lots. The LoD was calculated for each lot following the EP17-A2 guideline. The higher of the two LoD values from each lot is reported as the LoD.

The LoQ was evaluated using lithium heparin venous whole blood samples that were altered to create four (4) samples with low concentrations of glucose. Each sample was measured in twelve (12) replicates per lot across two i-STAT G cartridge lots. The LoQ was calculated for each of the two lots. The LoQ was defined as the greater of the two lots at which the lowest concentration met the pre-defined total error goal, i.e., ≤ 6 mg/dL.

The results from all studies are summarized in the table below:

Analyte	Measuring Range	LoB	LoD	LoQ
Glucose	20 -700 mg/dL	0 mg/dL	0.7 mg/dL	14 mg/dL

7. Assay Cut-Off:

Not Applicable.

B Comparison Studies:

1. Method Comparison with Predicate Device:

A method comparison study was conducted following the recommendations in CLSI EP09c-3rd ed guideline.

Lithium heparin arterial (n=173) (6.1% contrived samples) and venous whole blood (n=164) specimens collected across three (3) point of care sites were evaluated for glucose using the i-STAT G cartridge (white) on the i-STAT 1 analyzer and the i-STAT CHEM8+ cartridge on

the i-STAT 1 analyzer (comparative method). A Passing-Bablok linear regression analysis was performed using the first replicate result from the i-STAT G cartridge (white) on the i-STAT 1 analyzer versus the mean result of the comparative method. Accuracy results for arterial and venous whole blood specimens are shown in the table below.

	N	i-STAT G Range (mg/dL)	Comparative Devices Range (mg/dL)	Slope	Intercept	r	Claimed Measuring range (mg/dL)
Venous	164	23-680	22-682	1.00	1.50	1.00	20-700
Arterial	173	69-518	66-511	1.00	1.00	1.00	20-700

Capillary whole blood specimens (n=234) (4.7% contrived samples and samples from neonates) collected from skin punctures with balanced heparin capillary tubes from each study subject across multiple point of care sites were tested for glucose using the i-STAT G cartridge (white) on the i-STAT 1 analyzer and the epoc Blood Analysis System (comparator method, k200107). A Passing-Bablok linear regression analysis was performed using the singlicate result from the i-STAT G cartridge (white) versus the singlicate result of the comparative method. Accuracy results for capillary whole blood specimens are shown in the table below.

	N	i-STAT G Range (mg/dL)	Comparative Device Range (mg/dL)	Slope	Intercept	r	Claimed Measuring range (mg/dL)
Capillary blood (all samples)	234	27-678	21-676	1.00	2.00	1.00	20-700
Capillary blood (native samples only)	223	47-483	49-459	1.00	2.00	0.99	

2. Matrix Comparison:

The sponsor has provided the information to support that the glucose in the i-STAT G cartridge (white) on the i-STAT 1 System can be performed using lithium heparin, K_2 EDTA, K_3EDTA and non-anticoagulant venous and arterial whole blood. The assay can also be used for testing heparinized capillary whole blood.

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:

Expected values for the glucose assay on the i-STAT G cartridge (white) are cited from literature*:

Age	Reference Range ** (mg/dL)
Premature	20 – 60
Neonate	30 – 60
Newborn 1 day	40 – 60
Newborn > 1 day	50 – 80
Child	60 – 100
Adult	70 – 105

**for serum specimens

*P. C. Painter, J. Y. Cope, J. L. Smith, "Reference Ranges, Table 41-20" in Tietz Textbook of Clinical Chemistry – Second Edition, C.A. Burtis and E.R. Ashwood, eds.

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.