

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

A. 510(k) Number:

k070984

B. Purpose for Submission:

Modifications to previously 510(k) cleared glucose test strips.

The modifications are as follows: change in reagent formulation, decrease sample volume, expansion of the hematocrit range to 20%-70%, and change in strip artwork and color.

C. Measurand:

Whole blood glucose

D. Type of Test:

Quantitative, utilizing glucose dehydrogenase technology

E. Applicant:

Abbott Diabetes Care Inc.,

F. Proprietary and Established Names:

Precision[®] Point of Care Blood Glucose Test Strips and
Optium[®] Point of Care Blood Glucose Test Strips

G. Regulatory Information:

1. Regulation section:

21 CFR 862.1345

2. Classification:

Class II

3. Product code:

LFR, NBW

4. Panel:

75 (Chemistry)

H. Intended Use:

1. Intended use(s):

See Indications for use below.

2. Indication(s) for use:

The Precision[®] and Optium[®] Point of Care Blood Test Strips quantitatively measure glucose (D-glucose) in fresh neonatal, venous, arterial, and fingertip capillary whole blood. The test strips are for use outside the body (*in vitro* diagnostic use) by healthcare professionals for use in healthcare facilities with either the Precision Xtra or Optium Blood Glucose Monitoring Systems. Home users may use the system for capillary samples only. The test strips are not for use in diagnosis or screening of diabetes mellitus, but to be used as an aid in monitoring the effectiveness of diabetes control programs.

3. Special conditions for use statement(s):

For professional and home use

In the package insert the manufacturer has stated the following limitations:

1. “If the test fails to start, sufficient blood sample may not have been applied to the test strip. Discard the current test strip, and repeat with new strip.”
2. “Xylose may produce falsely elevated glucose results during a xylose absorption test for diagnostic evaluation of malabsorption”
3. Test results may be erroneously low if the patient is severely dehydrated, severely hypotensive, in shock or in a hyperglycemic-hyperosmolar state (with or without ketosis). Similar observations have been reported in the literature for other blood glucose monitoring systems.

4. Special instrument requirements:

Precision Xtra or Optium Blood Glucose meter (the sponsor claims that these meters are identical except for the name).

I. Device Description:

The Precision[®]/ Optium[®] Point of Care Blood Glucose Test Strips contain the following reagents in their strips: glucose dehydrogenase (GDH-NAD) $\geq 0.03\text{U}$, NAD + (as sodium salt) $\geq 1.0\ \mu\text{g}$, phenanthroline quinine $\geq 0.02\ \mu\text{g}$, non-reactive ingredients $\geq 16.3\mu\text{g}$.

J. Substantial Equivalence Information:

1. Predicate device name(s):

Precision[®]/ Optium[®] Point of Care Blood Glucose Test Strips

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

k021960

3. Comparison with predicate:

Similarities and Differences of the candidate and the predicate Blood Glucose Test Strips		
Item	Precision/Optium Point of Care Blood Glucose Test Strips (Predicate device) k021960	Precision/Optium Point of Care Blood Glucose Test Strips (Candidate device)
Intended Use	Professional and Home Use	Same
Assay Time	20 seconds	Same
Sample Volume	2.5 µl	0.6 µl
Second Application Time	30 seconds	None- In the package insert the users were told the following: “If the test fails to start, sufficient blood sample may not have been applied to the test strip. Discard the current test strip, and repeat with new strip.”
Meter platforms	Precision Xtra or Optium glucose meters	Same
Dynamic range	20-500 mg/dL	Same
Hematocrit range	20-70% for glucose range <300 mg/dL; 20-60% for glucose range >300 mg/dL	20-70% across the dynamic range
Enzyme	Glucose Dehydrogenase	Same
Cofactor	Nicotinamide Adenine Dinucleotide	Same

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

1. CLSI EP5-A, *Evaluation of Precision Performance of Clinical Chemistry Devices; Approved Guideline.*
2. CLSI EP7-A2 *Interference Testing in Clinical Chemistry; Approved Guideline- Second edition*
3. CLSI EP9-A2 *Method Comparison and Bias Estimation Using Patient Samples; Approved Guideline Second edition*
4. ISO 15197:2003, *In Vitro Diagnostic Test Systems – Requirements for Blood Glucose Monitoring Test Systems for Self Managing Diabetes Mellitus*

L. Test Principle:

The test principal of this device is based on amperometric biosensor technology, by determination of glucose oxidized by the enzyme (Glucose Dehydrogenase, GDH)

catalyzed reaction with Nicotinamide Adenine Dinucleotide (NAD). The reduced form of NAD (NADH) is re-oxidized by reaction with the electrochemical mediator, 1,10 phenanthroline quinone (1,10PQ). The reduced mediator is re-oxidized via electron transfer at the electrode surface. This current is translated into a number by the meter, after applying lot specific information from the ROM calibrator and after a 20 second count-down; a concentration value is then presented to the user.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. Precision/Reproducibility:

A precision study were performed to assess the precision and repeatability of the Precision POC modified test strips responses using venous whole blood concentrations between 30 and 350 mg/dL (spiked samples). Blood samples were collected from healthy donors into tubes that contained heparin. Four Precision meters and three lots of blood glucose test strips were tested with 20 replicates on one day. The precision of all three lots of the test strips was shown below:

Level	Mean of glucose (mg/dL)	Within-run (SD)	% CV
1	29.9	1.5	5.0
2	51.0	1.8	3.6
3	92.3	3.1	3.4
4	140.2	4.6	3.3
5	217.9	6.7	3.1
6	343.7	10.2	3.0

In addition, precision and repeatability of the modified test strips were tested with controls solutions (low, mid, and high). Four Precision meters and three lots of strips were tested in duplicate for each glucose control solution for 20 days. The precision of all three lots of the test strips was shown below:

Glucose control solution level	Mean of glucose (mg/dL)	Within-run (SD)	Total imprecision (SD)	Total % CV
Low	40.9	1.8	2.2	5.4
Mid	83.6	4.2	5.1	6.1
High	272.9	3.2	4.2	1.5

b. Linearity/assay reportable range:

A linearity study was performed using capillary whole blood samples collected from 24 donors. The capillary samples were spiked to varying glucose concentrations, distributed throughout the testing range. Three lots of blood

glucose test strips were tested in duplicate with each blood sample. Ranges of samples tested were from 26 to 495 mg/dL. YSI glucose analyzer was used as a reference method. The linear regression of all three lots is shown below:

$$Y = 0.98X - 3.0, r = 0.995, N = 288, (X = \text{YSI method}, Y = \text{Meter})$$

In addition, the sponsor performed a dynamic range study to evaluate the glucose values at the extreme ranges. Glucose levels at concentrations of 10, 20, 500, 600, and 700 mg/dL were tested between the YSI method and the glucose meters. When the YSI glucose level tested at 24 mg/dL, the glucose meters read 22 mg/dL (N=30).

The dynamic range study and the linearity study support the sponsor's claim that the linearity range of the modified test strips is 20 to 500 mg/dL.

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

No change to traceability. The Precision POC blood glucose test strip is traceable to YSI which employs NIST SRM 917b reference material.

d. Detection limit:

See linearity/reportable range studies above.

e. Analytical specificity:

i.) An interference study was performed to determine the effect of 27 potential interference substances. Blood samples were obtained in heparinized tubes, pooled and then spiked to a glucose level of approximately 100 mg/dL. Stock solutions of the potential interferents were prepared and spiked into the tested pool sample with different concentrations. The % bias was calculated based on the differences between the spiked sample and the control pool sample. The sponsor's acceptance criterion is $\leq 13\%$ bias for not significant interference. All the interference substances tested met the sponsor's acceptance criterion except for xylose; therefore, the sponsor put a warning in the limitation section of the package insert.

"Xylose may produce falsely elevated glucose results during a xylose absorption test for diagnostic evaluation of malabsorption"

ii.) A hematocrit study was performed to evaluate the hematocrit variation effect of the modified test strips. Oxygenated venous blood samples with up to 6 different Hct levels (10, 15, 20, 45, 55, and 70%) were prepared and used. Four different glucose target concentrations of oxygenated venous blood concentrations (35, 60, 90, and 400 mg/dL) were prepared. The % difference between the glucose strips results and YSI results were calculated and summarized as follows:

% difference between strip and YSI reference at HCT of 20%:

Target Glucose Level (mg/dL)	35 mg/dL		50 mg/dL		90 mg/dL	400 mg/dL
Range of Glucose by YSI (mg/dL)	36.3 – 41.4		52.5 – 61.5		94.8 – 111.0	402.5 – 486.3
Lot1	-5.2%	-2.0 mg/dL	6.4%	3.8 mg/dL	-0.1	9.6
Lot2	-18.0%	-7.0 mg/dL	-8.6%	-5.1 mg/dL	-7.0	1.9
Lot3	-17.9%	-7.0 mg/dL	-9.4%	-5.5 mg/dL	-8.0	4.2
All lots	-13.7%	-5.3 mg/dL	-3.9%	-2.3 mg/dL	-5.0	5.2

% difference between strip and YSI reference at HCT of 45%:

Target Glucose Level (mg/dL)	35 mg/dL		50 mg/dL		90 mg/dL	400 mg/dL
Range of Glucose by YSI (mg/dL)	36.3 – 41.4		52.5 – 61.5		94.8 – 111.0	402.5 – 486.3
Lot1	-13.0%	-4.8mg/dL	-11.8%	-6.7mg/dL	-6.5	-4.6
Lot2	-24.7%	-9.2mg/dL	-21.8%	-12.4mg/dL	-12.4	-9.1
Lot3	-26.8%	-9.9mg/dL	-23.8%	-13.6mg/dL	-12.5	-10.0
All lots	-21.5%	-8.0mg/dL	-19.1%	-10.9mg/dL	-10.4	-7.9

% difference between strip and YSI reference at HCT of 70%:

Target Glucose Level (mg/dL)	35 mg/dL		50 mg/dL		90 mg/dL	400 mg/dL
Range of Glucose by YSI (mg/dL)	36.3 – 41.4		52.5 – 61.5		94.8 – 111.0	402.5 – 486.3
Lot1	-25.3%	-10.1mg/dL	-15.3%	-8.9mg/dL	-12.8	-17.6
Lot2	-30.4%	-12.2mg/dL	-21.1%	-12.1mg/dL	-17.7	-18.6
Lot3	-33.3%	-13.3mg/dL	-22.4%	-12.7mg/dL	-18.8	-19.6
All lots	-29.6%	-11.9mg/dL	-19.6%	-11.2mg/dL	-16.4	-18.6

In addition, the sponsor calculated the mean % bias of the hematocrits from the reference Hct of 45%. The results are summarized in the table below:

Mean difference (% mean bias) from the 45% Hct:

Glucose Target range	Lot	20% Hct	45% Hct	70% Hct
35 mg/dL	Lot 1	8%	0%	-12%
	Lot 2	7%	0%	-6%
	Lot 3	9%	0%	-6%
	All lots	8%	0%	-8%
50 mg/dL	Lot 1	18%	0%	-12%
	Lot 2	13%	0%	-6%
	Lot 3	14%	0%	-6%
	All lots	15%	0%	-8%

90 mg/dL	Lot 1	6%	0%	-12%
	Lot 2	5%	0%	-6%
	Lot 3	4%	0%	-6%
	All lots	5%	0%	-8%
400 mg/dL	Lot 1	14%	0%	-12%
	Lot 2	11%	0%	-6%
	Lot 3	14%	0%	-6%
	All lots	13%	0%	-8%

The sponsor claimed that the reportable hematocrit range was 20%-70% for the modified glucose test strips.

- iii.) An altitude study was performed to determine the accuracy of the modified strips at 7,200 ft above sea level. Capillary samples were taken from 63 subjects and tested on the Precision POC test strips and the YSI glucose analyzer. The glucose concentration range tested was 48-410 mg/dL and the hematocrit range was 31-56 %. The Passing Bablok regressions results were as follows:

Results (Y) vs. YSI reference method (X):

$$Y = 0.91X + 5.68, r = 0.98, N=54$$

The overall accuracy according to the ISO acceptance criteria were as follow:

98.1% (106/108) of results fall within ± 15 mg/dL of YSI reference at glucose concentrations < 75 mg/dL and within $\pm 20\%$ of YSI reference at glucose concentrations ≥ 75 mg/dL.

- iv.) A temperature and humidity testing was performed to determine the effects of variation in temperature and humidity on the response of Precision POC test strips with spiked venous blood samples. Testing was conducted using six Precision glucose meters against the YSI glucose analyzer. Three lots of blood glucose test strips were tested with 12 replicate strips per blood glucose level (50, 90, and 350 mg/dL) and environmental condition (temperatures at 15, 25, and 40°C; humidity at 10, 50, and 90%). The % difference from the control condition (24°C/50%) between the glucose strips results and YSI results were calculated and summarized as follows:

Target glucose level (mg/dL)	Temp. (°C)	Humidity (%)	Test strip lot			
			Lot 1	Lot 2	Lot 3	All lots
50	15	10	-2mg/dL	-2mg/dL	-2mg/dL	-2mg/dL
		90	-1mg/dL	0mg/dL	0mg/dL	-1 mg/dL
	40	10	-1mg/dL	-2mg/dL	-2mg/dL	-2mg/dL
		90	6mg/dL	4mg/dL	3mg/dL	4mg/dL
90	15	10	-4%	-3%	-3%	-4%
		90	0%	2%	3%	3%
	40	10	-7%	-9%	-8%	-8%
		90	2%	-3%	-1%	-2%
350	15	10	-14%	-12%	-13%	-13%
		90	-5%	-2%	-3%	-3%
	40	10	0%	-2%	-4%	-3%
		90	7%	5%	7%	6%

The sponsor claimed that the temperature between 15-40 °C (59°-104°F) and humidity between 10- 90% provides acceptable glucose results.

f. Assay cut-off:

Not applicable.

2. Comparison studies:

a. Method comparison with predicate device and reference method:

183 lay persons with diabetes in three different clinics performed a finger-stick test using the modified test strips on the Precision glucose meter. A trained operator then performed a second finger-stick on the patient and tested on the same glucose meter. In addition, the trained operator also performed a veni-puncture to obtain a venous sample from the patient. Venous samples were analyzed on the YSI analyzer (reference method). The glucose concentration range tested was 39-485 mg/dL and the hematocrit range was 25-56 %. The linear regressions results were as follows:

Lay user's results (Y) vs. YSI reference method (X):

$$Y = 0.94X + 1.64, r = 0.98, N=156$$

Trained operator's results (Y) vs. YSI reference method (X):

$$Y = 0.92X + 2.78, r = 0.99, N=156$$

In addition, system accuracy based on ISO 15197 acceptance criteria was calculated. Number and % of results within ± 15 mg/dL (for glucose <75 mg/dL) or within $\pm 20\%$ (for glucose ≥ 75 mg/dL) of YSI reference by User:

User	Within 15 mg/dL or 20%
Lay user	(152/156) 97.4%
Trained operator	(155/156) 99.4%

b. Matrix comparison:

i.) Neonate blood samples were conducted with 175 patients in a clinic against a laboratory plasma method. Capillary samples from the neonates were run in duplicate with 3 different lots of test strips. The glucose concentration range tested was 31-123 mg/dL and the hematocrit range was 27-66%. The linear regressions results were as follows:

Neonate capillary sample (Y) vs. laboratory plasma method (X):

$$Y = 1.08X - 13.70, r = 0.96, N=330$$

The overall accuracy according to the ISO acceptance criteria for the neonate samples was as follow:

95.5% (315/330) of results fall within ± 15 mg/dL of YSI reference at glucose concentrations < 75 mg/dL and within $\pm 20\%$ of YSI reference at glucose concentrations ≥ 75 mg/dL.

Since the neonatal clinical samples did not cover the claimed measuring range, results from a study of spiked samples with high glucose concentrations and varying hematocrits were provided by the sponsor to demonstrate acceptable performance using ISO acceptance criteria. See Hematocrit study above.

ii.) Venous blood samples using EDTA and heparin samples were conducted with 144 patients against the YSI reference method. The glucose concentration range tested was 70-540 mg/dL (by YSI) and the hematocrit range was 20-50%. The Passing Bablok regressions were as follows:

Regression Results against YSI by Strip Lot

Tube	Lot	Slope	Intercept (mg/dL)	Slope 95% confidence interval	Intercept 95% confidence interval	r	N
EDTA	Lot 1	0.96	12.50	0.93 to 0.98	9.19 to 15.53	0.99	190
	Lot 2	0.92	9.39	0.89 to 0.95	6.29 to 13.72	0.99	190
	Lot 3	0.93	9.56	0.90 to 0.95	5.53 to 13.07	0.99	190
Heparin	Lot 1	0.96	13.06	0.93 to 0.99	10.21 to 15.73	0.99	184
	Lot 2	0.94	8.52	0.91 to 0.97	4.86 to 11.73	0.99	184
	Lot 3	0.93	8.52	0.90 to 0.96	4.82 to 11.88	0.99	184

The overall accuracy according to the ISO acceptance criteria for the EDTA samples was as follow:

98.9% (564/570) of results fall within ± 15 mg/dL of YSI reference at glucose concentrations < 75 mg/dL and within $\pm 20\%$ of YSI reference at glucose concentrations ≥ 75 mg/dL.

The overall accuracy according to the ISO acceptance criteria for the heparin samples was as follow:

98.7% (545/552) of results fall within ± 15 mg/dL of YSI reference at glucose concentrations < 75 mg/dL and within $\pm 20\%$ of YSI reference at glucose concentrations ≥ 75 mg/dL.

- iii.) Arterial blood samples were conducted with 120 patients in a clinic against a laboratory method and the YSI reference method. The glucose concentration range tested was 43-311 mg/dL (by YSI) and the hematocrit range was 19-50%. The linear regressions results were as follows:

Regression Results against YSI by Strip Lot

Lot	Slope	Intercept (mg/dL)	Slope 95% confidence interval	Intercept 95% confidence interval	r	N
Lot 1	1.00	3.87	0.98 to 1.03	0.38 to 7.11	0.98	234
Lot 2	0.99	0.40	0.95 to 1.03	-4.07 to 5.02	0.97	234
Lot 3	0.97	-0.76	0.93 to 1.00	-4.98 to 3.92	0.97	233

The overall accuracy according to the ISO acceptance criteria were as follow:

99.0% (694/701) of results fall within ± 15 mg/dL of YSI reference at glucose concentrations < 75 mg/dL and within $\pm 20\%$ of YSI reference at glucose concentrations ≥ 75 mg/dL.

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):

See section 2a above.

4. Clinical cut-off:

Not applicable

5. Expected values/Reference range:

Expected blood glucose levels for people without diabetes (referenced from American Diabetes Association Clinical Practice Recommendations):

The expected glucose range for a non-diabetic, non-pregnant fasting adult is ≤ 100 mg/dL (5.6 mmol/L). Two hours after meals is ≤ 140 mg/dL (7.8 mmol/L).

N. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Part 809.10.

O. Conclusion:

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