

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

A. 510(k) Number:

k072369

B. Purpose for Submission:

New device

C. Measurand:

Whole blood glucose

D. Type of Test:

Quantitative

E. Applicant:

HMD Biomedical LLC

F. Proprietary and Established Names:

Evolution Blood Glucose Monitoring System

G. Regulatory Information:

1. Regulation section:
21 CFR §862.1345, Blood Glucose Test System
21 CFR §862.1660, Quality control material
2. Classification:
Class II (assay)
Class I, reserved (control material)
3. Product code:
NBW, system, test, blood glucose, over the counter
CGA, glucose oxidase, glucose
JJX, single (specified) analyte controls
4. Panel:
Clinical Chemistry (75)

H. Intended Use:

1. Intended use(s):
See indications for use below.
2. Indication(s) for use:
The Evolution Blood Glucose Testing System is for the quantitative measurement of the concentration of glucose in whole blood taken from fingertip, ventral palm, dorsal hand, upper arm, forearm, calf and/or thigh by diabetic patients or health care professionals as an aid in the management of diabetes. Evolution Blood Glucose Testing System is for in vitro diagnostic use and is not to be used for the diagnosis of diabetes or for neonatal use. Alternate site testing should be done during steady state times when glucose is not changing rapidly.
3. Special conditions for use statement(s):
For over-the-counter use.

The device should not be used for patients who are dehydrated, in shock, critically ill or in a hyperosmolar state.

Not for use with newborns.

Alternate site testing (AST) can only be used during steady-state blood glucose conditions. AST should only be performed under the following conditions:

- Testing before a meal
- In a fasting state
- Two hours or more after a meal
- Two hours or more after insulin dosing
- Two hours after physical activity

4. Special instrument requirements:
Evolution Blood Glucose Meter

I. Device Description:

The Evolution Blood Glucose Monitoring System consists of: the Evolution Blood Glucose Meter, Test Strips, and three levels of Control Solutions (sold separately).

These products have been designed and tested to work together as a system to produce accurate blood glucose test results. The sponsor recommends that only Evolution test strips and control solutions be used with the Evolution meter. The performance of the test strips is verified by the control solutions. A color tag on the back of the test strips provides lot specific calibration information. No calibration by the user is required.

J. Substantial Equivalence Information:

1. Predicate device name(s):
Lifescan One Touch Ultra
2. Predicate 510(k) number(s):
k021819
3. Comparison with predicate:

Similarities		
Item	Device	Predicate
Detection method	Amperometry: current is generated by oxidation of reduced mediator	Amperometry
Enzyme	Glucose Oxidase	Glucose Oxidase
Test Range	20 – 600 mg/dL	20 – 600 mg/dL
Electrode	Carbon electrode	Carbon electrode
Opened Strip Stability	3 months	3 months
Humidity	10 – 90%	10 – 90%

Differences		
Item	Device	Predicate
Mediator	Hexaammineruthenium(III)Chloride	Potassium ferricyanide
Sample Volume	0.3 ul	1 ul
Test Time	3 seconds	5 seconds
Coding	Automatic	Button
Hematocrit Range	20 – 60%	30 – 55%
Memory Capacity	365 tests	150 tests
Temperature Range	50 - 104°F	43 - 111°F
Size: L x W x H (mm)	76 x 56 x 18	80 x 57 x 21
Weight	45 gr	42 gr

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

ISO 15197:2003: In vitro diagnostic test systems - Requirements for blood-glucose monitoring systems for self-testing in managing diabetes mellitus

CLSI EP5-T2, Precision Performance of Clinical Chemistry Devices

CLSI EP6-P2, Evaluation of the Linearity of Quantitative Analytical Methods; Proposed Guideline

CLSI EP7-P: Interference Testing in Clinical Chemistry; Proposed Guideline

CLSI EP9-T: Method Comparison and Bias Estimation Using Patient Samples; Approved Guideline

L. Test Principle:

The Evolution blood glucose test is based on measurement of electrical current caused by the reaction of glucose with the reagents on the electrode of the test strip. The blood sample is drawn into the end of the test strip through capillary action. Glucose in the sample reacts with glucose oxidase and hexaammineruthenium (III) chloride, generating a current that is proportional to the glucose concentration in the sample. The result is shown on the meter display.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. *Precision/Reproducibility:*

Within-run Precision was measured by using EDTA anti-coagulated whole blood to prepare samples at five different glucose concentrations. Each sample was tested 50 times. Results are summarized below:

HMD Evolution BGM: Within-run Precision

Sample	Mean (mg/dL)	Std. Dev (mg/dL)	% CV
Level 1	44.8	1.9	4.2
Level 2	88.8	2.4	2.7
Level 3	128.5	3.9	3.0

Sample	Mean (mg/dL)	Std. Dev (mg/dL)	% CV
Level 4	215.5	6.1	2.8
Level 5	373.8	11.5	3.1

Between-day precision was measured by reading three different control materials in duplicate twice a day for 20 days (n = 80). Results are summarized below:

HMD Evolution BGM: Between Day Precision

Sample	Mean (mg/dL)	Std. Dev (mg/dL)	% CV
Low	50.4	1.0	2.0
Normal	106.8	1.2	1.2
High	305.7	3.6	1.2

b. Linearity/assay reportable range:

Heparinized venous whole blood was spiked or glycolyzed to 11 concentrations between 27 mg/dL and 552 mg/dL (confirmed by YSI) then tested with the Evolution and YSI. Each dilution was tested five times by the Evolution method and in duplicate by YSI. Regression analysis showed a linear relationship between the Evolution and the YSI method: $y = 1.005x - 1.852$, $R = 0.999$

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

The sponsor provided the traceability and value assignment procedure for control solutions used in this device. They are prepared at three target concentrations by gravimetric addition of glucose to an aqueous matrix. The glucose concentration of the control solutions are verified with the YSI reference method and expected values are verified for each new manufactured lot of strips.

Shelf life studies show that the unopened test strips have a 26 month life-span and 3 months shelf-life once a vial of strips is opened. Unopened controls have a 26 month shelf life and are stable for 3 months after first use.

d. Detection limit:

The sponsor's studies support their claimed detection limit of 20 mg/dL.

e. Analytical specificity:

The sponsor evaluated the effect of hematocrit on whole blood samples spiked with five hematocrit levels (between 20 – 60%) at eight glucose concentrations between 44 - 567 mg. These values were compared to values from an YSI-2300 analyzer. The results indicated that bias introduced at hematocrit levels between 20% and 60% was within $\pm 12\%$.

Temperature and humidity studies were performed and showed that the device can be used from 50 – 104°F (10 to 40°C) and from 10% to 90% relative humidity. An altitude study was performed and demonstrated that meter performance was unaffected by altitudes $\leq 10,000$ feet.

Common interferences were evaluated by spiking venous blood with glucose to two concentrations. Each of these glucose concentrations was then spiked with the interfering compound at two concentrations to make the interference samples. Control samples were each spiked with the solvents used to make the interfering samples. For the common interfering compounds shown below, no interference effects were observed up to the concentration listed. No compound showed interference of $\geq \pm 11\%$.

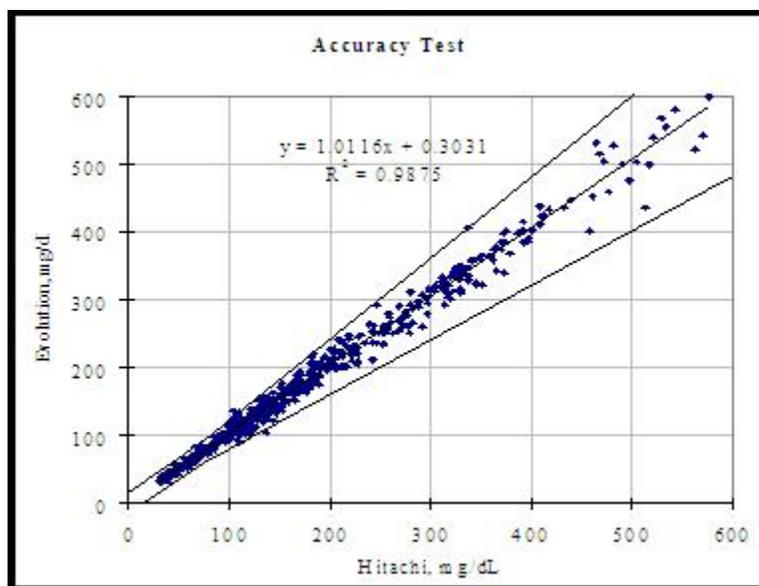
Compound	Concentration	Compound	Concentration
Acetaminophen	≤ 20 mg/dL	Levodopa	≤ 4 mg/dL
Ascorbic acid	≤ 3 mg/dL	Maltose	≤ 300 mg/dL
Bilirubin	≤ 40 mg/dL	Methyldopa	≤ 2.5 mg/dL
Cholesterol	≤ 500 mg/dL	Tetracycline	≤ 0.4 mg/dL
Creatinine	≤ 30 mg/dL	Tolazamide	≤ 5 mg/dL
Dopamine	≤ 13 mg/dL	Tolbutamide	≤ 100 mg/dL
EDTA	≤ 640 mg/dL	Triglycerides	≤ 3000 mg/dL
Galactose	≤ 50 mg/dL	Salicylic Acid	≤ 50 mg/dL
Gentisitic acid	≤ 50 mg/dL	Urea	≤ 500 mg/dL
Glutathione	≤ 1 mg/dL	Uric Acid	≤ 20 mg/dL
Heparin	≤ 100 mg/dL	Xylose	≤ 10 mg/dL
Ibuprofen	≤ 40 mg/dL		

f. *Assay cut-off:*
Not applicable.

2. Comparison studies:

a. *Method comparison with predicate device:*

System accuracy was evaluated by comparing the results 613 fingertip samples spanning the claimed assay range to the results obtained by a Hitachi 747. Samples ranged from 32 – 576 mg/dL and followed the sample distribution recommended in ISO 15197 Section 7.3.1.2. For some of the samples that were less than 40 mg/dL or greater than 400 mg/dL, pooled anti-coagulated capillary whole blood specimen was allowed to hydrolyze or was spiked to the desired glucose levels. Regression analysis of the samples yielded the following results: $y = 1.01x + 0.303$ $R^2 = 0.9875$.



98.7% of the individual samples were within the ISO 15197 criteria specifying 95% of samples are within ± 15 mg/dL when glucose concentration less than 75mg/dL and within $\pm 20\%$ when glucose concentration ≥ 75 mg/dL:

System accuracy results for glucose concentration <75 mg/dL (4.2 mmol/L)		
Within ± 5 mg/dL	Within ± 10 mg/dL	Within ± 15 mg/dL
94/112 (84 %)	110/112 (98 %)	110/112 (98 %)

System accuracy results for glucose concentration ≥ 75 mg/dL (4.2 mmol/L)			
Within $\pm 5\%$	Within $\pm 10\%$	Within $\pm 15\%$	Within $\pm 20\%$
286/501(43%)	438/501 (87%)	483/501 (97%)	495/501(99%)

LAY-USER STUDIES:

The sponsor conducted a series of studies to compare the accuracy of glucose measurement between the lay-user and the healthcare professionals. Studies were performed at three point-of-care (POC) sites and three physician’s office laboratories (POL). At each POC site the lay-user performed a fingerstick, tested their blood with the Evolution meter and recorded the result. A healthcare worker then obtained a capillary blood sample and a venous sample for testing by a reference method (Hitachi 747). At the three POL sites the lay-user performed a fingerstick, tested their blood with the Evolution meter. At Site 1 and 3 they also tested their blood with a One Touch Ultra and an Accu-Chek Active, respectively. At Site 2 a healthcare worker obtained a sample to be tested on an YSI 3000.

All sites met the ISO 15197 acceptability criteria of individual differences within ± 15 mg/dL deviation for glucose concentrations of <75 mg/dL and $\pm 20\%$ deviation for glucose concentrations of ≥ 75 mg/dL.

HMD Evolution: Results of Lay User Studies

Comparison	n =	Range* (mg/dL)	Regression Analysis	R ² value	% within ISO criteria
POC Site 1 (vs. Hitachi)	80	69 – 402	$y = 0.97x + 3.53$	0.974	98.8%
POC Site 2 (vs. Hitachi)	80	70 – 407	$y = 1.04x - 5.44$	0.975	95.0%
POC Site 3 (vs. Hitachi)	80	70 - 425	$y = 0.987x + 2.52$	0.981	97.5%
<i>All POC Sites</i>	<i>240</i>	<i>69 - 425</i>	$y = 1.01x - 0.39$	<i>0.976</i>	<i>97.1%</i>
POL Site 1 (vs. OneTouch)	80	72 – 429	$y = 0.96x + 3.97$	0.993	98.8%
POL Site 2 (vs. YSI)	80	70 – 401	$y = 1.00x + 0.69$	0.992	100%
POL Site 3 (vs. Active)	80	71 - 391	$y = 1.00x + 0.69$	0.993	100%

* by predicate

The sponsor assessed readability of the labeling by recruiting 100 lay users who were provided with the test kit containing labeling for the US market. Participants varied in age, education, country of origin, and were about evenly divided between men and women. Regression analysis of the participant's fingerstick value against a laboratory method (Hitachi 747) yielded the following results: $y = 1.01x - 2.84$, $R^2 = 0.9897$. Results of this study met the ISO 15197 acceptability criteria of individual differences within ± 15 mg/dL deviation for glucose concentrations of < 75 mg/dL and $\pm 20\%$ deviation for glucose concentrations of ≥ 75 mg/dL.

AST STUDIES:

The sponsor conducted alternative site testing (AST) using the ventral palm, the dorsal hand, the forearm, the upper arm, the calf, and the thigh and compared the results to concurrent fingerstick readings. Lay-users vigorously rubbed the alternative site for 5 - 10 seconds (until they felt warming) before obtaining the sample. Regression results are shown below and the percentage of results meeting ISO-15197 acceptance criteria for accuracy.

HMD Evolution: AST Study Results

Comparison	n =	Range (mg/dL)	Regression Analysis	R ² value	% within ISO criteria
Palm vs. finger	126	72 – 445	$y = 1.0094x + 0.747$	0.981	98.4%
Hand vs. finger	144	70 - 489	$y = 0.996x + 0.4019$	0.982	97.9%
Forearm vs. finger	155	71 - 467	$y = 0.9995x + 1.4551$	0.991	99%

Comparison	n =	Range (mg/dL)	Regression Analysis	R ² value	% within ISO criteria
Upper arm vs. finger	116	70 - 453	$y = 0.9978x + 0.3811$	0.992	100%
Calf vs. finger	130	71 - 466	$y = 0.9988x + 1.119$	0.989	98.5%
Thigh vs. finger	144	69 - 434	$y = 0.985x + 2.0998$	0.987	97.9%

b. Matrix comparison:

Not applicable; this device is only indicated for capillary whole blood.

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):

4. Clinical cut-off:

Not applicable.

5. Expected values/Reference range:

The normal fasting adult glucose range for a non-diabetic is 70 – 105 mg/dL. One to two hours after a meal, normal blood glucose levels should be less than 140 mg/dL. A medical professional should determine the range that is appropriate for diabetes patients.

N. Instrument Name:

HMD Evolution Blood Glucose Monitoring System

O. System Descriptions:

1. Modes of Operation:

Each test strip is single use and must be replaced with a new strip for additional readings.

2. Software:

FDA has reviewed applicant's Hazard Analysis and software development processes for this line of product types:

Yes or No

3. Specimen Identification:

There is no sample identification function with this device. Samples are applied directly to the test strip as they are collected.

4. Specimen Sampling and Handling:

This device is intended to be used with capillary whole blood from the finger, ventral palm, dorsal hand, forearm, upper arm, calf, and thigh only. Since the whole blood

sample is applied directly to the test strip there are no special handling or storage issues.

5. Calibration:

A color tag on the back of the test strips provides lot specific calibration information. No calibration by the user is required.

6. Quality Control:

Glucose control solutions at three different concentrations can be run with this device.

When a test strip is inserted into the meter, the control mode can be activated. This prevents control results from being stored in the internal memory. An acceptable range for each control level is printed on the test strip vial label. The user is cautioned not to use the meter if the control result falls outside these ranges.

P. Other Supportive Instrument Performance Characteristics Data Not Covered In the “Performance Characteristics” Section above:

The sponsor demonstrated acceptable performance across the claimed glucose range for blood volumes ≥ 0.3 ul.

Q. Proposed Labeling:

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

R. Conclusion:

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