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

A. 510(k) Number:

k113614

B. Purpose for Submission:

New blood glucose monitoring system combining the Compact Plus meter cleared under k081389 with a new glucose test strip. The new strip uses a modified GDH-PQQ methodology that has reduced reactivity to maltose

C. Measurand:

Capillary whole blood Glucose drawn from the fingertips or palm

D. Type of Test:

Quantitative amperometric assay, glucose dehydrogenase (mutant GDH- PQQ)

E. Applicant:

Roche Diagnostics Corporation

F. Proprietary and Established Names:

ACCU-CHEK Compact Plus Blood Glucose Monitoring System

G. Regulatory Information:

1. Regulation section:

   21 CFR §862.1345, Glucose Test System

2. Classification:

   Class II

3. Product code:

   NBW (System, Test, Blood Glucose, Over The Counter)

   LFR (glucose dehydrogenase, glucose)

4. Panel:

   Clinical Chemistry (75)

H. Intended Use:

1. Intended use(s):

   See Indications for Use below.

2. Indication(s) for use:

   The ACCU-CHEK Compact Plus Blood Glucose Monitoring System is intended to be used for the quantitative measurement of glucose (sugar) in fresh capillary whole blood samples drawn from the fingertips or palm. The ACCU-CHEK Compact Plus Blood Glucose Monitoring System is intended to be used by a single person and should not be shared.

   The ACCU-CHEK Compact Plus Blood Glucose Monitoring System is intended for self-testing outside the body (in vitro diagnostic use) by people with diabetes at home as an aid to monitor the effectiveness of diabetes control. The ACCU-CHEK Compact Plus Blood Glucose Monitoring System should not be used for the diagnosis of or screening of diabetes or for neonatal use. Alternative site testing should be done only during steady - state times (when glucose is not changing rapidly).

   The ACCU-CHEK Compact Plus Test Strips are for use with the ACCU-CHEK Compact Plus Blood Glucose Meter to quantitatively measure glucose (sugar) in fresh capillary whole blood samples drawn from the fingertips or palm.

3. Special conditions for use statement(s):

   For in vitro diagnostic use only
   Not for testing on neonates
   Do not use for diagnosis or screening of diabetes mellitus
   Inaccurate results may occur in “severe dehydration as a result of diabetic ketoacidosis or due to hyperglycemic hyperosmolar non-ketotic syndrome, hypotension, shock, decompensated heart failure NYHA Class IV, or peripheral arterial occlusive disease.”
   Not to be used for patients who are critically ill
   For over – the - counter (single patient use) only and should not be shared
   AST results should not be used to calibrate CGMs or used in insulin dose calculations

4. Special instrument requirements:

   ACCU-CHEK Compact Plus Blood Glucose Meter

I. Device Description:

The ACCU-CHEK Compact Plus Blood Glucose Monitoring System consists of the ACCU-CHEK Compact Plus Meter, ACCU-CHEK Compact Plus Test Strips (17 strips per drum), ACCU-CHEK Compact Plus Clear Control (Level 1 and 2, cleared under k031755), the ACCU-CHEK Softclix Plus Lancing Device (with lancets), Owner's Booklet, Self-Test Diary, and Warranty Card. The test strips and controls are required but not included in the starter kit and must be purchased separately.

J. Substantial Equivalence Information:

1. Predicate device name(s):

   ACCU-CHEK Compact Plus Meter

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

   k081389

3. Comparison with predicate:

Similarities		
Item	Candidate Device	Predicate (k081389)
Intended Use	Same	Quantitative measurement of glucose in whole blood
Test Strip Architecture	Same	Capillary Filling
Strip Delivery	Same	17 strip drum
Detection Principle	Same	Photometric
Reaction Principle	Same	Reduction of blood glucose via mediator and indicator to heteropoly blue
Test Strip Handling	Same	Automatically via meter mechanics
Minimum Sample Volume	Same	1.5 µL

Differences		
Item	Candidate Device	Predicate (k081389 and k031755)
Enzyme	Mutant Q - GDH	GDH-PQQ
Alternate site testing	Palm	Forearm, upper arm, thigh, calf, and palm
Users	Single-patient use only	Single-patient and multiple-patient use
Sample Type	Capillary blood only	Capillary and venous whole blood
Measuring Range	20 - 580 mg/dL	10 - 600 mg/dL
Hematocrit Range	30 – 55%	25 – 55%
Measuring Time	5 seconds	8 seconds
Operating Temperature	53.6 - 104° F (12 – 40° C)	50 - 104° F (10 – 40° C)
Operating Humidity	10 – 80% RH	15 – 85% RH
Altitude	13,123 feet	10, 150 feet

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

- CLSI EP5 – Evaluation of Precision Performance of Quantitative Measurement Methods
- CLSI EP7 - Interference Testing in Clinical Chemistry
- ISO15197:2003- In vitro diagnostic test systems – Requirements for blood-glucose monitoring systems for self-testing in managing diabetes mellitus.

L. Test Principle:

The test is based on electrochemical biosensor technology and the principle of capillary action. The electrical current generated by the reaction of glucose with the reagent of the strip is measured by the meter and is displayed as the corresponding blood glucose level. The strength of the current produced by the reaction depends on the amount of glucose in the blood sample.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

   a. Precision/Reproducibility:

Repeatability Precision (Within Vial)

This study was performed using three lots of test strips and ten meters. Heparinized venous blood samples in five glucose concentration ranges in accordance with EN ISO were prepared. For each strip lot, each venous blood sample was measured 10 times on 10 meters, so that 100 individual measurements were generated in each concentration range. Results are summarized below.

Glucose Concentration Range (mg/dL)	30-50			51-110			111-150		
Strip Lot	1	2	3	1	2	3	1	2	3
Mean (mg/dL)	33.6	34.8	35.7	82.0	84.5	83.4	130.8	130.1	130.8
SD (mg/dL)	2.2	2.6	2.2	2.3	2.2	2.2	2.4	3.2	2.7
CV(%)	6.5	7.5	6.2	2.8	2.6	2.6	1.8	2.5	2.1
n	100	100	100	100	100	100	100	100	100

Glucose Concentration Range (mg/dL)	151-250			251-400		
Strip Lot	1	2	3	1	2	3
Mean (mg/dL)	210.9	209.0	208.0	361.6	350.6	354.2
SD (mg/dL)	4.0	3.5	4.0	5.4	5.5	7.1
CV(%)	1.9	1.7	1.9	1.5	1.6	2.0
n	100	100	100	100	100	100

Intermediate Precision (Day-to-Day)

Intermediate precision was evaluated using three lots of test strips and ten meters. Glucose control solutions in 3 concentration ranges were used. For each test strip lot, each control solution was measured once per day on 10 meters on 10 days, so that 100 individual measurements were generated. Results are summarized below.

Control Level (mg/dL)	1			2			3		
Strip Lot	1	2	3	1	2	3	1	2	3
Mean (mg/dL)	41.4	43.4	42.0	148.6	144.5	139.3	313.4	301.6	288.9
SD (mg/dL)	0.7	0.9	1.3	3.2	3.0	3.9	6.5	8.1	11.8
CV(%)	1.7	2.1	3.0	2.2	2.1	2.8	2.1	2.7	4.1
n	100	100	100	100	100	100	100	100	100

b. Linearity/assay reportable range:

Linearity was evaluated using 11 venous blood samples ranging in glucose concentrations from 22.0 to 581.3 mg/dL (22.0, 35.5, 61.5, 93.0, 161.1, 232.3, 299.3,

373.2, 442.1, 509.5, and 581.3 mg/dL) as measured by the reference method. Each sample was tested once on five different meters for each of three strip lots. The values from the ACCU-CHEK Compact Plus meter were compared with those obtained from the reference method. The results from regression analysis are summarized below:

Lot #1: $y = 0.98x - 0.89$; $r^2 = 1.00$
Lot #2: $y = 0.97x + 0.99$; $r^2 = 1.00$
Lot #3: $y = 0.97x + 0.52$; $r^2 = 1.00$

The results of the study support the sponsor's claimed glucose measurement range of 20 to 580 mg/dL glucose.

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

The ACCU-CHEK Compact Plus Blood Glucose Monitoring System is calibrated to a hexokinase method on a laboratory analyzer. A method comparison was performed using this method as the comparative method. See Comparison studies in 2a below.

The controls recommended for the ACCU-CHEK Compact Plus Blood Glucose Monitoring System were previously cleared under k031755.

Value Assignment and Stability Testing: Two ACCU-CHEK Compact Plus Clear Control solutions are available for use with the ACCU-CHEK Compact Plus Blood Glucose Monitoring System. Value assignment and stability for the control solutions were evaluated in k031755. The shelf life and opened vial stability established in k031755 were 18 months and 3 months, respectively.

The sponsor provided a real-time protocol with acceptance criteria to verify the closed-drum stability (shelf life) and on-board or opened-drum stability of the test strips. The stability protocols and acceptance criteria were reviewed and found to be acceptable. The sponsor claims a closed-drum (shelf life) of 18 months and an on-board or opened-drum stability of 90 days when stored at 36-86° F (2-30° C). The labeling instructs the users not to freeze the test strips.

d. Detection limit:

The reportable range for the system is 20 – 580 mg/dL. This range was verified by the linearity study (M.1.b) above.

e. Analytical specificity:

Potential Interferent	**Concentration at which no significant interference is observed (mg/dL)**
Acetaminophen	20

Ascorbic Acid	3
Cholesterol	500
Creatinine	5
Conjugated Bilirubin	15
Unconjugated Bilirubin	20
Dopamine	0.09
Gentistic acid	1.8
Hemoglobin	200
Ibuprofen	50
L-Dopa	2
Glutathione, reduced	6.14
Maltose	450
Methyl-Dopa	1.5
Tolbutamide	64
Tolazamide	9
Triglycerides	3000
Uric Acid	23.5
Xylose	100

The sponsor has the following limitations in their labeling:

- Blood concentrations of galactose >15 mg/dL will cause overestimation of blood glucose results.
- Intravenous administration of ascorbic acid which results in blood concentrations of ascorbic acid >3 mg/dL will cause overestimation of blood glucose results.

f. Assay cut-off:

Not applicable.

2. Comparison studies:

a. Method comparison with predicate device:

System Accuracy:

To assess system accuracy, results from the ACCU-CHEK Compact Plus Blood Glucose Monitoring System were compared to a reference method, PCA-HK (Hitachi 917). Capillary samples from 100 participants with glucose concentrations ranging from 36-473 mg/dL glucose (obtained using PCA-HK) were analyzed. To obtain blood glucose concentrations <50 mg/dL and >400 mg/dL, samples were allowed to glycolize or were spiked to achieve the desired glucose concentration. Five samples < 50 mg/dL and five samples > 400 mg/dL were analyzed. The results relative to reference are summarized in the tables below:

System Accuracy Results for Glucose Concentrations < 75 mg/dL

Lot No.	Within ± 5 mg/dL	Within ± 10 mg/dL	Within ± 15 mg/dL
1	18 / 19 (95%)	19 / 19 (100%)	19 / 19 (100%)
2	11 / 19 (58%)	19 / 19 (100%)	19 / 19 (100%)
3	18 / 19 (95%)	19 / 19 (100%)	19 / 19 (100%)
combined	47/57 (82%)	57 / 57 (100%)	57 / 57 (100%)

System Accuracy Results for Glucose Concentrations ≥ 75 mg/dL

Lot No.	Within ± 5 %	Within ± 10 %	Within ± 15 %	Within ± 20 %
1	72 / 81 (89%)	81 / 81 (100%)	81 / 81 (100%)	81 / 81 (100%)
2	69 / 81 (85%)	80 / 81 (99%)	81 / 81 (100%)	81 / 81 (100%)
3	68 / 81 (84%)	80 / 81 (99%)	81 / 81 (100%)	81 / 81 (100%)
combined	209/243 (86%)	241 / 243 (99%)	243 / 243 (100%)	243 / 243 (100%)

Linear regression based on single glucose measurements produced the following:

Lot	n	Slope	Slope 95% CI	Intercept	Intercept 95% CI	r
1	100	1.03	1.02, 1.04	-2.0	-4.8, 0.6	0.99
2	100	1.00	0.99,1.02	1.4	-1.3, 4.1	0.99
3	100	0.99	0.97, 1.00	1.5	-1.5,,4.6	0.99

b. Matrix comparison:

User study results with capillary blood from alternate site (palm)

The study was performed at 1 clinical site with samples from 154 subjects using three lots of test strips. After reviewing the system's instructions for use, the subjects collected their own sample from the palm without any practice tests and tested their blood glucose using the Accu-Chek Compact Plus system. A healthcare professional then obtained a result from the patient's palm using the Accu-Chek Compact Plus system. In one instance a healthcare provider result was not obtained, resulting in a sample size of 153. Finally, a healthcare professional collected a sample from the finger to be tested on the hexokinase reference method. The results relative to reference are summarized in the tables below:

Untrained user results for glucose concentrations <75 mg/dL

Within ±5 mg/dL	Within ±10 mg/dL	Within ±15 mg/dL
11/26 (42%)	22/26 (85%)	26/26 (100%)

Untrained user results for glucose concentrations >75 mg/dL

Within ±5%	Within ±10%	Within ±15%	Within ±20%
49/128 (38%)	94/128 (73%)	117/128 (91%)	127/128 (99%)

Linear regression analysis results based on single glucose measurements collected by untrained users are summarized below:

n	Range of values mg/dL	Slope	Slope 95% CI	Intercept	Intercept 95% CI	r	Std. Error
154	43 – 361 mg/dL	1.067	1.039 – 1.097	-0.768	-4.227 – 3.289	0.990	6.460

Healthcare professional results for glucose concentrations <75 mg/dL

Within ±5 mg/dL	Within ±10 mg/dL	Within ±15 mg/dL
21/25 (84%)	25/25 (100%)	25/25 (100%)

Healthcare professional results for glucose concentrations >75 mg/dL

Within ±5%	Within ±10%	Within ±15%	Within ±20%
70/128 (55%)	114/128 (89%)	126/128 (98%)	128/128 (100%)

Linear regression analysis results based on single glucose measurements collected by healthcare professionals are summarized below:

n	Range of values mg/dL	Slope	Slope 95% CI	Intercept	Intercept 95% CI	r	Std. Error
153	43 – 361 mg/dL	1.043	1.023 – 1.063	-0.079	-2.556 – 1.649	0.993	5.282

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):

User study with capillary blood from the fingertip

To assess the performance of the Accu-Chek Compact Plus Blood Glucose Monitoring System in the hands of the intended users, the sponsor performed a study with 204 untrained lay user participants. After reviewing the system's instructions for use, the subjects performed their own fingerstick without any practice tests and tested their blood glucose using the Accu-Chek Compact Plus system. Immediately afterwards, a healthcare professional collected another fingerstick sample to be tested on the hexokinase reference method. The study was performed at 2 clinical sites using three lots of test strips. The results relative to reference are summarized in the tables below

Linear regression analysis results based on single glucose measurements are summarized below:

n	Range of values mg/dL	Slope	Slope 95% CI	Intercept	Intercept 95% CI	r	Std. Error
204	50 - 564	0.982	0.963-1.001	1.463	-1.250-3.772	0.991	8.554

System accuracy results for glucose concentration <75 mg/dL

Within ±5 mg/dL	Within ±10 mg/dL	Within ±15 mg/dL
26 / 31 (84%)	29 / 31 (94%)	31 / 31 (100%)

System accuracy results for glucose concentration >75 mg/dL

Within ±5%	Within ±10%	Within ±15%	Within ±20%
98 / 173 (57%)	156 / 173 (90%)	168 / 173 (97%)	173 / 173 (100%)

4. Clinical cut-off**:**

Not applicable.

5. Expected values/Reference range:

The sponsor states the following in their labeling:

Expected Values

The normal fasting glucose level for an adult without diabetes is below 100 mg/dl [1, 2.] . Two hours after meals, the normal blood glucose level for a non-diabetic adult is less than 140 mg/dl [2.]

References:

[1]American Diabetes Association: Diagnosis and Classification of Diabetes Mellitus (Position Statement). Diabetes Care 34 (Supp. 1) S66, 2011
[2]Tietz Fundamentals of Clinical Chemistry, 6th Edition, Edited by Burtis CA and Ashwood ED, W. B. Saunders Co., Philadelphia, PA, 2008, p. 849

N. Instrument Name:

ACCU-CHEK Compact Plus Blood Glucose Meter

O. System Descriptions:

1. Modes of Operation:

   Each test strip is single use and requires a sample volume of 1.5 uL.

   Does the applicant's device contain the ability to transmit data to a computer, webserver, or mobile device?

   Yes __X__or No _____

   Does the applicant's device transmit data to a computer, webserver, or mobile device using wireless transmission?

   Yes __X__or No _____

2. Software:

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

   Yes ____X____ 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 and palm. The whole blood sample is applied directly to the test strip by capillary action.

5. Calibration:

   The bar code on the label of the strip drum is automatically read by the meter. No manual coding is required.

6. Quality Control:

   Controls are not included in the ACCU-CHEK Compact Plus Blood Glucose Monitoring System starter kit, but the starter kit box labeling explains how users can obtain two levels of controls. The labeling also provides recommendations on when to test control materials. The meter cannot distinguish between blood samples and controls but control results can be stored in memory. An acceptable range for each control level is printed on the test strip vial label. If the control values fall outside these ranges, the user is referred to a troubleshooting chart which includes information on how to contact the Customer Care Service Center.

P. Other Supportive Instrument Performance Characteristics Data Not Covered In The "Performance Characteristics" Section above:

1. Hematocrit study

   In this study, three strip lots were tested singly on ten meters at the following hematocrit levels: 30, 35, 40, 45, and 55%. The glucose levels in venous blood samples fell into six categories: 20 – 30, 50 – 70, 100 – 150, 300 – 400, and 500 – 600 mg/dL. A single replicate was obtained for each combination of test strip, glucose level, and hematocrit. This resulted in n = 750 data points (5 glucose levels x 5 hematocrit levels x 10 replicates per sample x 3 strip lots). Glucose concentrations were verified by the sponsor's reference method. The bias relative to the reference method was acceptable to support the claim that hematocrit levels of 30 to 55% do not significantly affect the glucose results.

2. Sample Volume Study

   The sponsor performed a sample volume study to support the claimed minimum sample volume requirement for the ACCU-CHEK Compact Plus system (1.5 µL) using blood samples at three glucose concentration ranges (30 - 60, 80 - 120, and 400 - 580 mg/dL). The system displays an error code when insufficient sample is detected. Results support the claimed sample volume of 1.5 µL.

3. Altitude Study

   In this study, three test strip lots were tested on ten meters with blood samples adjusted to three glucose concentrations: 30 - 60, 80 - 120, and 400 - 580 mg/dL. The samples were tested at three altitude levels: sea level, 8202 feet (2500 meters), and at 13,123 feet (4000 meters). In each concentration range, a total of 50 measurements were performed on 10 meters at each test altitude with each of the 3 test strip lots. Glucose concentrations were verified by the sponsor's reference method. The bias relative to the reference method was acceptable to support the claim that altitudes up to 13, 123 feet do not significantly affect the glucose results.

4. Temperature and Humidity Studies

   In this study, three test strip lots were tested on five meters at three glucose concentrations at seven combinations of temperature and humidity. The temperatures tested were 53.6, 57, 86, and 104° F (12, 14, 30, and 40° C). The relative humidity levels tested were 10, 45, and 80%. Glucose concentrations were verified by the sponsor's reference method. The bias relative to the reference method was acceptable to support the claim that temperatures from 53.6 - 104° F (12 – 40° C) and relative humidities from 10 – 80% do not significantly affect the glucose results.

5. Infection Control studies

   The ACCU-CHEK Compact Plus Blood Glucose Monitoring System is intended for single-patient use only. Disinfection efficacy studies were performed on the materials comprising the meter by an outside commercial testing lab demonstrating complete inactivation of hepatitis B Virus (HBV) with the chosen disinfectant, Super Sani-Cloth Germicidal Disposable Wipes (EPA Reg. No. 9480-4). Robustness studies were also performed by the sponsor demonstrating that there was no change in performance or external materials of the meter after 260 cleaning and disinfection cycles, using Super Sani-Cloth Germicidal Disposable Wipes, to simulate 5 years of use by lay users. Labeling has been reviewed for adequate instructions in validated cleaning and disinfection procedures.

6. Electromagnetic Compatibility (EMC) testing.

   The ACCU-CHEK Compact Plus meter in this submission is identical to the meter cleared under k081389, which passed the testing requirements of IEC/EN 61326, IEC/EN 61326-A1, and IEC/EN 61326+A1-3.

7. Readability Assessment

   Flesch-Kincaid readability assessment was conducted for the meter user's manual and test strip package insert and were found to be 6.8 and 8.0, respectively.

8. Customer Service

   The Customer Care Service Center is available 24/7, 365 days a year. The toll free phone number is 1-800-858-8072.

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.