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

A. 510(k) Number:

k160944

B. Purpose for Submission:

New device

C. Measurand:

Capillary whole blood from fingertip, palm, and upper arm

D. Type of Test:

Quantitative amperometric assay, glucose dehydrogenase (FAD-GDH)

E. Applicant:

Roche Diabetes Care, Inc.

F. Proprietary and Established Names:

ACCU-CHEK Guide Blood Glucose Monitoring System
ACCU-CHEK Guide Control Solutions

G. Regulatory Information:

1. Regulation section:
   21 CFR 862.1345, glucose test system
   21 CFR § 862.1660, single (specified) analyte controls (assayed and unassayed)

2. Classification:
   Class II
   Class I, reserved

3. Product code:
   NBW, System, Test, Blood Glucose, Over the Counter
   LFR, Glucose Dehydrogenase, Glucose
   JJX, Quality Control Material (assayed and unassayed)

4. Panel:
   Clinical Chemistry (75)

H. Intended Use:

1. Intended use(s):
   See Indications for Use below.

2. Indications(s) for use:

   The ACCU-CHEK Guide blood glucose monitoring system is comprised of the ACCU-CHEK Guide meter and the ACCU-CHEK Guide test strips.

   The ACCU-CHEK Guide blood glucose monitoring system is intended to quantitatively measure glucose in fresh capillary whole blood from the fingertip, palm, and upper arm as an aid in monitoring the effectiveness of glucose control.

   The ACCU-CHEK Guide blood glucose monitoring system is intended for in vitro diagnostic single-patient use by people with diabetes.

   The ACCU-CHEK Guide blood glucose monitoring system is intended to be used by a single person and should not be shared.

   This system is not for use in diagnosis or screening of diabetes mellitus, nor for neonatal use. Alternative site testing should be done only during steady-state times (when glucose is not changing rapidly).

   ACCU-CHEK Guide Control Solutions are for use with the ACCU-CHEK Guide Blood Glucose Monitoring System to check that the meters and test strips are working together properly and that the test is performing correctly.

3. Special conditions for use statement(s):
   - Not for use in diagnosis or screening of diabetes mellitus.
   - Not for neonatal use.
   - Not for use on critically ill patients, patients in shock, dehydrated patients or hyper-osmolar patients.
   - Do not use Alternate Site Testing to calibrate a continuous glucose monitoring system or to make insulin dosing calculations.
   - Alternate site testing should be done only during steady-state times (when glucose is not changing rapidly).
   - Do not use the meter system to measure blood glucose in people who are experiencing cardiovascular collapse (severe shock) or decreased peripheral blood flow.
   - Do not use the meter at high hematocrit levels above 65% or low hematocrit levels below 10%.
   - This system has not been tested at altitudes higher than 10,150 feet.

4. Special instrument requirements:

   ACCU-CHEK Guide Meter

I. Device Description:

The ACCU-CHEK Guide System consists of the following:

- ACCU-CHEK Guide meter with batteries
- ACCU-CHEK Guide test strips (may be sold separately)
- ACCU-CHEK Guide control solutions (may be sold separately)

Each box of ACCU-CHEK Guide control solutions contains one vial (2.5 mL) of each of the 2 buffered aqueous solutions containing D-glucose: Level 1 and Level 2. These control solutions were previously cleared in k043474 as ACCU-CHEK Aviva Control Solutions.

J. Substantial Equivalence Information:

1. Predicate device name(s):

   ACCU-CHEK Aviva Connect Blood Glucose Monitoring System
   ACCU-CHEK Aviva Control Solutions

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

   k141867
   k043474

3. Comparison with predicate:

Similarities		
Item	Candidate Device (k160944)	Predicate (k141867)
Brand Name	ACCU-CHEK Guide	ACCU-CHEK Aviva Connect
Indications for Use/Intended Use	Intended to quantitatively measure glucose (sugar) in fresh capillary whole blood samples as an aid in monitoring the effectiveness of glucose control.	Same
Test Principle	Amperometric detection	Same
Measurement range	20-600 mg/dL	Same
Sample volume	0.6 µL	Same
Hematocrit range	10-65%	Same
Coding	None	Same
Connectivity	USB for PC connectivity and BLE (Bluetooth Low Energy) for wireless	Same

Similarities		
Item	Candidate Device (k160944)	Predicate (k141867)
	connectivity	
Auto Control Solution Identification	Yes	Same

Differences		
Item	Candidate Device (k160944)	Predicate (k141867)
Brand Name	ACCU-CHEK Guide	ACCU-CHEK Aviva Connect
Enzyme	FAD-GDH	Mut. Q-GDH
Alternate Site Testing	Palm and Upper arm	None
Operating Temperature Range	43-113°F (6 - 45 °C)	57-100°F (14 - 38 °C)
Operating Relative Humidity Range	10 – 90%	10 – 80%
Maximum Altitude claim	Up to 10,150 feet	Up to 10,000 feet

Similarities and Differences		
Item	Candidate Device (k160944)	Predicate (k043474)
Brand Name	ACCU-CHEK Guide control solutions	ACCU-CHEK Aviva control solutions
Indications for Use/Intended Use	For use to check that the meters and test strips are working together properly and that the test is performing correctly.	Same
Control Level	2 levels	Same
Control Type	Aqueous	Same
Unopened Shelf-life	24 months	Same

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

- CLSI EP7-A2, Interference Testing in Clinical Chemistry; Approved Guideline.
- IEC 60601-1-2 Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral Standard: Electromagnetic disturbances - Requirements and tests, 4th edition.

L. Test Principle:

The enzyme on the test strip, an FAD-dependent glucose dehydrogenase (GDH) expressed in Aspergillus Oryzae, converts the glucose in the blood to gluconolactone. This reaction creates a DC electrical current that the meter interprets for the blood glucose result. The sample and the environmental conditions are evaluated using AC and DC signals.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. Precision/Reproducibility:

Repeatability studies were performed with venous whole blood samples at 5 glucose concentration ranges using 3 test strip lots and 10 ACCU-CHEK Guide meters. Ten runs were performed on each sample with 10 replicates per strip lot resulting in a total of 100 replicates collected for each test strip lot and each glucose level tested. Results are summarized below:

Glucose Level	30-50 (mg/dL)			50-110 (mg/dL)			110-150 (mg/dL)		
Test Strip Lot	1	2	3	1	2	3	1	2	3
Mean (mg/dL)	40.3	40.3	40.9	81.7	81.2	82.4	131.9	131.2	133.3
SD	1.4	1.3	1.3	2.1	2.0	1.8	2.4	2.8	2.6
CV%	3.5	3.2	3.2	2.5	2.4	2.2	1.8	2.1	2.0
N	100	100	100	100	100	100	100	100	100

Glucose Level	150-250 (mg/dL)			250-400 (mg/dL)		
Test Strip Lot	1	2	3	1	2	3
Mean (mg/dL)	206.0	204.4	209.6	330.2	328.1	332.4
SD	5.0	5.8	4.0	8.5	9.6	7.2
CV%	2.4	2.8	1.9	2.6	2.9	2.2
N	100	100	100	100	100	100

Intermediate precision was evaluated using three glucose linearity solutions, Level 2, Level 3, and Level 4 using 3 test strip lots and 10 ACCU-CHEK Guide meters. One run was performed on each of ten days with each glucose linearity solution in10 replicates per strip lot, resulting in a total of 100 replicates collected for each test strip lot and each glucose linearity solution tested. Results are summarized below:

Glucose Linearity solution	Level 2			Level 3			Level 4		
Test Strip Lot	1	2	3	1	2	3	1	2	3
Mean (mg/dL)	45.2	44.8	44.6	116.4	116.9	116.6	298.1	297.8	296.5
SD	1.4	1.4	1.4	2.6	2.5	3.3	6.6	6.6	7.2
CV%	3.1	3.1	3.1	2.2	2.2	2.8	2.2	2.2	2.4
N	100	100	100	100	100	100	100	100	100

b. *Linearity/assay reportable range:*

Linearity was evaluated using 3 test strip lots and 36 ACCU-CHEK Guide meters by testing 10 venous blood samples with glucose concentrations ranging from 14 to 603.2 (14, 38.8, 60.8, 89.7, 123.4, 155.7, 198.8, 289, 449.4, 603.2) mg/dL. One run (across all 36 meters) was performed with each sample using each of the strip lots. The values from the ACCU-CHEK Guide meter were compared with those obtained from the reference method. The results from regression analysis are summarized below:

Lot #1: $y=0.974x+0.097$; $R^2 = 0.998$
Lot #2: $y=0.955\ x+0.51$; $R^2 = 0.998$
Lot #3: $y=0.957\ x+1.55$; $R^2 = 0.998$

The results of the study support the sponsor's claimed glucose measurement range of 20 to 600 mg/dL. The meter will display "LO" when the result is less than 20 mg/dL and "HI" when result is greater than 600 mg/dL. The sponsor validated the "LO" and "HI" functions and demonstrated that they functioned as intended.

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

Traceability: According to the sponsor, the ACCU-CHEK Guide system is traceable to the NIST SRM 917 glucose reference material. A method comparison was performed using the candidate device and a perchloric acid hexokinase method (PCA-HK, Roche Cobas c 501) as the reference method (see Section 2.a.)

Value Assignment for Control Solutions: The previously cleared (k043474) ACCU-CHEK Aviva control solutions (Levels 1 and 2) are available for use with the ACCU-CHEK Guide test system as ACCU-CHEK Guide Control Solutions. Value assignment for the control solutions is established for the ACCU-CHEK Guide test system and is based on the mean of repeated measurements compared to the established target values for each level. The control solution ranges are printed on the test strip vial label.

Control Solution Stability: Protocols and acceptance criteria for open vial and closed vial (shelf-life) stability for the control solutions were previously reviewed and found to be acceptable under k043474. The labeling claims are 24 month shelf life stability and 3 month open-vial stability when stored at the recommended storage temperatures of 36°F to 90°F (2°C to 32°C). Labeling instructs the user not to freeze the solutions.

Test Strip Stability: The protocols and acceptance criteria for the ACCU-CHEK Guide test strips were reviewed and found to be acceptable. The sponsor claims that both closed-vial (shelf life) and open-vial stability are up to 18 months when stored at the recommended storage temperatures of 39-86°F (4-30°C) and 10-90% RH. The labeling instructs the users not to freeze the test strips.

d. Detection limit:

The reportable range for the ACCU-CHEK Guide Blood Glucose Monitoring System is 20 to 600 mg/dL. This range was verified by the linearity study (M.1.b).

e. Analytical specificity:

To assess potential interference the sponsor used venous whole blood samples adjusted to 3 different glucose levels of 70, 120 and 250 mg/dL, split into a control sample and a test sample. Various endogenous and exogenous substances were then added to the test sample only. The % difference between the test and control sample was calculated and the concentration tested at which no significant interference was observed is presented in the table below:

Potential Interfering Substance	Concentration at which no significant interference is observed (mg/dL)		Potential Interfering Substance	Concentration at which no significant interference is observed (mg/dL)
Acetaminophen	20		L-Dopa	2
Ascorbic acid	5		Maltitol	20.2
Bilirubin (unconjugated)	60		Maltose	360
Cholesterol	500		Mannitol	600
Creatinine	30		Methyl Dopa	1.5
Dopamine	0.09		Pyridinealdoxime Methiodide (PAM)	25
Galactose	300		Salicylic Acid	60
Gentisic Acid	1.8		Sorbitol	70
Glutathione (reduced)	6.14		Tolazamide	200
Hemoglobin	1000		Tolbutamide	100
Heparin (Li)	8000 U/dL		Triglycerides	1800
Ibuprofen	50		Uric Acid	23.5
Lactitol	100		Xylitol	200

The sponsor has the following limitations in their labeling:

- Abnormally high concentrations of ascorbic acid (vitamin C) resulting in blood concentration in excess of 5 mg/dL may cause inaccurate results. If you are not sure please check with your doctor.
- Do not use this system during xylose absorption test.

f. Assay cut-off:

Not Applicable

2. Comparison studies:

a. *Method comparison with predicate device:*
To assess system accuracy, results from the ACCU-CHEK Guide Blood Glucose Monitoring System were compared to a reference method, PCA-HK (Roche Cobas c 501). Capillary samples from 361 participants with glucose concentrations ranging from 47.3-410.1 mg/dL glucose obtained on the reference were measured using one of three test strip lots by a technician. The natural sample results relative to reference are summarized in the tables below:

ACCU-CHEK Guide vs. Reference for natural fingerstick samples
For glucose concentrations <75 mg/dL

within ± 5 mg/dL	within ± 10 mg/dL	within ± 15 mg/dL
9/11 (81.8%)	11/11 (100%)	11/11 (100%)

For glucose concentrations ≥ 75 mg/dL

within ± 5 %	within ± 10 %	within ± 15 %	within ± 20 %
239/350 (68.3%)	342/350 (97.7%)	350/350 (100%)	350/350 (100%)

Linear regression results ACCU-CHEK Guide capillary vs. whole blood PCA-HK reference (N=361):

$Y=0.94X + 3.44$, $r=0.996$

b. *Matrix comparison:*
Not Applicable

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 Performance Study:
To assess the performance of the ACCU-CHEK Guide Blood Glucose Monitoring System in the hands of lay users the sponsor performed a study with 120 lay user participants. Results were analyzed by comparing blood glucose results from finger stick samples using the ACCU-CHEK Guide meter obtained by the lay users against the reference method value (PCA-HK). The samples ranged from 60.3 to 457.7

mg/dL as measured by the reference method. The results are summarized in the tables below:

Lay-user finger stick results ACCU-CHEK Guide vs. PCA-HK reference:

For glucose concentrations <75 mg/dL

within ± 5 mg/dL	within ± 10 mg/dL	within ± 15 mg/dL
8/12 (66.7%)	12/12 (100%)	12/12 (100%)

For glucose concentrations ≥ 75 mg/dL

within ± 5 %	within ± 10 %	within ± 15 %	within ± 20 %
63/108 (58.3%)	103/108 (95.4%)	107/108 (99.1%)	108/108 (100%)

Regression Analysis finger stick results ACCU-CHEK Guide vs. PCA-HK reference by lay users:
Y = 0.95X+3.56; r =0.994

All 120 lay users were provided with labeling for the ACCU-CHEK Guide blood glucose monitoring system. No other training or prompting was provided to the subjects. The subjects then performed their own capillary finger stick and dosed one ACCU -CHEK Guide test strip without any assistance from the technician. After testing was completed, the subjects then filled out a questionnaire regarding their experience with the testing and product labeling. The study demonstrated success in the operation of the ACCU -CHEK Guide glucose system in the hands of lay users.

Alternative Site Test (Palm Site) by Lay Users:
Alternate Site study at palm site was performed by a total of 372 volunteers. Each lay user measured his/her own samples, while another blood sample from each lay user was also collected by a technician and measured by the reference method (PCA-HK). The samples ranged from 48.6 to 457.7 mg/dL as measured by the reference method. The results are summarized in the tables below:

Lay-user Palm Results Guide vs. PCA-HK reference:

For glucose concentrations <75 mg/dL

within ± 5 mg/dL	within ± 10 mg/dL	within ± 15 mg/dL
8/9 (88.9%)	9/9 (100%)	9/9 (100%)

For glucose concentrations ≥ 75 mg/dL

within ± 5 %	within ± 10 %	within ± 15 %	within ± 20 %
175/363 (48.2%)	308/363 (84.8%)	356/363 (98.1%)	362/363 (99.7%)

Regression Analysis palm results ACCU-CHEK Guide vs. PCA-HK reference by lay users:
Y = 0.94X+2.00; r =0.991

Alternative Site Test (Upper Arm Site) by Lay Users:
Alternate Site study at upper arm site was performed by a total of 365 volunteers who had hematocrit between 30 and 53%. Each lay user measured his/her own samples, while another blood sample from each lay user was also collected by a technician and measured by the reference method (PCA-HK). The samples ranged from 49.9 to 410.2 mg/dL as measured by the reference method. The results are summarized in the tables below:

Lay-user Upper Arm Results Guide vs. PCA-HK reference:

For glucose concentrations <75 mg/dL

within ± 5 mg/dL	within ± 10 mg/dL	within ± 15 mg/dL
7/10 (88.9%)	10/10 (100%)	10/10 (100%)

For glucose concentrations ≥ 75 mg/dL

within ± 5 %	within ± 10 %	within ± 15 %	within ± 20 %
156/355 (43.9%)	281/355 (79.2%)	337/355 (94.9%)	351/355 (98.9%)

Regression Analysis upper arm results ACCU-CHEK Guide vs. PCA-HK reference by lay users:
Y = 0.91X+5.25; r =0.978

4. Clinical cut-off:
   Not Applicable

5. Expected values/Reference range:

Time of day	People without diabetes
Fasting and before meals	<100 mg/dL
2 hours after meals	<140 mg/dL

American Diabetes Association: Classification and Diagnosis of Diabetes. Sec. 2. Standards of Medical Care in Diabetes-2016. Diabetes Care, 39, (Suppl. 1), S13-S22, 2016.

N. Instrument Name:

ACCU-CHEK Guide Blood Glucose Meter

O. System Description:

1. Modes of Operation:

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

   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 _____.

   The applicant has provided documentation that indicates the device was designed and developed under good software life-cycle processes.

3. Specimen Identification:

   Samples are applied directly to the test strip as they are collected. The ACCU-CHEK Guide meter memory stores up to 720 glucose test results with the time and date of the test and up to 32 control solutions results.

4. Specimen Sampling and Handling:

   This device is intended to quantitatively measure glucose in fresh capillary whole blood from the finger, psalm and upper arm. There is not patient identification with this system.

5. Calibration:

   The meter does not require calibration or coding by the user.

6. Quality Control:
   The ACCU-CHEK Guide Control Solutions are used as quality control checks to make sure that the ACCU-CHEK Guide system and ACCU-CHEK Guide test strips are working correctly. The labeling provides instructions on when quality control testing should be performed. Once the control solution result is displayed on the meter a control bottle symbol and a flashing L are displayed prompting the user to select the control solution level that was used.

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

1) Hematocrit study:
The effect of different hematocrit levels was evaluated using venous whole blood samples with hematocrit levels of 10 – 65% (10,15, 20, 25, 30, 45, 50, 55, 60, and 65%) spiked with glucose to achieve target concentrations of 40, 80, 127, 200, and 360 mg/dL. A total of 30 replicates were performed on 30 ACCU-CHEK Guide meters for each combination of strip lot, glucose concentration, and hematocrit level. The results demonstrated that the ACCU CHEK Guide Blood Glucose Monitoring System produces accurate results over the claimed hematocrit range of 10 – 65%.

2) Altitude study:
To evaluate the effects of altitude on the Guide system results, venous blood samples from three donors were altered to 5 glucose concentrations (60, 110, 160, 350 and 500 mg/dL) and tested at 10,150 feet above sea level. The meter results were compared to those obtained with the reference method (PCA-HK). The results demonstrate acceptable bias to the reference to support the claims in the labeling that altitudes up to 10,150 feet have no significant effect on blood glucose measurements from the ACCU-CHEK Guide Blood Glucose Monitoring System.

3) Temperature and humidity studies:
The sponsor performed temperature and humidity studies using venous blood samples at target glucose concentrations of 70, 120, and 250 mg/dL to evaluate temperatures ranging from 39-113°F (4-45°C) and relative humidity from 10-90%. Six combinations of the claimed temperature and humidity operating conditions, including low temperature/low humidity, high temperature/low humidity, low temperature/high humidity, and high temperature/high humidity conditions, were evaluated and meter results compared to a reference method. The results support the claimed range of operating conditions: 43-113°F (6-45°C) and 10-90% relative humidity.

4) Sample volume study:
The sponsor performed a sample volume study with 24 ACCU-CHEK Guide meters to support the claimed minimum sample volume requirement of 0.6 µL using blood samples at three glucose concentrations (45, 120, 450 mg/dL). The system displays an error code when insufficient sample is detected. Results support the claimed sample volume of 0.6 µL and demonstrate that insufficient sample volume error function is effective.

5) Infection Control Studies:
The device is intended for single-patient use. Disinfection efficacy studies were performed on the materials comprising the meter by an outside commercial testing laboratory demonstrating complete inactivation of hepatitis B virus (HBV) with the chosen disinfectant, Super Sani-Cloth (EPA registration #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

(representing weekly disinfection for 5 years, the expected lifetime of the meter). The subject device labeling was reviewed for adequate instructions for the validated cleaning and disinfection procedures.

6) The sponsor provided appropriate documentation certifying that electromagnetic (EMC) testing was performed and the ACCU-CHEK Guide Blood Glucose Monitoring Systems was found to be compliant.

7) ACCU-CHEK Customer Care Service Center is available 24 hours a day, 365 day a year by calling 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.