

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

**A. 510(k) Number:**

k071493

**B. Purpose for Submission:**

New Device

**C. Measurand:**

Whole blood glucose

**D. Type of Test:**

Quantitative amperometric assay

**E. Applicant:**

TaiDoc Technology Corporation

**F. Proprietary and Established Names:**

Clever Chek TD-4209, Clever Chek TD-4222, Clever Chek TD-4225 Blood Glucose Monitoring Systems

**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

CGA - Glucose Oxidase, Glucose

4. Panel:

75 (Clinical Chemistry)

**H. Intended Use:**

1. Intended use(s):

See Indications for use below.

2. Indication(s) for use:

Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System is intended for use in the quantitative measurement of glucose in fresh capillary whole blood from the finger and the following alternative sites: the palm, the forearm, the upper-arm, the calf and the thigh. It is intended for use by healthcare professionals and people with diabetes mellitus at home as an aid in monitoring the effectiveness of diabetes control program. It is not intended for the diagnosis of or screening for diabetes mellitus.

The alternative site testing in the Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System can be used only during steady-state blood glucose conditions.

Professionals may use the Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System to test neonatal blood from the heel, but may not be used in screening for neonatal hypoglycemia.

3. Special conditions for use statement(s):

For over-the-counter (OTC) use

The alternative site testing in the Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System can be used only during steady-state blood glucose conditions.

Alternative site testing (AST) should ONLY be used in the following intervals:

- In a pre-meal or fasting state (more than 2 hours since the last meal)
- Two hours or more after taking insulin
- Two hours or more after exercise

Warnings in the labeling include the following statements:

- Inaccurate results may occur in severely hypotensive individuals or patients in shock
- Inaccurate low results may occur for individuals experiencing a hyperglycemic-hyperosmolar state, with or without ketosis
- Critically ill patients should not be tested with glucose meters

4. Special instrument requirements:

Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Meters

**I. Device Description:**

The Clever Chek TD-4209, Clever Chek TD-4222 and Clever Chek TD-4225 Blood Glucose Monitoring Systems each consist of four main products: the blood glucose meter, test strips (including the “check & code” strip), control solutions (2 levels of Taidoc control solution – cleared under k012430), and the lancet device (cleared under k833344). 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 TaiDoc test strips and control solutions specified in the manual be used with the blood glucose meters. The performance of the test strips is verified by the control solutions. The check & code strip verifies the status of the meter.

**J. Substantial Equivalence Information:**

1. Predicate device name(s):

Accu-Chek Aviva Blood Glucose Test System; Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System

2. Predicate 510(k) number(s):  
k060620; k062235

3. Comparison with predicate:

#### **Similarities**

Item	Device	Predicate (Accu-chek Aviva)
Intended Use	Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System is intended for use in the quantitative measurement of glucose in fresh capillary whole blood from the finger and the following alternative sites: the palm, the forearm, the upper-arm, the calf and the thigh. It is intended for use by healthcare professionals and people with diabetes mellitus at home as an aid in monitoring the effectiveness of diabetes control program. It is not intended for the diagnosis of or screening for diabetes mellitus. The alternative site testing in the Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System can be used only during steady-state blood glucose conditions. Professionals may use the Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System to test neonatal blood from the heel, but may not be used in screening for neonatal hypoglycemia.	The ACCU-CHEK Aviva Test Strips are used with the ACCU-CHEK Aviva meter. The ACCU-CHEK Aviva test system is designed to quantitatively measure the concentration of glucose for monitoring glucose in the home or in health care facilities. Testing sites include traditional fingertip site along with palm, forearm, upper arm, thigh, and calf. Professionals may use the test strips to test capillary, venous, arterial, and neonatal blood; home use is limited to capillary whole blood testing.
Detection method	Amperometry	Amperometry
Test Strip calibration	Code strip	Code key

#### **Differences**

Item	Device	Predicate (Accu-chek Aviva)
Test range	20 – 600 mg/dL	10 – 600 mg/dL
Enzyme	Glucose oxidase	Glucose dehydrogenase
Sample volume (µl)	0.7 µl	0.6 µl
Storage condition	39.2°F-104°F/4°C-40°C Below 85% RH	36°F-90°F/2°C-32°C
Coding	Code strip	Code strip
Reaction time	7	5
Hematocrit	20-60%	20-70%

The sponsor also compared the Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 Blood Glucose Monitoring System cleared under k062235. The sponsor claims that the only difference is the test strip, TD-4306 in the new device to TD-4302 cleared under k062235.

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

- CLSI EP5-A2: Evaluation of Precision Performance of Quantitative Measurement Methods: Second Edition
- CLSI EP6-A: Evaluation of the Linearity of Quantitative Measurement Procedures: A Statistical Approach; Approved Guideline
- CLSI EP9-A: Method Comparison and Bias Estimation Using Patient Samples; Approved Guideline
- ISO 15197: In vitro diagnostic test systems - Requirements for blood-glucose monitoring systems for self-testing in managing diabetes mellitus
- ISO 14971: Medical Devices – Application of risk management to medical devices

**L. Test Principle:**

Once a whole blood sample is applied to the sample chamber of the test strip, the process of glucose measurement commences. Glucose measurement is based on electrical potential caused by the reaction of glucose with the reagents contained on the strip's electrodes. The glucose in the sample is oxidized by the enzyme glucose oxidase, producing gluconic acid. The electrical current resulting from this enzymatic reaction is measured and converted to glucose concentration by the meter. The magnitude of the current is proportional to the concentration of glucose in the sample.

**M. Performance Characteristics (if/when applicable):**

1. Analytical performance:

*a. Precision/Reproducibility:*

The sponsor evaluated within-day precision of the device using whole blood samples spiked with five different glucose concentrations, three different reagent lots, and 10 different TD-4209 glucose meters. Each combination of multivariate factors was evaluated using 10 measurements. Day-to-day precision was evaluated using three glucose control solutions with concentration levels, low, normal, and high. The day-to-day precision was evaluated over a ten-day period using three different reagent lots and ten TD-4224 glucose meters. The summary of test results is presented below.

**Repeatability (within-day precision)**

Sample level (mg/dL)	No. of Assay	Mean (mg/dL)	SD (mg/dL)	CV (%)
30-50	100	41.8	2.03	4.85
51-110	100	91.1	2.76	3.03
111-150	100	143.0	3.53	2.47
151-250	100	239.6	6.65	2.77
251-400	100	364.6	6.48	1.78

**Reproducibility (day-to-day precision)**

Control Samples	No. of Assays	Mean (mg/dL)	SD (mg/dL)	CV (%)
Low	100	75.9	3.35	4.41
Medium	100	127.9	5.59	4.37
High	100	315.1	11.93	3.79

The test strip TD-4306 provided in the new device is also intended to measure blood glucose levels in neonates, which is a high risk population. To cover the neonate glucose range, with-in day precision using whole blood samples was evaluated for glucose levels at the lower range from 20 to 100 mg/dL prepared with dextrose to obtain five different glucose concentrations. Tests were done for three different reagent lots, and 10 different TD-4209 glucose meters.

Results are summarized in the table below. The sponsor's acceptance criterion is CV less than 5%, however, at glucose level 20-25 mg/dL, the CV is 9.63%.

Sample level (mg/dL)	No. of Assays	Mean (mg/dL)	SD (mg/dL)	CV (%)
20-25	100	27.6	2.65	9.63
30-40	100	41.8	2.03	4.85
50-60	100	56.7	2.74	4.83
70-80	100	81.4	2.95	3.62
90-100	100	91.1	2.76	3.03

**b. Linearity/assay reportable range:**

The sponsor used nine spiked whole blood samples in the range (20-600 mg/dL) as reference values and compared with the values generated from YSI-2300 analyzer. A regression analysis showed linearity of Clever Chek TD-4209, Clever Chek TD-4222, and Clever Chek TD-4225 blood glucose monitoring systems with correlation coefficients ( $R^2$ ) of 0.998, 0.999, and 0.999, and with regression equations  $y = 0.96X + 6.5$ ,  $y = 0.97X + 4.32$ , and  $y = 0.96X + 7.754$ , respectively.

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

The sponsor states that formulation for the control solution does not change from the predicate device previously cleared under k012430. However, the

sponsor provided data to confirm the stability of both strips and control solutions for 90-day period recommended in the package insert. The sponsor included the protocols for strip calibration procedure in the labeling. The sponsor also provided the traceability and value assignment procedure for control solutions used in this device. The sponsor conducted studies to evaluate the in-use stability of the TD-4209 glucose monitoring system at the assigned temperature range of 50°F-104°F (10°C-40°C). Using control solutions at low, medium and high concentration tested at 50°F and 104°F compared with room temperature, results showed <2% CV for all glucose concentrations and met the acceptability criterion (<5% CV).

*d. Detection limit:*

The sponsor has not conducted studies to determine the limit of detection (LOD), however, as supported by linearity studies, the sponsor has established the measuring range of 20 - 600 mg/dL for the Clever Chek TD-4209, Clever Chek TD-4222, and Clever Chek TD-4225 Blood Glucose Monitoring Systems.

*e. Analytical specificity:*

The sponsor tested the following exogenous and endogenous substances for interference. Two glucose levels (75-85 mg/dL and 300 mg/dL) were tested. Interferents and the levels tested were, Acetaminophen (0-20 mg/dL), Ascorbic acid (0-3 mg/dL), Dopamine (0-12.25 mg/dL), Uric acid (0-20 mg/dL), Triglycerides (0-2000 mg/dL), and Bilirubin (0-20 mg/dL). Based on acceptance criterion of a mean glucose difference of  $\pm 10\%$  of the glucose values obtained in the absence of interfering substances, the following conclusions were drawn with regard to interfering substances.

Substance	Test Concentration (mg/dL)	No Interference (mg/dL)	
		Low Glucose level (75-85)	High Glucose level (300)
Acetaminophen	20	5	5
Ascorbic Acid	3	3*	3*
Dopamine	13	2	2
Methyl-Dopa	2.5	0.5	0.75
Bilirubin	20	15	15
Uric acid	20	10	15
Triglycerides	2000	2000*	2000*

\* No interference up to test concentration

The sponsor evaluated the effect of hematocrit levels 20 – 70% on whole blood samples spiked with six hematocrit levels for glucose values (7 levels) distributed within the measuring range (23 - 486 mg/dL) of the device. The values generated were compared with the glucose values from YSI-2300 analyzer. The regression analysis for each hematocrit level is summarized in the table below. Based on the regression analysis and also the sponsor's

acceptability criterion of  $\pm 15$  mg/dL deviation for glucose concentrations of  $< 75$  mg/dL and  $\pm 20\%$  deviation for glucose concentration of  $\geq 75$  mg/dL, the sponsor claimed results generated by the device is comparable to the values of YSI-2300 instrument at hematocrit levels between 20-60%.

Hematocrit %	Slope and Y-intercept	R
20	$y = 1.029x + 6.912$	0.999
30	$y = 1.013x + 2.789$	0.995
38	$y = 0.979x + 0.500$	0.998
45	$y = 1.050x - 4.723$	0.999
60	$y = 0.861x + 6.369$	0.999
70	$y = 0.775x + 6.943$	0.999

To determine the impact of hematocrit levels on neonates, the sponsor used 100 neonate samples with hematocrit level varied from 38 to 68%. Analysis was done using TD-4306 strip (with Clever Chek TD-4222) and the values were compared with the values generated using YSI-2300 glucose analyzer. Results met the sponsors acceptance criteria of 95% of the individual difference is within  $\pm 15$  mg/dL when glucose concentration less than 75 mg/dL and is within  $\pm 20\%$  when glucose concentration  $\geq 75$  mg/dL.

An altitude study was performed with whole blood samples from 20 volunteers (glucose range: 68-157 mg/dL) and 3 control solutions at low, medium and high concentrations. All the controls met the sponsors acceptability criterion of  $CV < 5\%$  for the control solutions measured at sea level and at an altitude of 10,744 feet. The data submitted support use of the device up to 10,744 feet.

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

## 2. Comparison studies:

### *a. Method comparison with predicate device:*

The sponsor demonstrated that the Clever Chek TD-4209/TD-4222/TD-4225 Blood Glucose Monitoring System for finger stick is equivalent to a standard reference method (YSI-2300). Samples from 156 volunteers with glucose concentrations distributed over the range of 21 – 568 mg/dL were evaluated at three different laboratory sites. Percent distribution of the samples corresponding to the glucose concentration ranged as follows: 20-50 mg/dL – 10%; 51-110 mg/dL – 32%; 111- 150 mg/dL – 32%; 151-250 mg/dL – 10%; 251- 400 mg/dL – 10%; and 401-600 mg/dL – 6%. To obtain the blood glucose concentrations less than 40 and more than 400 mg/dL, a pooled capillary whole blood specimen was spiked with the desired glucose levels. Based on data analysis, device met the minimum system accuracy requirement established according to the ISO 15197 guidelines, which is 95% of the

individual difference is within  $\pm 15\text{mg/dL}$  when glucose concentration less than  $75\text{mg/dL}$  and is within  $\pm 20\%$  when glucose concentration  $\geq 75\text{mg/dL}$ . In comparison with YSI-2300, all three laboratory sites showed regression correlation ( $R^2$ ) values ranging between 0.981-0.992. Results for all three sites combined and for each Clever Chek TD-4209/TD-4222/TD-4225 meter using strip TD-4306 are given below.

Clever Chek TD-4209/TD-4222/TD-4225 meters vs. YSI-2300 reference method

Total (N=156)	TD-4209 vs. YSI-2300	TD-4222 vs. YSI-2300	TD-4225 vs. YSI-2300
slope	0.964	0.997	0.984
y=intercept	2.104	2.528	2.994
R square	0.990	0.987	0.989

To demonstrate the accuracy of the device for glucose monitoring in neonates by healthcare professionals, the sponsor conducted an accuracy study using 100 neonatal whole blood samples drawn from the heel. The age of the newborns was from 1-90 days (60% is less than 7 days) and hematocrit level varied from 38 to 68%. Analysis was done using TD-4306 strip (with Clever Chek TD-4222) and the values were compared with the values generated using YSI-2300 glucose analyzer and the Accu-chek Aviva glucose meter. Data was presented in compliance with ISO 15197 standard and Error Grid Analysis. Results generated given below meets the ISO 15197 acceptance criteria of 95% (68/71) of the individual difference is within  $\pm 15\text{mg/dL}$  when glucose concentration less than  $75\text{mg/dL}$  and is within  $\pm 20\%$  when glucose concentration  $\geq 75\text{mg/dL}$ . Regression analysis conducted against YSI-2300 values generated equation  $y = 0.8902x + 6.8212$  with correlation coefficient of 0.9378 (n=100).

Difference distribution for glucose concentration  $< 75\text{mg/dL}$

Difference within $\pm 5\text{mg/dL}$	40%	19/48
Difference within $\pm 10\text{mg/dL}$	90%	43/48
Difference within $\pm 15\text{mg/dL}$	98%	47/48

Difference distribution for glucose concentration  $\geq 75\text{mg/dL}$

Difference within $\pm 5\%$	15%	8/52
Difference within $\pm 10\%$	60%	31/52
Difference within $\pm 15\%$	87%	45/52
Difference within $\pm 20\%$	96%	50/52

The sponsor conducted a consumer study to evaluate the accuracy of glucose measurement between the lay-user and the healthcare professionals. Using



129 volunteer samples (Glucose range: 41 – 420 mg/dL) at three distribution sites, they showed the device meets their acceptability criteria as well as ISO-15197 criteria with 95% of individual differences within  $\pm 15$  mg/dL deviation for glucose concentration of  $<75$  mg/dL and  $\pm 20\%$  deviation for glucose concentration of  $\geq 75$  mg/dL.

The sponsor conducted the alternative site testing (AST) using the palm, the forearm, the upper arm, the calf, and the thigh in comparison to data obtained using finger. A total of 129 samples were tested at three sites. The results generated demonstrated the device meets the sponsor's acceptance criteria (95% of individual differences fell within  $\pm 15$  mg/dL deviation for glucose concentration of  $<75$  mg/dL and  $\pm 20\%$  deviation for glucose concentration of  $\geq 75$  mg/dL) as well as the ISO-15197 acceptance criteria for accuracy. Regression analysis of the values generated also shown below indicated correlation between the finger and the alternative sites.

Comparison	N	Range (mg/dL)	Slope and Y-intercept	R <sup>2</sup>
Palm vs. finger	100	42-329	$Y = 1.022x - 2.524$	0.983
Forearm vs. finger	100	45-311	$Y = 0.982x + 2.891$	0.983
Upper arm vs. finger	100	45-311	$Y = 0.980x + 1.550$	0.979
Calf vs. finger	100	42-329	$Y = 0.993x + 0.389$	0.979
Thigh vs. finger	100	45-326	$Y = 0.972x + 4.344$	0.979

*b. Matrix comparison:*

See above: *Method comparison with predicate device*

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 sponsor included the following Expected Values for normal glucose levels in their strip labeling:

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Status	Plasma glucose range for people without diabetes (mg/dL)
Before meals	70-110
2 hours after meals	$<120$

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Source: American Diabetic Association Clinical Practice Recommendations 2003

**N. Instrument Name:**

Clever Chek TD-4209/Clever Chek TD-4222/Clever Chek TD-4225 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 reviewed applicant's Hazard Analysis and software development processes for this line of product types in k041107. See k041107 for more information.

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, the palm, the forearm, the upper-arm, the calf, and the thigh only. For neonates, healthcare professionals may use this device for glucose testing from whole blood from the heel. Since the whole blood sample is applied directly to the test strip, there are no special handling or storage issues.

5. Calibration:

A code strip is provided with each batch of test strips to calibrate the meter for that batch. No further calibrations are required of the user.

6. Quality Control:

Glucose control solutions at two different concentrations to be run with this device are included in the 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 referred to the troubleshooting section of the owner's manual if control results fall outside these ranges.

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

**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.