

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

A. 510(k) Number:

k073492

B. Purpose for Submission:

New Device

C. Measurand:

Whole blood glucose

D. Type of Test:

Quantitative amperometric, glucose oxidase

E. Applicant:

Tyson Bioresearch Inc.

F. Proprietary and Established Names:

DIACHEX DETERMINE Blood Glucose Monitoring System

DIACHEX INFINITY 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

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:

The DIACHEX DETERMINE / DIACHEX INFINITY Blood Glucose Monitoring System is intended for use in the quantitative measurement of glucose (sugar) in fresh capillary whole blood from the fingertip and the alternative sites: the palm and the forearm. The DIACHEX DETERMINE / DIACHEX INFINITY Blood Glucose Test Strips are for testing outside the body (in vitro diagnostic use). The DIACHEX DETERMINE / DIACHEX INFINITY Blood Glucose Monitoring System is intended for use at home (over the counter [OTC]) by persons with diabetes, or in clinical setting by healthcare professionals as an aid in monitoring the effectiveness of diabetes control. It is not intended for the diagnosis of or screening for diabetes mellitus. The alternative site testing in the systems can be

used only during steady-state blood glucose conditions. It is not intended for neonatal testing.

3. Special conditions for use statement(s):

For Over-the-Counter use.

The alternative site testing in the DIACHEX DETERMINE / DIACHEX INFINITY Blood Glucose Monitoring Systems 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

It is not intended for the diagnosis of or screening for diabetes mellitus, and is not intended for use on neonates. For in vitro diagnostic use only, Over the Counter and professional use. The device should not be used for patients who are dehydrated, in shock, critically ill or in a hyperosmolar state.

4. Special instrument requirements:

DIACHEX DETERMINE blood glucose meter

DIACHEX INFINITY blood glucose meter

I. Device Description:

DIACHEX DETERMINE / DIACHEX INFINITY Blood Glucose monitoring systems each consist of the blood glucose meter, test strips, control solutions (3 levels of DIACHEX control solutions), and the lancing device with lancets. In addition, DIACHEX DETERMINE system kit has a Glucose chip for strip coding. The sponsor recommends that only corresponding DIACHEX 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 (cleared under k052818).

J. Substantial Equivalence Information:

1. Predicate device name(s):
DIACHEX Blood Glucose Monitoring System
2. Predicate 510(k) number(s):
k062829
3. Comparison with predicate:

Similarities

The sponsor claims that there were no changes to the main electronic component, function of the meter, and detection algorithm. Additionally, blood glucose test strips are identical to the previously cleared DIACHEX blood glucose test strips, except for the shape of the electrode.

Differences

Item	Proposed Device		Predicate DIACHEX (k062829)
	DIACHEX DETERMINE	DIACHEX INFINITY	
Blood Sample	Fingertip, Palm, and Forearm	Fingertip, Palm, and Forearm	Fingertip
Sample volume	0.5 uL	0.5 uL	0.5 uL
Test time	5 seconds	5 seconds	10 seconds
Reminder alarm	2 user alarm settings	4 user alarm settings	Not present
Hypoglycemic and hyperglycemic alarm	2 user alarm settings	2 user alarm settings	Not present
PC download option	RS232	RS232	Not present
LCD Display	Alarm, strip, code, and control solution icons	Alarm, strip, code, and control solution icons	-
Option of Average results	7, 14, and 30 days	7, 14, and 30 days	14 days
Coding	Glucose chip	No coding required	Glucose chip
Strip eject button	Not present	One eject button	Not present

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

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

L. Test Principle:

Glucose measurement is based on electrochemical biosensor technology using the enzyme glucose oxidase. The glucose in the sample is oxidized to produce gluconic acid. The electrical current resulting from this enzymatic reaction is measured and correlated to glucose concentration by the meter. The magnitude of the current is proportional to the concentration of glucose in the sample. The test strip is calibrated to display the equivalent of plasma glucose values to allow comparison of results with laboratory methods.

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, tested using three test strip lots and 10 glucose meters. All blood samples were maintained at hematocrit level of approximately 42%. Each glucose concentration level was evaluated using

10 measurements. The sponsor conducted day-to-day precision studies using three levels of glucose control solutions each with three lots of test strips and using 10 meters over ten days. Results are summarized in the tables below.

Within-day precision

Lot No.	DIACHEX DETERMINE					DIACHEX INFINITY				
	YSI	Avg.	Bias (%)	SD	CV (%)	YSI	Avg.	Bias (%)	SD	CV (%)
Lot 1	37.1	38.2	3.0	1.94	5.08	39.2	38.4	-2.0	1.98	5.15
	85.4	83.1	-2.7	2.94	3.54	83.6	81.5	-2.5	2.67	3.28
	125	118.3	-5.4	4.37	3.69	132	130.0	-1.6	3.96	3.05
	216	213.5	-1.2	5.17	2.42	224	221.8	-1.0	5.30	2.39
	351	360.8	2.8	7.64	2.12	357	355.3	-0.5	7.76	2.18
Lot 2	39.2	41.7	6.5	1.69	4.04	41.4	40.3	-2.7	1.74	4.32
	95.2	91.3	-4.1	2.70	2.96	85.8	84.7	-1.3	2.89	3.41
	135	131.7	-2.5	3.81	2.89	130	129.8	-0.1	3.77	2.90
	220	216.6	-1.5	5.72	2.64	219	218.1	-0.4	5.59	2.56
	349	350.3	0.4	7.35	2.10	362	364	0.5	8.10	2.23
Lot 3	36.9	38.1	3.1	1.85	4.87	40.7	39.8	-2.2	1.94	4.88
	89.3	91.9	2.9	2.82	3.06	87.9	87.5	-0.5	2.94	3.35
	130	125.9	-3.2	4.13	3.28	126	124.6	-1.2	4.35	3.49
	236	233.5	-1.1	5.24	2.24	226	222.5	-1.6	6.04	2.71
	358	365.9	2.2	7.7	2.10	353	354.5	0.4	6.68	1.88

Day-to-day precision

Control level (mg/dL)	Statistics	DIACHEX DETERMINE			DIACHEX INFINITY		
		Lot 1	Lot 2	Lot 3	Lot 1	Lot 2	Lot 3
Level 1	Mean	39.0	38.3	38.5	37.7	37.6	37.8
	SD	1.71	1.83	1.90	1.80	1.84	1.66
	CV%	4.38	4.76	4.94	4.76	4.88	4.40
Level 2	Mean	109.4	114.5	110.3	109.3	109.4	109.4
	SD	2.93	2.82	3.40	2.94	2.82	2.83
	CV%	2.68	2.46	3.08	2.69	2.58	2.59
Level 3	Mean	405.7	396.3	403.3	403.1	400.2	400.7
	SD	6.45	6.76	7.38	6.27	6.74	6.90
	CV%	1.59	1.71	1.83	1.55	1.68	1.72

b. Linearity/assay reportable range:

The sponsor used whole blood samples from volunteers depleted of glucose and then spiked with B-D-Glucose to desired concentrations. The sponsor used 10

different levels (YSI values: 24.6 mg/dL, 46.1 mg/dL, 76.4 mg/dL, 124 mg/dL, 182 mg/dL, 234 mg/dL, 352 mg/dL, 443 mg/dL, 518 mg/dL, 572 mg/dL) covering the glucose range of 20 – 600 mg/dL. The samples were evaluated using three lots and 10 meters from each type of glucose meter, generating 10 values per glucose level. The values generated were compared to YSI generated values. The linear regression analysis of data generated is given in the table below.

Regression	DIACHEX DETERMINE			DIACHEX INFINITY		
	Lot 1	Lot 2	Lot 3	Lot 1	Lot 2	Lot 3
Slope	1.02	1.00	1.02	1.01	1.00	1.01
Intercept	-3.31	-2.24	-1.37	-1.79	-1.23	-1.51
R2	0.9996	0.9997	0.9997	0.9999	0.9997	0.9997

- c. *Traceability, Stability, Expected values (controls, calibrators, or methods):*
 The sponsor claims that the only change made to the test strip compared to the predicate was the shape of the electrodes. Based on the ongoing studies, the sponsor demonstrated that there was <10% bias between the values generated for five months at 40°C.

The control solutions supplied with the device were cleared under k052818.

There is an additional feature, the no coding feature, on the INFINITY model only, which allows a single fixed-code number to be programmed into the meters at the time of manufacturing.

- d. *Detection limit:*
 The sponsor has established the measuring range of 20 - 600 mg/dL based on the linearity studies for DIACHEX DETERMINE and DIACHEX INFINITY Blood Glucose Monitoring Systems.
- e. *Analytical specificity:*
 Following CLSI EP7 guidelines, the sponsor tested the exogenous and endogenous substances listed in the table below for interference at two glucose concentrations. For each substance, one control sample (no interferent) and four test samples with series of dilution concentrations were prepared. Each sample was measured at glucose concentrations of approximately 60-80 mg/dL and 200-285 mg/dL respectively. Results were averaged for the control samples (n=5) and for the four parallel test samples (n=5). The mean difference between control and test samples was calculated as: $\text{Glucose Difference (\%)} = 100\% \times \frac{\text{Mean (Test Sample)} - \text{Mean (Control)}}{\text{Mean (Control)}}$. Based on the interference limit of a mean glucose difference of $\pm 10\%$ of the glucose values obtained in the absence of interfering substances, the following no interference levels were established by the sponsor.

Interferent	Physiologic/Therapeutic Test Level (mg/dL)	High Test Level (mg/dL)	No Interference Level (mg/dL)	Blood Glucose concentration (mg/dL)	
				Low level	High Level
Acetaminophen	2	4	3	76.3	265
Ascorbic acid	2	15	7.5	76.7	272
Bilirubin	1.2	20	20	72.9	277
Cholesterol	30	500	375	82.3	277
Creatinine	1.5	30	30	72.2	275
EDTA	---	4	4	75.2	245
Galactose	---	20	20	70.7	281
Glycerol	---	9.21	9.21	73.4	265
Heparin	---	60	60	69.9	270
Ibuprofen	4.2	40	40	68.5	255
L-Dopa	0.3	2	1	68.9	265
Maltose	---	40	40	74.4	266
Salicylate	30	125	125	71.1	255
Sodium Fluoride	---	500	500	65.1	248
Tetracycline	0.4	4	4	62.1	265
Tolazamide	2.5	5	3.75	72.6	265
Tolbutamide	10	100	100	66.6	244
Triglyceride	190	2000	2000	73.0	251
Uric acid	7.7	20	15	67.7	266

The sponsor evaluated the effect of hematocrit levels between 29 – 59% on whole blood samples spiked with 11 hematocrit levels at 4 levels of glucose distributed within the measuring range (45 - 372 mg/dL) of the device. The mean values of the 6 replicated measurements generated were compared with the glucose values from YSI 2300 analyzer. Based on the regression analysis, the results generated by the device are comparable to the values of YSI-2300 instrument at hemtocrit levels between 35-55%.

An altitude study was performed with whole blood samples from 20 volunteers (glucose range: 68-157 mg/dL) at elevations of 164 feet, 5084 feet, 7545 feet, and 10168 feet. Altitude differences within individuals were within ± 10 mg/dL deviation for glucose concentration of <75 mg/dL and $\pm 15\%$ deviation for glucose concentration of ≥ 75 mg/dL. They also showed acceptable correlation (R^2 : 0.9803-0.9990) based on the linear regression analysis.

f. Assay cut-off:
Not Applicable.

2. Comparison studies:

a. *Method comparison with predicate device:*

The sponsor conducted accuracy studies to demonstrate that the DIACHEX DETERMINE / DIACHEX INFINITY Blood Glucose Monitoring Systems are equivalent to a standard reference method (YSI-2300). Samples from 118 volunteers that included 13 contrived samples covering the lower (7 samples: 25.4-49 mg/dL glucose) and upper (6 samples: 460-571 mg/dL glucose) ends of the glucose measuring range were evaluated. The hematocrit levels of the 118 samples ranged from 34-51%. All participants claimed to be in glucose steady state. Percent distribution of the samples corresponding to the glucose concentration ranged as follows: <50 mg/dL – 5.9%; 50-80 mg/dL – 13.6%; 80-120 mg/dL – 17.8%; 120-200 mg/dL – 30.5%; 200- 300 mg/dL – 15.3%; 300-400 mg/dL – 10.2%; and >400 mg/dL – 6.8%. This test was conducted by a laboratory technician. Based on data analysis, the device met the minimum system accuracy requirement established according to the ISO 15197 guidelines, which is that 95% of the individual differences are within ± 15 mg/dL when glucose concentration is less than 75mg/dL, and within $\pm 20\%$ when glucose concentration ≥ 75 mg/dL. Results of the linear regression analysis are summarized in the table below.

Technician evaluation Fingertip (N=118)	Predicate DIACHEX	DIACHEX DETERMINE	DIACHEX INFINITY
slope	0.98	0.98	0.98
y=intercept	0.62	-0.32	1.31
R square	0.9843	0.9867	0.9879

Using DIACHEX DETERMINE meter, the sponsor conducted a second study to demonstrate the accuracy of lay user testing for fingertip, palm and forearm. This study included 112 lay users and 12 contrived samples covering the extreme ends of the range (i.e. 33-48 mg/dL and 462-581 mg/dL). All participants claimed to be in glucose steady state. Lay users were first requested to test the blood glucose using the fingertip, the palm, and the forearm, followed by trained technicians performing the fingertip test and YSI laboratory test. The values obtained were compared with the values generated using YSI. Based on data analysis, the device met the minimum system accuracy requirement established according to the ISO 15197 guidelines, which is that 95% of the individual differences are within ± 15 mg/dL when glucose concentration is less than 75mg/dL and within $\pm 20\%$ when glucose concentration is ≥ 75 mg/dL. Linear regression analysis of the lay user and technician values compared with YSI values are summarized below.

Fingertip	Lay User vs. YSI (N=112)	Technician vs. YSI (N=124)	Lay User vs. Technician (N=112)
slope	0.98	0.97	1.00
y=intercept	-0.52	1.31	-0.62
R square	0.9789	0.9872	0.9900

The sponsor's alternate site testing (AST) is limited to the palm and the forearm. Using the same volunteers described above, with hematocrit levels ranging from 33-54%, the linear regression analysis conducted is summarized in the following table for DIACHEX DETERMINE.

Comparison	N	Slope and Y-intercept	R ²
Finger vs. YSI	112	y= 0.98x-0.52	0.9789
Palm vs. YSI	111	y=0.96x-1.77	0.9796
Palm vs. fingertip	111	y=0.97x+3.12	0.9861
Forearm vs YSI	111	y=0.95x+2.34	0.9745
Forearm vs. fingertip	111	y=0.96x+3.54	0.9825

Based on data analysis, the device met the minimum system accuracy requirement established according to the ISO 15197 guidelines as follows:

Difference distribution for glucose concentrations < 75 mg/dL

Within ± 5 mg/dL	Within ± 10 mg/dL	Within ± 15 mg/dL
17/20 (85%)	19/20 (95%)	20/20 (100%)

Difference distribution for glucose concentrations ≥75 mg/DL

Within ± 10%	Within ± 15%	Within ± 20%
110/116 (95%)	114/116 (98%)	116/116 (100%)

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):*

Not Applicable.

4. Clinical cut-off:

Not Applicable

5. Expected values/Reference range:

Based on the published literature, the sponsor included the following Expected Values for normal glucose levels in their strip labeling:

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

Source: American Diabetic Association Clinical Practice Recommendations 2003

N. Instrument Name:

DIACHEX DETERMINE and DIACHEX INFINITY Blood Glucose Monitoring Systems

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 k052818. Additionally, in this submission, the sponsor provided data to support the accuracy of PC downloaded feature that allows the user to download glucose meter readings to a personal computer. Only the memory information within DETERMINE and INFINITY glucose meters can be downloaded to PC through RS-232 port and can be cleared by software. The sponsor also provided all Over The Shelf Software (OTSS) components and related design validation verification and testing activities.

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, and the forearm only. Since the whole blood sample is applied directly to the test strip, there are no special handling or storage issues.

5. Calibration:

For DIACHEX DETERMINE, 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. For DIACHEX INFINITY, a single calibration code is programmed into the meters at the time of manufacturing.

6. Quality Control:

Glucose control solutions at three different concentrations to be run with this device are available for use but not supplied with the device. 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. There are three DIACHEX Control Solutions (Low, Normal, and High) for each of the three meters that are available for the user to choose from. The sponsor recommends the use of at least two controls solutions, normal with the user's choice of either high or low control solution to check the accuracy of the system.

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

Not applicable

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.