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

A. 510(k) Number: K081495

B. Purpose for Submission: New hematology analyzer

C. Measurand: CBC, 3-part differential

D. Type of Test: 16 quantitative hematology parameters

E. Applicant: Abbott Laboratories

F. Proprietary and Established Names:

- Proprietary Name: CELL-DYN Emerald™
- Established Name: Automated Differential Cell Counter

G. Regulatory Information:

1. Regulation section: 21 CFR 864.5220

2. Classification: Class II

3. Product code: GKZ

4. Panel: Hematology (81)

H. Intended Use:

1. Intended use(s):

   The CELL-DYN Emerald is an automated hematology analyzer designed for *in-vitro* diagnostic use in clinical laboratories.

2. Indication(s) for use: same as the Intended Use

3. Special conditions for use statement(s): N/A

4. Special instrument requirements: N/A

I. Device Description:

The CELL-DYN Emerald system is a bench top analyzer with built-in monitor and

data station. The analyzer aspirates blood from an opened collection tube held up to the aspiration probe. It provides automated CBC, leukocyte 3-part differential. The system provides three histograms (WBC, RBC, PLT), Dispersional Data Alerts, Suspect Parameter Messages, and Critical Limit Fagging.

J. Substantial Equivalence Information:

1. Predicate device name(s): Abbott CELL-DYN 1800

2. Predicate 510(k) number(s): K030513

3. Comparison with predicate:

Similarities		
Item	Device CELL-DYN Emerald	Predicate CELL-DYN 1800
Intended Use	Automated hematology analyzer designed for *in vitro* diagnostic use in clinical laboratories	Same
Principle of Measurement	- Electrical impedance - Modified methemoglobin analysis	Same
IVD Parameters	WBC, RBC, HGB, HCT, MCV, MCH, MCHC, RDW, PLT, MPV, LYM%, LYM#, MID%, MID#, GRA%, GRA#	Same
Sampling mechanism	Manual open tube	Same
Sample identification	- Alphanumeric sample identification - Handheld bar code scanner	Same
Sample type	Whole blood	Same
Reagents	Diluent, CN-Free Lyse reagent	Same
Throughput	Approximately 60 seconds	Same

Differences		
Item	Device CELL-DYN Emerald	Predicate CELL-DYN 1800
Anticoagulant	K_2EDTA	K_3EDTA
Sample aspiration volume	- Open mode: 9.8 µL	- Open mode: 30 µL - Predilute: 40 µL
Data input	Keypad (internal)	Keyboard (external)
Password protection	Yes	No
Reagents	Cleaner (with enzyme)	Detergent

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

Class II Special Controls Guidance Document: Premarket Notifications for Automated Differential Cell Counters for Immature or Abnormal Blood Cells; Final Guidance for Industry and FDA

L. Test Principle:

CBC analysis is based on the electrical impedance counting and absorption spectrophotometry. Electrical impedance is used to count and size WBCs, RBCs, and PLTs. This method counts and sizes cells by detecting and measuring changes in electrical resistance when a cell suspended in a conductive liquid passes through a small aperture. The system counts the individual cells and provides cell size distribution. Hemoglobin is measured using a methemoglobin chromagen formed using the cyanide-free lytic reagent. The methemoglobin is measured photometrically at 555 nm.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. Precision/Reproducibility:

- Short-term imprecision: The study was performed at the internal site at least 4 times on 3 CD-Emerald instruments, and 1 CD-Emerald instrument at each of the 3 external sites with normal fresh blood. Each imprecision data set was based on 31 runs of the same specimen.

Fresh Blood Imprecision (n=31)

Measurand (units)*	Ranges Tested	Observed %CV (to be reported as a Range)	%CV (95% Confidence Limit)
WBC (K/µL)	4.7-10.2	1.5-3.4	3.5
RBC (M/µL)	4.2-5.4	0.7-1.9	2.0
HGB (g/dL)	12.2-16.1	0.4-1.8	2.1
HCT (%)	35.7-50.7	0.9-1.6	1.7
MCV (fL)	73.4-96.0	0.3-0.8	0.8
RDW (%)	11.8-17.0	2.1-3.4	3.3
PLT (K/µL)	185.2-387	2.8-5.8	6.1
MPV (fL)	7.6-9.0	1.3-2.6	2.7
LYM %	13.1-50.1	1.7-5.0	5.4
MID %	6.3-11.0	3.4-7.3	8.1
GRA %	43.1-75.8	1.1-3.0	2.9
*Results are expressed in Standard (US) units.			

- Long-term imprecision: Tri-level CELL-DYN 16 Control (2 lots) were tested in duplicate on 6 CD-Emerald instruments for the duration of the study. Statistical analysis, as defined in CLSI EP5-A2 and EP-15-A2 was used to estimate the repeatability and within-device imprecision by standard deviation and %CV of measurands listed on the commercial control package insert.

Commercial Control Imprecision

Control Level	Average CV%[1]
WBC x 10^9/L	
Low	5.4
Normal	3
High	2.4
RBC x 10^{12}/L	
Low	2
Normal	1.8
High	1.7
HGB g/dL	
Low	3
Normal	1.8
High	1.6
HCT %	
Low	2.2
Normal	1.9
High	1.8
MCV fL	
Low	1
Normal	0.9
High	0.8

Control Level	Average CV%[1]
MCH pg	
Low	2.9
Normal	1.6
High	1.4
MCHC g/dL	
Low	2.9
Normal	1.6
High	1.4
RDW %	
Low	3.4
Normal	3
High	2.8
PLT X 10^9/L	
Low	10.4
Normal	4.9
High	4
MPV fL	
Low	3.5
Normal	1.8
High	1.6

Control Level	Average CV%[1]
LYM %	
Low	5.6
Normal	1.5
High	1.9
MID%	
Low	9.7
Normal	5.1
High	2.9
GRA %	
Low	2.9
Normal	1.5
High	2.4
LYM#	
Low	10.5
Normal	3.2
High	3.6
MID#	
Low	19.1
Normal	6.5
High	4.2
GRA#	
Low	5.2
Normal	3.6
High	2.7

[1]*Values are the sample count-weighted averages of the individual instrument and individual lot %CV.*

b. Linearity/assay reportable range/analytical measuring range: Simple manipulations (concentration/dilution) of fresh whole blood from normal donors were done to generate certain low and high analytical range for correlation samples. The unmodified specimen results were taken as truth, and the dilution ratios provided calculated expected values. The means of the dilution replicates were plotted against the calculated expected results. In

addition, commercially available linearity kits from R&D Systems was assayed and analyzed. The correlation coefficient (r) values of >0.975 for WBC, RBC, HGB, and PLT were obtained in the study.

c. *Carryover:* Carryover was performed on 3 CD-Emerald instruments, at least three times per instruments for WBC, RBC, HGB, and PLT measurands. Fresh whole blood samples with High Target Values (HTV) were tested in triplicates; followed by 3 aspirations of whole blood Low Target Value (LTV) samples. Carryover (%) was calculated using the following equation:

Carryover (%) = (LTV1-LTV3)/(HTV3-LTV3) x 100

% Carryover (95% CI) was obtained for the following parameters:

Measurands (Units)	Low Target Value	High Target Value	% Carryover (95% Confidence Limit)
WBC (K/µL)	>0 and <3	>90	<1%
RBC (M/µL)	>0 and <1.5	>6.20	<1%
HGB (g/dL)	>0 and <5.0	>22.0	<1%
PLT (K/µL)	>0 and <100	>900	<2.2%

d. *Traceability, Stability, Expected values (controls, calibrators, or methods):* N/A

e. *Detection limit:* N/A

f. *Analytical specificity:* N/A

g. *Assay cut-off:* N/A

2. Comparison studies:

a. *Method comparison with predicate device:* Clinical samples were analyzed on the test instruments and compared against predicate devices for both CBC and differentials. Correlation was also determined by comparing the differential results obtained by the CD-Emerald to those by manual microscopy. The CD-Emerald's WBC Overall Flagging ability was evaluated by comparing their results against the predicate's results.

- Correlation to CD-1800:

The internal Abbott site obtained the following results on 330 blood samples.

Comparability (Correlation) to CD-1800 Internal Site					
		Data Range			
Measurand*	**r-value**	**Min**	**Max**	**Intercept**	**Slope**
WBC (K/µL)	0.997	0.4	42.3	0.578	0.905
RBC (M/µL)	0.993	1.31	7.38	-0.147	1.032
HGB (g/dL)	0.997	4.8	24.4	0.222	1.004
HCT (%)	0.993	14.7	66.9	-0.158	1.036
MCV (fL)	0.921	63.6	119.6	-12.170	1.175
RDW (%)	0.758	11.8	20.9	6.320	0.558
PLT (K/µL)	0.990	2.0	1039.0	1.212	1.044
MPV (fL)	0.912	6.8	11.5	2.641	0.580
LYM (%)	0.970	4.0	75.6	1.240	1.011
MID (%)	0.761	1.6	17.8	1.560	0.895
GRA (%)	0.972	21.9	94.4	-1.782	0.990
* Results are expressed in Standard (US) units. Correlation coefficient, established by Passing-Bablok regression analysis.					

The external laboratory GA-Atlanta obtained the following results on 569 blood samples.

Comparability (Correlation) to CD-1800 External Site					
		Data Range			
Measurand*	**r-value**	**Min**	**Max**	**Intercept**	**Slope**
WBC (K/µL)	0.997	0.4	82.5	0.602	0.895
RBC (M/µL)	0.992	1.36	6.81	-0.270	1.074
HGB (g/dL)	0.994	4.3	19.6	-0.230	1.038
HCT (%)	0.988	12.9	57.5	-0.810	1.032
MCV (fL)	0.943	60.7	110.1	-8.067	1.097
RDW (%)	0.750	10.9	26.4	4.467	0.690
PLT (K/µL)	0.982	4.0	958.0	5.554	0.995
MPV (fL)	0.916	6.0	10.9	2.582	0.561
LYM (%)	0.986	2.5	76.9	1.057	1.034
MID (%)	0.819	1.7	19.8	2.005	0.979
GRA (%)	0.982	12.6	95.7	-7.150	1.048
* Results are expressed in Standard (US) units. Correlation coefficient, established by Passing-Bablok regression analysis.					

- Correlation of to manual microscopy:

Measurand	Range Tested*	Replicates	r-value†	Slope	Y-intercept
GRA%	23.15 – 95.70%	180	0.932	0.943	1.302
MID%	1.800 – 19.25%	180	0.874	0.612	3.350
LYM%	2.500 – 62.10%	180	0.943	0.989	3.317

* Results are expressed in traditional US units. These values do not represent the analytical measurement range, which is provided in another table. † Correlation coefficient, established by Passing-Bablock regression analysis.

- WBC Overall Flagging ability

  Out of Normal Range (Distributional)
  PLUS Normals with No Flags

		CD EMERALD		
		Normal	Abnormal	
CD 1800	Normal	730	19	749
	Abnormal	18	1402	1420
		748	1421	2169

Agreement	98.29%
Sensitivity	98.73%
Specificity	97.46%
Positive Predictive Value	98.66%
Negative Predictive Value	97.59%
CD1800 Flagging rate	65.47%
CD Emerald flagging rate	65.51%

b. Matrix comparison: N/A

3. Clinical studies:

   a. Clinical Sensitivity: N/A

   b. Clinical specificity: N/A

   c. Other clinical supportive data (when a. and b. are not applicable): N/A

4. Clinical cut-off**:** N/A

5. Expected values/Reference range:

Whole blood samples were collected from 270 males and females. The manufacturer recommends the laboratory to establish their reference ranges.

Reference Ranges				
Measurand	Units	Sex	N	Range
WBC	K/µL	M/F	270	4.70-10.30
RBC	M/µL	M/F	270	4.03 - 5.46
HGB	g/dL	M/F	270	12.40 - 16.90
HCT	%	M/F	270	36.60 - 48.30
MCV	fL	M/F	270	81.50 - 96.80
MCH	pg	M/F	270	27.50 - 33.10
MCHC	g/dL	M/F	270	32.40 - 35.70
RDW	%	M/F	270	11.80 - 14.90
PLT	K/µL	M/F	270	165.00 - 385.00
MPV	fL	M/F	270	7.20 - 10.20
LYM%	%	M/F	270	12.70 - 47.80
MID%	%	M/F	270	6.30 - 14.00
GRA%	%	M/F	270	43.50 - 78.90

N. Instrument Name: CELL-DYNN Emerald

O. System Descriptions:

1. Modes of Operation: manual open tube

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: manual entry, handheld bar code scanner

4. Specimen Sampling and Handling: Manual open tube

5. Calibration: Abbott commercial calibrator, fresh whole blood

6. Quality Control: Abbott commercial control materials

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.