DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
10903 New Hampshire Avenue
Document Control Center – WO66-G609
Silver Spring, MD 20993-0002

December 14, 2016

INSTRUMENTATION LABORATORY CO.
CAROL MARBLE
REGULATORY AFFAIRS DIRECTOR
180 HARTWELL ROAD
BEDFORD MA 01730

Re: K160412
Trade/Device Name: GEM Premier 5000 (Measured Parameters: pH, pCO2, pO2)
Regulation Number: 21 CFR 862. 1120
Regulation Name: Blood gases (pCO_2 and pO_2) and blood pH test system
Regulatory Class: II
Product Code: CHL
Dated: December 7, 2016
Received: December 8, 2016

Dear Ms. Marble:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Parts 801 and 809); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820); and if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

If you desire specific advice for your device on our labeling regulations (21 CFR Parts 801 and 809), please contact the Division of Industry and Consumer Education at its toll-free number (800) 638 2041 or (301) 796-7100 or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to http://www.fda.gov/MedicalDevices/Safety/ReportaProblem/default.htm for the CDRH's Office of Surveillance and Biometrics/Division of Postmarket Surveillance.

You may obtain other general information on your responsibilities under the Act from the Division of Industry and Consumer Education at its toll-free number (800) 638-2041 or (301) 796-7100 or at its Internet address http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/default.htm.

Sincerely yours,

Courtney H. Lias -S

Courtney H. Lias, Ph.D.
Director
Division of Chemistry and Toxicology Devices
Office of In Vitro Diagnostics
and Radiological Health
Center for Devices and Radiological Health

Enclosure

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

Indications for Use

Form Approved: OMB No. 0910-0120
Expiration Date: January 31, 2017
See PRA Statement below.

510(k) Number *(if known)*
K160412

Device Name
GEM Premier 5000 (Measured Parameters: pH, pCO2, pO2)

Indications for Use *(Describe)*

The GEM Premier 5000 is a portable critical care system for use by health care professionals to rapidly analyze heparinized whole blood samples at the point of health care delivery in a clinical setting and in a central laboratory. The instrument provides quantitative measurements of pH and pO2 from venous, arterial and capillary heparinized whole blood, as well as quantitative measurements of pCO2 from venous and arterial heparinized whole blood. These parameters, along with derived parameters, aid in the diagnosis of a patient's acid/base status.

pH, pCO2 and pO2 measurements in whole blood are used in the diagnosis and treatment of life-threatening acid-base disturbances.

Type of Use *(Select one or both, as applicable)*

☒ Prescription Use (Part 21 CFR 801 Subpart D) ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) Summary

This 510(k) Summary of Safety and Effectiveness is being submitted in accordance with the requirements of the Safe Medical Device Act of 1990 and 21 CFR 807.92.

Submitter's Information	Instrumentation Laboratory (IL) Co. 180 Hartwell Road Bedford, MA 01730, USA

Contact Person	Carol Marble, Regulatory Affairs Director Phone: 781-861-4467 Fax: 781-861-4207 Email: cmarble@ilww.com

Preparation Date	December 7, 2016

Device Trade Name	GEM Premier 5000 (Measured Parameters: pH, pCO_2 and pO_2)

Predicate Device	GEM Premier 4000	K133407

Regulatory Information					
Analyte	**Regulation Section**	**Regulatory Description**	**Class**	**Product Code**	**Panel**
pH, pCO_2, pO_2,	862.1120	Blood Gases (pCO_2, pO_2) and Blood pH system	II	CHL	75

Device Description	
The GEM Premier 5000 system provides health care professionals in central laboratory or point-of-care clinical settings with fast, accurate, quantitative measurements of pH and pO_2 from venous, arterial and capillary heparinized whole blood, as well as quantitative measurements of pCO_2 from venous and arterial heparinized whole blood.	
Key Components	**Description**
Analyzer	Employs a unique color touch screen and a simple set of menus and buttons for user interaction. The analyzer guides operators through the sampling process with simple, clear messages and prompts.
GEM Premier 5000 PAK (disposable, multi-use GEM PAK)	Houses all required components necessary to operate the instrument once the cartridge is validated. These components include the sensors, CO-Ox optical cell, Process Control (PC) Solutions, sampler, pump tubing, distribution valve and waste bag. The GEM PAK has flexible menus and test volume options to assist facilities in maximizing efficiency. NOTE: The EEPROM on the GEM PAK includes all solution values and controls the analyte menu and number of tests. Step 1: After inserting the GEM PAK, the instrument will perform an automated PAK warm-up during which the sensors are hydrated and a variety of checks occur, all of which take about 40 minutes. During warm-up, the instrument requires no user intervention**.** Step 2: After GEM PAK warmup, Auto PAK Validation (APV) process is automatically completed: two completely independent solutions (PC Solution D and E) that are traceable to NIST standards, CLSI procedures or internal standards, containing two levels of concentration for each analyte, are run by the analyzer to validate the integrity of the PC Solutions and the overall performance of the analytical system. Step 3: After successful performance of APV, iQM2 manages the quality control process, replacing external quality controls.
Intelligent Quality Management 2 (iQM2)	iQM2 is an active quality process control program designed to provide continuous monitoring of the analytical process before, *during* and after sample measurement with real-time, automatic error detection, automatic correction of the system and automatic documentation of all corrective actions. iQM2 is a statistical process control system that performs 5 types of continuous, quality checks to monitor the performance of the GEM PAK, sensors, CO-Ox, and reagents. These checks include System, Sensor, IntraSpect, Pattern Recognition and Stability Checks.

Indications for Use / Intended Use	
GEM Premier 5000	The GEM Premier 5000 is a portable critical care system for use by health care professionals to rapidly analyze heparinized whole blood samples at the point of health care delivery in a clinical setting and in a central laboratory. The instrument provides quantitative measurements of pH and pO_2 from venous, arterial and capillary heparinized whole blood, as well as quantitative measurements of pCO_2 from venous and arterial heparinized whole blood. These parameters, along with derived parameters, aid in the diagnosis of a patient's acid/base status. pH, pCO_2, pO_2 measurements in whole blood are used in the diagnosis and treatment of life-threatening acid-base disturbances.

Special Conditions for Use Statement

- For prescription use only.
- For clinical laboratory and point-of-care use.

Substantial Equivalency		
The GEM Premier 5000 system is substantially equivalent in function and intended use to the following predicate device for pH, pCO_2, pO_2:		
Item	**Predicate Device**	**New Device**
Trade Name	GEM Premier 4000	GEM Premier 5000
510(k) No.	K133407	K160412
Manufacturer	Instrumentation Laboratory Co.	Instrumentation Laboratory Co.
Indications for Use	The GEM Premier 4000 is a portable critical care system for use by health care professionals to rapidly analyze whole blood samples at the point of health care delivery in a clinical setting and in a central laboratory. The instrument provides quantitative measurements of pH, pCO_2, pO_2, sodium, potassium, chloride, ionized calcium, glucose, lactate, hematocrit, total bilirubin and CO-Oximetry (tHb, O_2Hb, COHb, MetHb, HHb) parameters. Total bilirubin can also be quantitated from heparinized plasma samples when analyzed in the tBili/CO-Ox mode. These parameters, along with derived parameters, aid in the diagnosis of a patient's acid/base status, electrolyte and metabolite balance and oxygen delivery capacity. Total bilirubin measurements are used in the diagnosis and management of biliary tract obstructions, liver disease and various hemolytic diseases and disorders involving the metabolism of bilirubin. In neonates, the level of total bilirubin is used to aid in assessing the risk of kernicterus.	The GEM Premier 5000 is a portable critical care system for use by health care professionals to rapidly analyze heparinized whole blood samples at the point of health care delivery in a clinical setting and in a central laboratory. The instrument provides quantitative measurements of pH and pO_2 from venous, arterial and capillary heparinized whole blood, as well as quantitative measurements of pCO_2 from venous and arterial heparinized whole blood. These parameters, along with derived parameters, aid in the diagnosis of a patient's acid/base status. pH, pCO_2, pO_2 measurements in whole blood are used in the diagnosis and treatment of life-threatening acid-base disturbances.

Substantial Equivalency (Cont.)				
Item	**Predicate Device**		**New Device**	
Trade Names	GEM Premier 4000	K133407	GEM Premier 5000	K160412
Intended User	Central Laboratory and Point-of-Care		Same	
Sample Type	Heparinized whole blood		pH, pO_2	Arterial, venous or capillary heparinized whole blood
			pCO_2	Arterial or venous heparinized whole blood
Blood Gas Measurement	Potentiometry: pH and pCO_2		Same	
	Amperometry: pO_2			
Sample Introduction	Aspiration		Same	
PAK Shelf-Life Stability	Up to 180 days		Same	
PAK Storage Temperature	15-25°C		Same	
System Operating Temperature	12-32°C		Same	
Operating System Software	Linux-based		Same	
Calibration	2-point calibration		Same	
QC Material	CVP 1 and 2		PC Solution D and E (PAK Internal)	
	CVP 3 and 4		PC Solution D and E (PAK Internal)	
	CVP 5 tBili		Same; No Formulation Change	

Substantial Equivalency (Cont.)				
Item	**Predicate Device**		**New Device**	
Trade Name	GEM Premier 4000	K133407	GEM Premier 5000	K160412
Instrument Dimensions	GEM Premier 4000 Instrument: • Height: 18 inches • Width: 12 inches • Depth: 15 inches • Weight: 44 pounds		GEM Premier 5000 Instrument: • Height: 18.6 inches • Width: 13.0 inches • Depth: 16.4 inches • Weight: 45.4 pounds	
Cartridge (PAK) Dimensions	GEM Premier 4000 Cartridge (PAK): • Height: 6.75 inches • Width: 10 inches • Depth: 8 inches • Weight: 8 pounds		GEM Premier 5000 Cartridge (PAK): • Height: 6.75 inches • Width: 10 inches • Depth: 8 inches • Weight: 8.1 pounds	
Reportable Range	**Analyte**	**GEM Premier 4000**	**GEM Premier 5000**	
	pH	7.00 to 8.00	7.00 to 7.92	
	pCO_2	6 to 125 mmHg	6 to 125 mmHg	
	pO_2	5 to 690 mmHg	6 to 690 mmHg	

Performance Summary

Internal Precision Study – Aqueous Controls

In accordance with CLSI EP05-A3, an internal 20-day precision study was performed on the GEM Premier 5000, with GEM System Evaluator. Each of the control levels was run on three (3) GEM Premier 5000 analyzers for twenty (20) days, with two (2) runs per day and one (1) replicate measured per run per level (n=120). All results were within specification.

Material	Analyte	Level	Mean	N	Within Analyzer SD	Within Analyzer %CV	Total SD	Total %CV
GEM System Evaluator	pH	Level 1	7.14	120	0.008	0.1%	0.008	0.1%
		Level 2	7.38	120	0.004	0.1%	0.006	0.1%
		Level 3	7.57	120	0.003	0.0%	0.003	0.0%
	pCO_2 (mmHg)	Level 1	87	120	2.3	2.7%	2.3	2.7%
		Level 2	35	120	0.7	1.9%	0.8	2.3%
		Level 3	14	120	0.3	2.2%	0.3	2.3%
	pO_2 (mmHg)	Level 1	31	120	1.9	6.1%	2.4	7.9%
		Level 2	88	120	1.2	1.4%	2.2	2.4%
		Level 3	370	120	4.8	1.3%	5.9	1.6%

Internal Precision Study – GEM PAK (Cartridge) Process Control Solutions D and E

In accordance with CLSI EP05-A3, an internal 20-day precision study was performed with the GEM PAK (cartridge) Process Control Solutions (PCS) D and E run on three (3) GEM Premier 5000 analyzers for twenty (20) days, with two (2) runs per day and one (1) replicate measured per run per level (N=120 per analyte/per level). All results were within specification.

Material	Analyte	Mean	N	Within Analyzer SD	Within Analyzer %CV
PCS D	pH	7.35	120	0.001	0.0%
PCS E		7.21	120	0.001	0.0%
PCS D	pCO_2 (mmHg)	25	120	0.1	0.4%
PCS E		68	120	0.3	0.5%
PCS D	pO_2 (mmHg)	55	120	1.1	1.9%
PCS E		98	120	1.1	1.1%

Performance Summary (Cont.)

Internal Precision Study – Whole Blood

In accordance with CLSI EP05-A3, an internal precision study was performed using five (5) different concentrations of whole blood per analyte, each run on three (3) GEM Premier 5000 analyzers per sample mode for five (5) days, with one (1) run per day and eight (8) replicates measured per run per level (N=120 per analyte/per sample mode). All results were within specification.

Sample Modes and Volumes:

- Normal Mode 150 µL
- Micro Mode 65 µL

NOTE: Capillary not claimed for pCO_2 on the GEM Premier 5000.

Analyte	Mode	Level	Mean	N	Within Run SD	Within Run %CV	Total SD	Total %CV
pH	Normal Mode	1	7.11	120	0.004	0.1%	0.005	0.1%
		2	7.33	120	0.007	0.1%	0.007	0.1%
		3	7.35	120	0.004	0.1%	0.005	0.1%
		4	7.42	120	0.005	0.1%	0.006	0.1%
		5	7.68	120	0.012	0.1%	0.014	0.2%
	Micro Mode	1	7.10	120	0.006	0.1%	0.007	0.1%
		2	7.32	120	0.004	0.1%	0.006	0.1%
		3	7.35	120	0.004	0.1%	0.005	0.1%
		4	7.41	120	0.005	0.1%	0.006	0.1%
		5	7.67	120	0.013	0.2%	0.015	0.2%
pCO_2 (mmHg)	Normal Mode	1	112	120	2.7	2.4%	2.9	2.3%
		2	70	120	1.1	1.5%	1.5	2.0%
		3	50	120	0.6	1.2%	0.8	1.5%
		4	36	120	0.5	1.3%	0.8	1.9%
		5	10	120	0.5	4.6%	0.8	7.7%

Performance Summary (Cont.)

Internal Precision Study – Whole Blood (Cont.)

Analyte	Mode	Level	Mean	N	Within Run SD	Within Run %CV	Total SD	Total %CV
pO_2 (mmHg)	Normal Mode	1	32	120	0.4	1.2%	0.9	2.7%
		2	62	120	0.7	1.1%	0.9	1.2%
		3	204	120	2.3	1.1%	3.1	1.4%
		4	415	120	8.6	2.1%	13.0	2.8%
		5	722	120	18.6	2.6%	32.7	4.3%
	Micro Mode	1	31	120	0.9	3.0%	1.6	5.3%
		2	62	120	0.7	1.1%	0.9	1.4%
		3	204	120	4.3	2.1%	5.5	2.5%
		4	402	120	15.3	3.8%	16.4	3.8%
		5	693	120	26.5	3.8%	34.0	4.8%

Performance Summary (Cont.)

Reproducibility Study with Aqueous Controls – Point-of-Care (POC) Setting

In accordance with CLSI EP05-A3, a reproducibility study was performed at three (3) external clinical point-of-care (POC) sites. The studies were run by a total of nine (9) different operators on three (3) different GEM Premier 5000 instruments, using a single lot of GEM Premier 5000 PAKs (cartridges). Each site used the same lots of GEM System Evaluator (GSE), running each control level in triplicate, twice a day for 5 days, for a total of 30 replicates per level (N=90 pooled). All results at all sites were within specification.

Pooled Multi-Site POC Data																
Analyte	**Material/ Level**	**N**	**Insert Range**	**Target**	**SD/CV Spec**	**Mean**	**Repeatability**		**Between-Run**		**Between-Day**		**Between-Site**		**Reproducibility**	
							SD	**%CV**	**SD**	**%CV**	**SD**	**%CV**	**SD**	**%CV**	**SD**	**%CV**
pH	GSE 1	90	7.10-7.18	7.14	0.02	7.14	0.002	0.0%	0.001	0.0%	0.000	0.0%	0.000	0.0%	0.002	0.0%
	GSE 2	90	7.35-7.43	7.39	0.02	7.39	0.007	0.1%	0.003	0.0%	0.003	0.0%	0.002	0.0%	0.008	0.1%
	GSE 3	90	7.53-7.61	7.57	0.02	7.57	0.002	0.0%	0.000	0.0%	0.003	0.0%	0.000	0.0%	0.003	0.0%
pCO_2 (mmHg)	GSE 1	90	78-96	87	4%	87	0.4	0.5%	0.7	0.9%	0.6	0.7%	0.0	0.0%	1.1	1.2%
	GSE 2	90	29-39	34	2.5	34	0.9	2.5%	0.0	0.0%	0.3	0.9%	0.0	0.0%	0.9	2.7%
	GSE 3	90	10-16	13	2.5	13	0.4	3.3%	0.0	0.0%	0.2	1.2%	0.0	0.0%	0.5	3.5%
pO_2 (mmHg)	GSE 1	90	21-41	31	5	28	0.7	2.3%	0.4	1.4%	0.6	2.2%	1.6	5.8%	1.9	6.7%
	GSE 2	90	77-97	87	5	87	1.4	1.7%	0.0	0.0%	0.6	0.7%	1.0	1.2%	1.9	2.2%
	GSE 3	90	325-389	357	5%	357	7.9	2.2%	0.0	0.0%	0.0	0.0%	4.8	1.3%	9.3	2.6%

Performance Summary (Cont.)

External Precision – Whole Blood

To evaluate whole blood precision on the GEM Premier 5000 system in the central laboratory and point-of-care (POC) settings, whole blood patient samples were tested at 2 external central laboratories and 1 internal Customer Simulation Laboratory (CSL), as well as at 3 external POC locations. For the central laboratory setting, the studies were performed by 3 operators on 3 GEM Premier 5000 instruments using a single lot of GEM Premier 5000 PAK (cartridge). For the POC setting, the studies were performed by 11 operators on 3 GEM Premier 5000 instruments, using a single lot of GEM Premier 5000 PAK (cartridge). At least two whole blood specimens were analyzed in triplicate daily for 5 days in both normal mode (150 µL) for pH, pCO_2 and pO_2, and micro capillary (65 µL) mode for pH and pO_2. At the internal Customer Simulation Laboratory (CSL), contrived whole blood specimens were analyzed in addition to native specimens in order to cover the low and high medical decision levels of each analyte.

The precision results are summarized below:

NOTE: Capillary not claimed for pCO_2 on the GEM Premier 5000.

Analyte	Mode	Site	N	Mean	Within Sample SD
pH	Normal Mode	POC1	54	7.36	0.008
		POC2	42	7.33	0.009
		POC3	30	7.35	0.008
		POC-All	126	7.35	0.008
		CSL	30	7.32	0.009
		Lab1	30	7.36	0.009
		Lab2	30	7.32	0.007
		Lab-All	90	7.33	0.008
	Micro Mode	POC1	30	7.29	0.009
		POC2	36	7.32	0.012
		POC3	36	7.28	0.012
		POC-All	102	7.30	0.011
		CSL	30	7.30	0.008
		Lab1	30	7.33	0.007
		Lab2	30	7.26	0.009
		Lab-All	90	7.30	0.008

Performance Summary (Cont.)

External Precision – Whole Blood (Cont.)

Analyte	Mode	Site	N	Mean	Within Sample SD
pCO_2 (mmHg)	Normal Mode	POC1	48	43	1.1
		POC2	39	42	0.8
		POC3	30	49	1.7
		POC-All	117	44	1.2
		CSL	24	53	1.3
		Lab1	30	46	1.3
		Lab2	24	46	0.8
		Lab-All	78	48	1.2
pO_2 (mmHg)	Normal Mode	POC1	27	52	1.5
		POC2	12	63	0.4
		POC3	12	71	2.0
		POC-All	51	59	1.5
		CSL	30	52	0.6
		Lab1	21	55	0.8
		Lab2	15	50	3.9
		Lab-All	66	53	0.8
	Micro Mode	POC1	21	53	1.5
		POC2	6	45	1.2
		POC3	18	58	1.1
		POC-All	45	54	1.3
		CSL	30	54	0.8
		Lab1	24	60	1.0
		Lab2	18	52	1.1
		Lab-All	72	56	1.0

Performance Summary (Cont.)

LoB, LoD and LoQ

In accordance with CLSI EP17-A2, LoB, LoD and LoQ were established for pH, pCO_2 and pO_2 using three (3) lots of GEM Premier 5000 PAKs (cartridges).

Following are the combined data results for LoB, LoD and LoQ:

Analyte	LoB	LoD	LoQ
pH*	8.90	8.87	8.04
pCO_2 (mmHg)	0	1	4
pO_2 (mmHg)	NA	NA	2

*Note: By definition, LoQ must be ≥ LoD ***except*** for pH. Since pH is measured on a negative log scale, larger pH values represent lower analyte levels. Thus, for pH, LoQ must be ≤ LoD.

Linearity

In accordance with CLSI EP06-A, eight (8) or nine (9) levels per analyte were prepared by tonometering whole blood to challenge the claimed reportable range for each parameter. Each blood level was analyzed in triplicate on three (3) GEM Premier 5000 test analyzers and results compared to standard reference procedures (i.e. tonometry for gases).

Combined data from limit of quantitation (LOQ) and linearity were used to support the lower limits of the claimed reportable ranges.

Analyte	# of Levels	N per Level	Slope	Intercept	R^2	Tested Range	Reportable Range
pH	8	9	0.972	0.191	0.998	6.67 to 7.97	7.00 to 7.92
pCO_2 (mmHg)	8	9	1.045	-2.027	0.998	1 to 149	6 to 125
pO_2 (mmHg)	9	9	1.028	-4.069	0.995	5 to 727	6 to 690

Performance Summary (Cont.)

Analytical Specificity

In accordance with EP07-A2, an interference study was conducted on the GEM Premier 5000. A screening test was used to identify substances that produce a clinically significant interference based on measurement at two different analyte concentrations. The table below lists substances that were screen tested with no observed interference on pH, pCO_2 and pO_2 results:

No Observed Interference with pH, pCO_2 and pO_2	
Substance	**Concentration**
Acetaminophen	1324 µmol/L
Albumin (Human)	60 g/L
Amoxicillin	206 µmol/L
Aprotinin	50 mg/L
Atracurium	50 mg/L
Benzalkonium (Chloride)	5 mg/L
Bilirubin	20 mg/dL
Ceftriaxone	1460 µmol/L
Ciprofloxin	30.2 µmol/L
Diazepam	18 µmol/L
Epinephrine	0.5 µmol/L
Ethanol	86.8 mmol/L
Etomidate	50 mg/L
Fentanyl	0.02 µg/ml
Gentamycin	21 µmol/L
Halothane	759 µmol/L
Hematocrit	25%
	75%
Hemoglobin (Hemolysis)	2 g/dL (20%)
Lithium (Chloride)	3.2 mmol/L
Methadone	6.46 µmol/L
Midazolam	0.5 µg/mL
Morphine	1.75 µmol/L
Omeprazole	17.4 µmol/L
Phenobarbital	431 µmol/L
Propofol	0.05 mg/mL
Suxamethonium	68 µmol/L
Thiopental	248 µmol/L
Thyroxine	1.29 µmol/L
Triglycerides (Intralipids)	2% or 4012 mg/dL

Performance Summary (Cont.)

Internal Method Comparison

In accordance with EP09-A3, an internal method comparison study was conducted using clinical samples to compare the GEM Premier 5000 to the following predicate devices:

- Tonometry: pO_2, pCO_2 (tonometry used due to instability of blood gases)
- GEM Premier 4000: pH

Samples were altered as needed to cover the medical decision levels. All parameter levels passed specification for all sample modes.

NOTE: Capillary not claimed for pCO_2 on the GEM Premier 5000.

Analyte	N	Slope	Intercept	R^2	Medical Decision Level	Bias at Medical Decision Level
pH	373	0.953	0.344	0.993	7.30	0.001
					7.35	-0.001
					7.45	-0.006
pCO_2 (mmHg)	150	1.026	-0.991	0.997	35	-0.1
					50	0.3
					70	1.2%
pO_2 (mmHg)	148	1.027	-1.266	0.999	30	-0.5
					45	0.0
					60	0.4

Performance Summary (Cont.)

Whole Blood Performance at Medical Decision Levels

The data from the internal method comparison and precision studies were combined to assess the performance at medical decision levels.

Total Error was computed based on the following equation and the results were compared to the GEM Premier 5000 Total Error Specifications:

Total Error Observed = Bias + 2 * SD (or %CV)

Note: Previously shown bias and precision data were used in Total Error computations below.

Analyte	Medical Decision Level	Absolute Value of Bias at Medical Decision Level	2*(SD or %CV)	Total Error Observed Bias + 2*(SD or %CV)
pH	7.30	0.001	0.013	0.014
	7.35	0.001	0.008	0.009
	7.45	0.006	0.010	0.016
pCO_2 (mmHg)	35	0.1	0.9	1.0
	50	0.3	1.2	1.5
	70	1.2%	3.0%	4.2%
pO_2 (mmHg)	30	0.5	0.7	1.2
	45	0.0	1.4	1.4
	60	0.4	1.4	1.8

Performance Summary (Cont.)

Reference Ranges

Analyte	Reference Range	Unit
pH cH cH pH	7.35 to 7.45 35.5 to 44.7 35.5 to 44.7 7.32 to 7.43 (venous)	pH nmol/L nEq/L pH
pCO_2	Arterial blood: 35 to 48 (male) and 32 to 35 (female) Arterial blood: 4.6 to 6.4 (male) and 4.3 to 6.0 (female) Venous blood (right atrium) - 6-7 mmHg (0.80-0.93 kPa) higher than arterial pCO_2	mmHg kPa
pO_2	83 to 108 11.0 to 14.4	mmHg kPa
TCO_2	19.0 to 24.0 22.0 to 26.0 (venous)	mmol/L
BE	-2.0 to 3.0	mmol/L
HCO_3^-	21 to 28 21 to 28 22 to 29 (venous) 22 to 29 (venous)	mmol/L mEq/L mmol/L mEq/L

Sources: Burtis, Carl and David Bruns, Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Elsevier Saunders, 7th edition, 2015, pp 952-982

Wu, A., Tietz Clinical Guide to Laboratory Tests, W.B. Saunders Co., St. Louis MO, 4th Edition, 2006: 951-982

Note: TCO_2, HCO_3^- and BE (Base Excess) are derived parameters.

Performance Summary (Cont.)

Clinical Testing

In accordance with EP09-A3, a method comparison study was conducted on the GEM Premier 5000 compared to the predicate device, the GEM Premier 4000, in the point-of-care (POC) setting using heparinized whole blood patient samples from the intended use population.

- Study Design:
  - Three (3) external point-of-care (POC) sites.
  - One (1) internal Customer Simulation Laboratory (CSL) at IL, where three (3) intended POC users were brought on site to run the samples, allowing spiking to cover the reportable ranges.

The pooled results from the POC sites and the IL internal Customer Simulation Laboratory (CSL) for the Normal Mode (with samples collected in syringes) are presented below.

Pooled Point-of-Care Site and CSL Data - Normal Mode (with Syringe Samples)					
Analyte	**N**	**Slope**	**Intercept**	**r**	**Sample Range**
pH	479	0.941	0.427	0.991	7.01 to 7.92
pCO_2 (mmHg)	492	0.955	3.545	0.991	11 to 117
pO_2 (mmHg)	506	0.992	5.093	0.996	6 to 685

To support capillary claims, finger-stick samples were collected at an external POC site (N=65 native samples) and the IL internal Customer Simulation Laboratory (CSL) (N=106 native samples) with POC operators. The observed total error at the medical decision levels is shown below:

NOTE: Capillary not claimed for pCO_2 on the GEM Premier 5000.

Pooled Point-of-Care Site and CSL Data with Native Capillary Samples Only							
Analyte	**N**	**Range Min**	**Range Max**	**MDL**	**Bias at MDL**	**95% CI of Bias at MDL**	**TEa**
pH	171	7.36	7.59	7.30	0.002	-0.015 to 0.020	± 0.04
				7.35	0.005	-0.006 to 0.016	± 0.04
				7.45	0.010	0.005 to 0.014	± 0.04
pO_2 (mmHg)	167	52	105	30	6.1	1.3 to 11.6	± 9.0
				45	5.1	2.0 to 8.6	± 9.0
				60	4.1	2.0 to 5.7	± 9.0

Performance Summary (Cont.)

Clinical Testing

In addition, the data from the native capillary samples (finger-stick samples) previously presented were pooled with contrived capillary samples prepared internally. The regression analysis is shown below:

NOTE: Capillary not claimed for pCO_2 on the GEM Premier 5000.

Pooled Point-of-Care Site and CSL Data with Additional Contrived Capillary Results					
Analyte	**N**	**Slope**	**Intercept**	**r**	**Sample Range**
pH	189	0.935	0.494	0.975	7.07 to 7.89
pO_2 (mmHg)	218	1.008	2.545	0.996	6 to 676

Conclusion	The technological and functional characteristics of the new GEM Premier 5000 as described above are substantially equivalent to that of the predicate device (GEM Premier 4000) for pH, pCO_2, pO_2. The analytical and clinical study results demonstrate that the GEM Premier 5000 is safe and effective for its intended purpose and equivalent in performance to the predicate device.