



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

I Background Information:

A 510(k) Number

K223608

B Applicant

Instrumentation Laboratory Company

C Proprietary and Established Names

GEM Premier 7000 with iQM₃

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
CHL	Class II	21 CFR 862.1120 - Blood Gases (PCO ₂ , PO ₂) And Blood Ph Test System	CH - Clinical Chemistry
JGS	Class II	21 CFR 862.1665 – Sodium test system	CH - Clinical Chemistry
CEM	Class II	21 CFR 862.1600 - Potassium test system	CH - Clinical Chemistry
CGZ	Class II	21 CFR 862.1170 - Chloride test system	CH - Clinical Chemistry
JFP	Class II	21 CFR 862.1145 - Calcium test system	CH - Clinical Chemistry
CGA	Class II	21 CFR 862.1345 - Glucose test system	CH - Clinical Chemistry
KHP	Class I	21 CFR 862.1450 - Lactic acid test system	CH - Clinical Chemistry
MQM	Class I, reserved	21 CFR 862.1113 – Bilirubin (total and unbound) in the neonate test system	CH - Clinical Chemistry

Product Code(s)	Classification	Regulation Section	Panel
GKF	Class II	21 CFR 864.5600 – Automated hematocrit instrument	HE – Hematology
GHS	Class II	21 CFR 864.7425 - Carboxyhemoglobin assay	HE - Hematology
GKR	Class II	21 CFR 864.5620 – Automated hemoglobin system	HE - Hematology
GLY	Class II	21 CFR 864.7500 - Whole blood hemoglobin assays	HE - Hematology

II Submission/Device Overview:

A Purpose for Submission:

Modification of an existing device

B Measurand:

pH, pCO₂, pO₂, sodium, potassium, chloride, ionized calcium, glucose, lactate, hematocrit, total bilirubin, and CO-Oximetry (tHb, O₂Hb, COHb, MetHb, HHb, sO₂*)

C Type of Test:

Quantitative, potentiometric for pH, pCO₂, Na⁺, K⁺, Cl⁻, Ca⁺⁺

Quantitative, amperometry for pO₂, glucose and lactate

Quantitative, electrical conductivity for hematocrit

Quantitative, spectrophotometric method for total bilirubin, tHb, O₂Hb, COHb, MetHb, HHb, sO₂

III Intended Use/Indications for Use:

A Intended Use(s):

See Indications for Use below.

B Indication(s) for Use:

The GEM Premier 7000 with iQM₃ is a portable critical care system for use by health care professionals to rapidly analyze lithium 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, pCO₂, pO₂, sodium, potassium, chloride, ionized calcium, glucose, lactate, hematocrit, total bilirubin, and CO-Oximetry (tHb, O₂Hb, COHb, MetHb, HHb, sO₂*) parameters from arterial, venous, or capillary lithium heparinized whole blood. 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.

*sO₂ = ratio between the concentration of oxyhemoglobin and oxyhemoglobin plus deoxyhemoglobin.

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

Electrolytes in the human body have multiple roles. Nearly all metabolic processes depend on or vary with electrolytes:

- Sodium (Na⁺) measurements are used in the diagnosis and treatment of aldosteronism, diabetes insipidus, adrenal hypertension, Addison's disease, dehydration, inappropriate antidiuretic secretion, or other diseases involving electrolyte imbalance.
- Potassium (K⁺) measurements are used to monitor electrolyte balance in the diagnosis and treatment of disease conditions characterized by low or high blood potassium levels.
- Ionized calcium (Ca⁺⁺) measurements are used in the diagnosis and treatment of parathyroid disease, a variety of bone diseases, chronic renal disease, and tetany.
- Chloride (Cl⁻) measurements are used in the diagnosis and treatment of electrolyte and metabolic disorders, such as cystic fibrosis and diabetic acidosis.

Hematocrit (Hct) measurements in whole blood of the packed red cell volume of a blood sample are used to distinguish normal from abnormal states, such as anemia and erythrocytosis (an increase in the number of red cells).

Glucose (Glu) measurement is used in the diagnosis, monitoring and treatment of carbohydrate metabolism disturbances including diabetes mellitus, neonatal hypoglycemia, idiopathic hypoglycemia, and pancreatic islet cell carcinoma.

Lactate (Lac) measurement is used:

- to evaluate the acid-base status of patients suspected of having lactic acidosis;
- to monitor tissue hypoxia and strenuous physical exertion;
- in the diagnosis of hyperlactatemia.

Total Bilirubin (tBili) measurement is used to aid in assessing the risk of kernicterus and hyperbilirubinemia in neonates.

CO-Oximetry (tHb, COHb, MetHb, O₂Hb, HHb, and sO₂) evaluates the ability of the blood to carry oxygen by measuring total hemoglobin and determining the percentage of functional and dysfunctional hemoglobin species.

- Total Hemoglobin (tHb): Total hemoglobin measurements are used to measure the hemoglobin content of whole blood for the detection of anemia.
- COHb: Carboxyhemoglobin measurements are used to determine the carboxyhemoglobin content of human blood as an aid in the diagnosis of carbon monoxide poisoning.

- MetHb: Methemoglobin measurements are used to determine different conditions of methemoglobinemia.
- HHb: Deoxyhemoglobin, as a fraction of total hemoglobin, is used in combination with oxyhemoglobin to measure oxygen status.
- O2Hb: Oxyhemoglobin, as a fraction of total hemoglobin, is used in combination with deoxyhemoglobin to measure oxygen status.
- sO2: Oxygen saturation, more specifically the ratio between the concentration of oxyhemoglobin and oxyhemoglobin plus deoxyhemoglobin, is used to measure oxygen status.

C Special Conditions for Use Statement(s):

Rx - For Prescription Use Only

D Special Instrument Requirements:

GEM Premier 7000 with iQM₃

IV Device/System Characteristics:

A Device Description:

The GEM Premier 7000 system with iQM₃ is a modified GEM Premier 5000 (predicate cleared under K203079) that includes a hemolysis detection feature within the Intelligent Quality Management system (iQM₃).

B Principle of Operation:

Same as the predicate cleared under K203079 except for the addition of the photometric hemolysis detection feature.

C Instrument Description Information:

1. Instrument Name:
GEM Premier 7000 with iQM₃
2. Specimen Identification:
Same as the predicate cleared under K203790
3. Specimen Sampling and Handling:
Same as the predicate cleared under K203790
4. Calibration:
Same as the predicate cleared under K203790
5. Quality Control:
iQM₃ has the same quality control functions as iQM₂ in the predicate except for the addition of the hemolysis detection feature.

V Substantial Equivalence Information:

A Predicate Device Name(s):

GEM Premier 5000

B Predicate 510(k) Number(s):

K203790

C Comparison with Predicate(s):

Device & Predicate Device(s):	<u>K223608</u>	<u>K203790</u>
Device Trade Name	GEM Premier 7000 with iQM ₃	GEM Premier 5000
General Device Characteristic Similarities		
Intended Use/Indications For Use	The instrument provides quantitative measurements of pH, <i>p</i> CO ₂ , <i>p</i> O ₂ , sodium, potassium, chloride, ionized calcium, glucose, lactate, hematocrit, total bilirubin, and CO-Oximetry (tHb, O ₂ Hb, COHb, MetHb, HHb, sO ₂ *). 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.	Same
Intended User	Central Laboratory and Point-of-Care	Same
Measurement Principle	Potentiometry: pH, <i>p</i> CO ₂ , Na ⁺ , K ⁺ , Cl ⁻ , Ca ⁺⁺ Amperometry: <i>p</i> O ₂ , Glucose, Lactate Spectrophotometry: tHb, O ₂ Hb, COHb, MetHb, HHb, sO ₂ , bilirubin Conductivity: hematocrit	Same
Sample Type	Venous, arterial and capillary lithium heparinized whole blood	Same
General Device Characteristic Differences		
Hemolysis detection	iQM ₃ - hemolysis detection in whole blood samples	iQM ₂ without hemolysis detection feature

VI Standards/Guidance Documents Referenced:

CLSI EP05-A3: Evaluation of Precision of Quantitative Measurement Procedures, Third Edition;
CLSI EP09c: Measurement Procedure Comparison and Bias Estimation Using Patient Samples, Third Edition;
CLSI EP07: Interference Testing in Clinical Chemistry, Third Edition;
CLSI EP37: Supplemental Tables for Interference Testing in Clinical Chemistry, First Edition;
Content of Premarket Submissions for Management of Cybersecurity in Medical Devices
Guidance for Industry and Food and Drug Administration Staff, October 2, 2014.

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

1. Precision/Reproducibility:

An internal precision study was performed in normal mode (syringe) and in micro mode (capillary) using lithium heparin venous whole blood samples at 5 different levels for each analytes and the results support that the precision is not changed by adding the hemolysis detection feature to the device.

2. Linearity:

Previously established in K160225, K160412, and K160415.

3. Analytical Specificity/Interference:

In addition to the studies described in K160225, K160412, and K160415, a new interference study was performed to evaluate the potential impact of hemolysis interference on potassium results. Venous whole blood was ultrasonically-lysed to generate a high hemolysis pool (100% = 1000 mg/dL plasma-free hemoglobin). The high hemolysis pool was mixed with native venous whole blood without hemolysis (0%) to generate 3 additional hemolysis levels (25%, 50%, 75%). Testing was performed using two concentrations of potassium: 3.8 mmol/L and 5.3 mmol/L. Each combination of potassium level and hemolysis level was tested in triplicate on 3 GEM Premier 7000 with iQM₃, using 3 different cartridge lots, for a total of 9 replicates of each hemolysis level/potassium level. Both the normal mode and the micro mode were evaluated. Interference was calculated as the bias between the average result with the interfering substance and the average control measurement. The sponsor considered no significant interference to be $\leq 7\%$ bias for this study. The highest level of hemolysis with no significant interference was 115 mg/dL plasma-free hemoglobin. Hemolysis of ≥ 116 mg/dL was found to have significant interferences the with potassium result.

The labeling contains the following statement:

Do not use hemolyzed samples, as hemolyzed samples may cause falsely elevated potassium results. A GEM Premier 7000 with iQM₃ hemolysis flag (estimated hemolysis = 116 mg/dL) indicates hemolysis interference has been detected and the potassium result should not be

reported out of the laboratory. It is strongly recommended that hemolysis detection remain enabled in order to detect hemolysis in samples.

4. Assay Reportable Range:

Previously established in K160225, K160412, and K160415.

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):

As described in K160225, K160412, and K160415.

6. Detection Limit:

Previously established in K160225, K160412, and K160415.

7. Assay Cut-Off:

Not applicable.

8. Accuracy (Instrument):

See method comparison study.

9. Carry-Over:

Not applicable

B Comparison Studies:

1. Method Comparison with Predicate Device:

Lithium heparin venous and arterial whole blood and fingerstick capillary samples were assayed by 3 point-of-care (POC) operators at 1 simulated clinical site using 2 GEM Premier 7000 with iQM₃ and 2 GEM Premier 5000. Venous and arterial samples were assayed in normal mode and fingerstick capillary samples were assayed in normal mode and micro mode. Each sample was run in singlicate on 1 GEM Premier 7000 with iQM₃ and 1 GEM Premier 5000. Deming Regression was used for analytes with constant SD and Passing-Bablok was used for analytes with mixed variability. The results support that the addition of the hemolysis detection feature did not impact the accuracy of device results in normal mode or in micro mode.

The representative study results for venous and arterial samples from POC in normal mode are shown below:

Analyte	N	Sample Range	Analysis	Slope	Intercept	R
pH	156	7.03-7.75	Deming	0.981	0.135	0.996
pCO ₂ (mmHg)	159	10-116	Passing-Bablok	1.000	0.000	0.997
pO ₂ (mmHg)	160	30-536	Passing-Bablok	1.000	1.000	0.999
Sodium (mmol/L)	159	105-169	Deming	0.964	5.256	0.994

Analyte	N	Sample Range	Analysis	Slope	Intercept	R
Potassium(mmol/L)	152	2.2-18.6	Passing-Bablok	1.000	0.000	0.999
Chloride (mmol/L)	158	48-156	Passing-Bablok	1.000	0.000	0.997
Ionized Calcium (mmol/L)	159	0.36-3.70	Passing-Bablok	0.982	0.003	0.999
Glucose (mg/dL)	155	12-637	Passing-Bablok	1.000	0.000	0.999
Lactate (mmol/L)	156	0.7-16.6	Passing-Bablok	0.970	-0.027	0.997
Hematocrit (%)	157	19-68	Deming	0.996	-0.370	0.995
Total hemoglobin (g/dL)	157	7.0-22.2	Deming	0.994	0.055	0.998
Oxyhemoglobin (%)	157	6.0-98.4	Deming	0.995	0.377	1.000
Carboxyhemoglobin (%)	157	1.2-65.6	Deming	0.998	0.020	0.999
Methemoglobin (%)	128	0.7-26.6	Passing-Bablok	0.994	0.045	0.999
Deoxyhemoglobin (%)	124	1.1-92.8	Deming	0.999	-0.082	1.000
sO2 (%)	157	6.1-100.0	Deming	0.997	0.294	1.000
Total bilirubin (mg/dL)	106	2.0-35.8	Passing-Bablok	0.985	-0.003	0.999

The study results for capillary fingerstick samples from POC in normal mode are shown below:

Analyte	N	Sample Range	Analysis	Slope	Intercept	R
pH (pH units)	140	7.07-7.71	Deming	0.987	0.089	0.982
pCO2 (mmHg)	140	10-113	Passing-Bablok	1.000	0.000	0.991
pO2 (mmHg)	140	32-554	Passing-Bablok	1.000	-3.000	0.997
Sodium (mmol/L)	137	106-169	Deming	0.990	1.685	0.987
Potassium (mmol/L)	138	2.2-18.0	Passing-Bablok	1.000	0.100	0.995
Chloride (mmol/L)	137	48-148	Passing-Bablok	1.000	0.000	0.993
Ionized Calcium (mmol/L)	138	0.36-3.60	Passing-Bablok	1.000	0.000	0.997
Glucose (mg/dL)	136	35-626	Passing-Bablok	1.000	0.000	0.998
Lactate (mmol/L)	135	0.5-12.5	Passing-Bablok	0.974	-0.100	0.993
Hematocrit (%)	138	17-67	Deming	0.977	-1.135	0.979
Total hemoglobin (g/dL)	133	7.1-22.0	Deming	0.981	-0.005	0.992
Oxyhemoglobin (%)	130	6.1-97.5	Deming	0.979	0.834	0.997
Carboxyhemoglobin (%)	131	0.7-65.2	Deming	1.003	0.040	0.999
Methemoglobin (%)	107	0.7-26.7	Passing-Bablok	1.000	0.000	1.000
Deoxyhemoglobin (%)	128	1.1-92.6	Deming	0.975	0.349	0.997
sO2 (%)	130	6.2-99.2	Deming	0.984	0.845	0.996
Total bilirubin (mg/dL)	109	2.2-35.9	Passing-Bablok	0.986	-0.200	0.999

The study results for capillary fingerstick samples in micro mode are shown below:

Analyte	N	Sample Range	Analysis	Slope	Intercept	R
pH (pH units)	116	7.08-7.71	Deming	0.985	0.096	0.980
pCO ₂ (mmHg)	116	11-99	Passing-Bablok	1.000	0.000	0.989
pO ₂ (mmHg)	116	33-567	Passing-Bablok	0.978	-0.648	0.996
Sodium (mmol/L)	114	106-170	Deming	1.007	-0.445	0.990
Potassium (mmol/L)	114	2.2-18.6	Passing-Bablok	0.995	0.000	0.995
Chloride (mmol/L)	112	48-157	Passing-Bablok	0.996	-1.000	0.996
Ionized Calcium (mmol/L)	114	0.35-3.55	Passing-Bablok	0.987	0.006	0.997
Glucose (mg/dL)	113	36-662	Passing-Bablok	1.000	-2.000	0.999
Lactate (mmol/L)	115	0.5-13.4	Passing-Bablok	1.000	0.000	0.997
Hematocrit (%)	114	19-72	Deming	0.963	1.838	0.978

2. Matrix Comparison:

Not applicable.

C Clinical Studies:

1. Clinical Sensitivity:

Not applicable.

2. Clinical Specificity:

Not applicable.

3. Other Clinical Supportive Data (When 1. and 2. Are Not Applicable):

Not applicable.

D Clinical Cut-Off:

Not applicable.

E Expected Values/Reference Range:

Previously established in K160225, K160412, and K160415.

F Other Supportive Instrument Performance Characteristics Data:

The GEM Premier 7000 with iQM₃ does not report a specific plasma free hemoglobin result to the user, but displays flags indicating different degrees of hemolysis (mild, moderate, gross) to represent the estimated hemolysis (plasma free hemoglobin).

To verify the hemolysis flag performance of the GEM Premier 7000 with iQM₃ in whole blood samples, a hemolysis verification study was performed using a volumetric spiking procedure by adjusting native (venous and arterial) whole blood samples with ultrasonically lysed whole blood to span 6 hemolysis index categories to verify the hemolysis flag performance in venous and arterial samples in normal mode. Hemolysate-contrived venous samples transferred to a capillary device were tested in micro mode to verify the hemolysis flag performance in capillary samples. All results were analyzed using a volumetric target value and overall agreement analysis was performed for the pooled dataset (venous, arterial, and transferred capillary samples) as well as for venous, arterial, and transferred capillary samples separately. All samples were correctly flagged, and 99.2% of venous, 97.6% of arterial, and 99.2% of transferred capillary samples were correctly flagged based on the target value of the spiked hemoglobin.

VIII Proposed Labeling:

The labeling supports the finding of substantial equivalence for this device.

IX Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.