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

I Background Information:

A 510(k) Number
K211559

B Applicant
Medica Corporation

C Proprietary and Established Names
EasyStat 300

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
CHL	Class II	21 CFR 862.1120 - Blood Gases (pCO2, pO2) And Blood pH Test System	CH - Clinical Chemistry

II Submission/Device Overview:

A Purpose for Submission:
New Device

B Measurand:
pCO2, pO2 and pH

C Type of Test:
pH and pCO2 – quantitative, potentiometry
pO2 – quantitative, amperometric technology

III Intended Use/Indications for Use:

A Intended Use(s):
See indications for use below.

B Indication(s) for Use:

The EasyStat 300 is designed for clinical laboratory use, making quantitative measurements of pO2 (partial pressure of oxygen), pCO2 (partial pressure of carbon dioxide), and pH (hydrogen ion activity) in whole blood (arterial/venous) samples from Li-Heparinized Syringes or Capillary Tubes. This Analyzer should only be used by trained technicians in clinical laboratories to aid in the diagnosis and treatment of patients with blood gas and/or acid-base disturbances.

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

C Special Conditions for Use Statement(s):

Rx - For Prescription Use Only
For in vitro diagnostic use only

D Special Instrument Requirements:

EasyStat 300 Analyzer

IV Device/System Characteristics:

A Device Description:

The candidate device is comprised of the EasyStat 300 Analyzer, the EasyStat reagent pack, reference electrode, pO2 sensor, ion selective electrode cartridges (for pH and pCO2), barcode scanner, and calibrators. The system is designed for use by trained medical professionals in the clinical laboratory and is for prescription use only.

The EasyStat 300 consists of a reagent module containing calibrating solutions A2, B2, and C2. The analyzer runs in two modes: the syringe mode (175µL of lithium heparinized venous whole blood and arterial blood) and the capillary mode (100µL of lithium heparinized venous whole blood and arterial blood) to analyze patient samples. To operate the analyzer in the capillary mode, a separate capillary tube kit is required. Medica's EasyQC materials are required to be run every day to validate the performance of the analyzer.

B Principle of Operation:

pH: pH is measured using a potentiometric method based on the use of an ion-selective electrode. One side of the membrane is in contact with a solution of constant pH. The other side is in contact with a solution of unknown pH. A change in potential develops which is proportional to the pH difference of these solutions. This change in potential is measured against a reference electrode of constant potential. The magnitude of the potential difference is a measure of the pH of the unknown sample.

pCO2: pCO2 is measured using a potentiometric method based modified pH sensor. Carbon dioxide in the sample makes contact with a polymeric membrane mounted on a combination measuring/ reference electrode. CO_2 diffuses across the membrane into a thin layer of electrolyte solution in response to partial pressure difference. This solution then becomes equilibrated with the external gas pressure. CO_2 in the solution becomes hydrated, which results in a change in hydrogen ion activity, according to the equation:

$CO_2 + H_2O <=> H^+ + [HCO_3–]$

The change in hydrogen ion activity in the electrolyte solution produces a potential which is measured against the internal filling solution. This change in potential is measured against the constant potential of the reference electrode half cell and is logarithmically related to the pCO2 of the unknown sample.

pO2: pO2 is measured amperometrically by the generation of a current at the sensor surface. As oxygen diffuses through a gas permeable membrane, the oxygen molecules are reduced at the cathode, consuming four electrons for every molecule of oxygen reduced. This flow of electrons is then measured by the sensor and is directly proportional to the partial pressure of oxygen in the sample.

C Instrument Description Information:

1. Instrument Name:
   EasyStat 300

2. Specimen Identification:
   The specimen identification may be manually entered or automatically scanned by the device.

3. Specimen Sampling and Handling:
   The EasyStat 300 accepts lithium heparinized venous whole blood and arterial blood from syringes or capillary tubes.

   The sample type is selected using the device touchscreen. Samples may be introduced via a collection glass/plastic syringe or a capillary tube. After the sample type (i.e. whole blood arterial/venous samples) is selected and loaded, the probe is placed in the sample, which will aspirate the appropriate sample volume (i.e. syringe mode - 175 µL, capillary mode - 100 µL). Once the sample is loaded, the analyzer moves the sample to the sensor module for analysis.

4. Calibration:
   The EasyStat 300 undergoes pump calibration, air calibration, and 2-point calibration. Once the first calibration is completed, the analyzer will continue to perform calibrations automatically on a fixed schedule. The time between calibrations is determined based on the age (in hours) since the sensors/cartridges were first installed.

5. Quality Control:
   The EasyStat 300 requires the use of three levels of Medica's EasyQC materials for use on the analyzer. Results that exceed the entered ranges are flagged for identification. Quality control recommendations are provided in the labeling. It is recommended that each laboratory follow their local, state, and federal regulations as it applies to quality control materials.

6. Reagents:
   The EasyStat 300 utilizes a reagent module which contains all the reagents, concentration of calibration reagents, current reagent module serial number and installation date, and reagent volume % remaining with the number of days remaining before calibrators expire.

V Substantial Equivalence Information:

A Predicate Device Name(s):

EasyStat pH, PCO2, PO2, Hct, Na+, K+, Ca++ Analyzer

B Predicate 510(k) Number(s):

K021515

C Comparison with Predicate(s):

Device & Predicate Device(s):	K211559	K021515
Device Trade Name	EasyStat 300	EasyStat PH, PCO2, PO2, HCT, NA+, K+, CA++ Analyzer
General Device Characteristic Similarities		
Intended Use/Indications For Use	Analyzer for clinical laboratory use intended to measure pH, pCO2, and pO2. pCO2, pO2, and pH measurements in blood are used in the diagnosis and treatment of life-threatening acid-base disturbances.	Same
Sample type	Venous whole blood and arterial blood	Same
Measuring Range – pCO2	5.0-150.0 mmHg	Same
Measuring Range – pO2	5-700 mmHg	Same
Measurement principle	pH: Potentiometric pCO2: Potentiometric pO2: Amperometric	Same
General Device Characteristic Differences		
Analytes measured	pH, pCO2, pO2	pH, pCO2, pO2, HCT, NA+, K+, CA++
Measuring Range – pH	6.800-8.000 units	6.500-8.000 units
Sample volume	175µL Syringe 100 µL Capillary	120µL Syringe 95 µL Capillary
Analysis Time	110 seconds 120 seconds	120 seconds

Communication ports	USB for barcode scanner	None
	Ethernet port	None
	SanDisk (SD) card port	None

VI Standards/Guidance Documents Referenced:

IEC 60601-1-2:2014 Medical Electrical Equipment - Part 1-2: General Requirements For Basic Safety And Essential Performance - Collateral Standard: Electromagnetic Disturbances - Requirements And Tests.
Clinical and Laboratory Standards Institute (CLSI) EP05-A3: Evaluation of Precision of Quantitative Measurement Procedures; Approved Guideline—Third Edition.
CLSI EP25-A: Evaluation of Stability of In Vitro Diagnostic Reagents.
CLSI EP07- 3rd Edition: Interference Testing in Clinical Chemistry.
CLSI EP37-1st Edition: Supplemental Tables for Interference Testing in Clinical Chemistry.
CLSI EP 17-A2, 2nd Edition: Evaluation of Detection Capability for Clinical Laboratory Measurement Procedures.

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

1. Precision/Reproducibility:
   Two precision studies (i.e. Within-Run and Run-to-Run) were performed following the recommendations in CLSI EP05-A3.

   Within Run Precision Evaluation:
   Within run precision testing was performed using lithium heparinized venous whole blood in both the "Syringe" and the "Capillary" modes. Testing was performed on three EasyStat 300 analyzers over five days. Venous whole blood samples were collected in the following manner: the first set of samples was analyzed immediately after collection, and the other two were tonometered with a gas mixture to change the levels of pH, pCO2, and pO2. Five venous whole blood samples were tested in five replicates at each concentration level in the syringe mode, and then subsequently in the capillary mode. The results from one representative analyzer for both modes are summarized below.

   Precision Performance of the EasyStat 300 operating in Syringe mode:

Analyzer					
Analyte	Level	N	Mean	Within-Run	
				SD	%CV
pCO	1	25	37.2 mmHg	0.56	1.5
	2	25	66.8 mmHg	1.49	2.2
	3	25	131.1 mmHg	3.52	2.7
pO2	1	25	39 mmHg	0.60	1.5
	2	25	78 mmHg	1.50	1.9
	3	25	224 mmHg	3.40	1.5
pH	1	25	7.41 pH units	0.01	0.10
	2	25	7.25 pH units	0.01	0.10
	3	25	7.59 pH units	0.01	0.10

Precision Performance of the EasyStat 300 operating in Capillary mode:

Analyzer					
Analyte	Level	N	Mean	Within-Run	
				SD	%CV
pCO2	1	25	35.2 mmHg	1.31	3.7
	2	25	67.4 mmHg	3.09	4.6
	3	25	135.5 mmHg	5.61	4.1
pO2	1	25	39 mmHg	0.70	1.8
	2	25	79 mmHg	1.80	2.3
	3	25	222 mmHg	2.80	1.3
pH	1	25	7.41 pH units	0.01	0.10
	2	25	7.22 pH units	0.01	0.10
	3	25	7.58 pH units	0.01	0.10

Multi-Day Precision Testing:
Two 20-Day precision studies were performed using three levels of aqueous quality control solutions and three different concentrations of pH, pCO2, and pO2 on three EasyStat 300 analyzers. Analyzers were calibrated twice daily, prior to testing of the QC materials. After each calibration, two samples of each QC level (i.e. level 1, 2, 3) were tested in syringe and capillary modes. The results from one representative analyzer for both modes are summarized below.

Precision Performance of the EasyStat 300 operating in "Syringe" mode:

Analyzer							
Analyte	Level	N	Mean	Within-Run		Total	
				SD	%CV	SD	%CV
pCO2	1	80	68.1 mmHg	0.50	0.7	0.59	0.9
	2	80	45.2 mmHg	0.43	0.9	0.46	1.0
	3	80	21.4 mmHg	1.09	5.1	1.13	5.3
pO2	1	80	35 mmHg	0.84	2.4	1.33	3.8
	2	80	98 mmHg	1.89	1.9	2.23	2.3
	3	80	137 mmHg	1.56	1.1	1.97	1.4
pH	1	80	7.182 pH units	0.002	0.02	0.002	0.03
	2	80	7.410 pH units	0.003	0.04	0.003	0.04
	3	80	7.623 pH units	0.001	0.01	0.002	0.03

Precision Performance of the EasyStat 300 operating in "Capillary" mode:

Analyzer							
Analyte	Level	N	Mean	Within-Run		Total	
				SD	%CV	SD	%CV
pCO2	1	80	63.2 mmHg	0.68	1.1	1.00	1.6
	2	80	41.2 mmHg	0.42	1.0	0.46	1.1
	3	80	21.2 mmHg	0.23	1.1	0.25	1.2
pO2	1	80	52 mmHg	2.41	4.6	4.00	7.7
	2	80	108 mmHg	1.99	1.8	2.25	2.1
	3	80	141 mmHg	2.50	1.8	2.72	1.9
pH	1	80	7.20 pH units	0.01	0.09	0.01	0.16
	2	80	7.42 pH units	0.00	0.03	0.01	0.06
	3	80	7.61 pH units	0.00	0.04	0.00	0.06

2. Linearity:
To support the measuring range, pH and pO2 were tested for linearity at 11 levels, and pCO2 was tested at nine levels. The samples were venous whole blood from healthy subjects that were adjusted to different levels by addition of HCL or NaOH for pH samples, and tonometrization for pO2 and pCO2 samples. Samples at the different levels were tested in triplicate on the EasyStat 300 analyzers. For pH, pO2 and pCO2, regression analysis demonstrated first order linearity.

The linear regression results are given in the table below:

Analyte	Tested Range	Claimed Measuring Range	Slope	Intercept	r
pH	6.75-7.99	6.80 - 8.00 pH units	1.01	-0.07	0.99
pCO2	5.0-184.6	5.0 - 150.0 mmHg	1.08	-2.42	0.99
pO2	5.0 – 718	5.0 -700.0 mmHg	1.01	1.19	0.99

Based on these results, the linearity data support the claimed measuring interval for pH, pCO2, and pO2.

3. Analytical Specificity/Interference:

An interference testing study for endogenous and exogenous substances was performed on lithium heparin venous whole blood samples in accordance with CLSI EP37-Edition 1. With these samples, an interference screening test was conducted at 2 levels of pH (7.19 pH units and 7.48 pH units), pCO2 (37 mmHg and 90 mmHg), and pO2 (23 mmHg and 143 mmHg), tested in triplicate, on three EasyStat 300 analyzers. Interference was calculated as the bias between the average test result with interfering substance and average control measurement on one EasyStat 300 analyzer.

The following substances did not cause interference at the concentrations listed below:

Endogenous substances:

Substance	Highest conc. tested without significant interference
Albumin	60 g/L
Conjugated Bilirubin	20 mg/dL
Hemoglobin	2500 mg/dL
Triglycerides	2000mg/dL
Hematocrit	65%

Exogenous substances:

Substance	Highest conc. tested without significant interference
Acetaminophen	15.6 mg/dL
Amoxicillin	0.206 mM
Aprotinin	50 mg/L
Atracurium	50 mg/L
Benzalkonium (Chloride)	5 mg/L
Ceftriaxone	1.46 mM
Ciprofloxin	30.2 µM
Epinephrine	0.5 µM
Ethanol	600 mg/dL
Gentamycin	21 µmol/L
Halothane	759 µmol/L
Hematocrit	25%
Heparin	100 kU/L
Lithium (Chloride)	3.2 mmol/L
Omeprazole	0.9 mg/dL
Propofol	270 µM
Suxamethonium	68 µM
Thyroxine	1.29 µM

4. Assay Reportable Range:
   See section VII A.2 Linearity.

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):
   Traceability:
   Blood gases analytes (i.e. pCO2 and pO2) and pH run on the Easystat300 analyzer are traceable to NIST standards and SRM2181/2182/2183/2184 reference materials, respectively.

   Stability:
   Shelf life stability studies demonstrated that the ISE cartridge as it pertains to measuring pH has an on-board stability of 30 days when stored in the claimed range of 4-25°C. The sensors for pCO2 and pO2 have an on-board stability of 90 days. The protocols for stability and acceptance criteria were reviewed and found to be adequate.

6. Detection Limit:
The Limit of Blank (LoB), Limit of Detection (LoD) and Limit of Quantification (LoQ) were evaluated in accordance with CLSI EP17-A2.

For pCO2 and pO2, the LoB and LoD of the EasyStat300 analyzer were evaluated using tonometered lithium heparin venous whole blood samples. LoQ was defined as the lowest concentration at which measured total error was less than the pre-defined total allowable error of ± 5 mmHg.

For pH, a saline aqueous solution buffered at low pH were used to estimate LoB, LoD, and LoQ. Linearity studies were used to support the lower end of the measuring range for pH (see section VII.A.2. above).

The results are summarized in the table below:

Analyte	LoB	LoD	LoQ
pCO2	2.8 mmHg	4.6 mmHg	4.6 mmHg
pO2	3 mmHg	4 mmHg	4.6 mmHg
pH	6.14 pH units	6.50 pH units	6.50 pH units

These results support the claimed measuring ranges for pH, pCO2, and pO2.

7. Assay Cut-Off:
Not applicable.

8. Accuracy (Instrument):
See Section B1. Method Comparison with Predicate Device.

9. Carry-Over:
Not applicable.

B Comparison Studies:

1. Method Comparison with Predicate Device:
Whole blood and arterial samples were collected in lithium heparin anticoagulated syringes and capillary tubes and tested, of which ~3% samples were contrived, on the predicate device (i.e. the EasyStat analyzer) and on the EasyStat 300 analyzer. Testing was performed in capillary and syringe modes on the EasyStat and EasyStat 300 analyzers. The results for pO2 were analyzed using Passing-Bablok regression. The results for pCO2 and pH were analyzed using Ordinary Least Squares (OLS) regression. The results are summarized below:

Method comparison in Syringe mode:

Analyte	Sample size	Sample range	Slope	Intercept	R^2
pCO2	263	7.6-142.3 mmHg	1.04	-1.16	0.99
pO2	270	5-691 mmHg	1.03	-0.89	0.99
pH	272	6.75-8.00 pH units	1.04	-0.30	0.96

Method comparison in Capillary mode:

Analyte	Sample size	Sample range	Slope	Intercept	R^2
pCO2	216	22.6-85.6 mmHg	0.94	2.67	0.91
pO2	222	29-375 mmHg	1.01	-1.86	0.97
pH	221	7.07-7.52 pH units	0.98	0.16	0.92

2. Matrix Comparison:
Not applicable. The acceptable sample types for this device are lithium heparin venous whole blood and arterial blood.

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:
Reference ranges for pH, pCO2 and pO2 are cited from the literature [1, 2] :

Arterial blood:
pH: 7.350-7.450 (pH units)
pCO2: 35-45 mmHg
pO2: 83-108 mmHg

Venous whole blood:
pH: 7.340-7.360 (pH units)
pCO2: 44.0-46.0 mmHg
pO2: 38-42 mmHg

[1] Tietz NW, Fundamentals of Clinical Chemistry, 5th ed. 2001, pg. 509.

[2] Burnett RW, Noonan DC. "Calculations and Correction Factors Used in Determination of Blood pH and Blood Gases", Clin. Chem., Vol 20, No. 12, pp. 1499-1506 (1974).

F Other Supportive Instrument Performance Characteristics Data:

Operating conditions (temperature, humidity):
A study was conducted to test the performance of pH, pCO2 and pO2 at different temperature and humidity conditions. Temperatures ranging from 15 - 30°C and 5 –85% relative humidity (RH) were tested. Three levels of aqueous QC materials were tested in 15 replicates for each level. The study results support the labeled operating conditions claim of 15-30°C (59 – 86°F) and 5-85% RH.

VIII Proposed Labeling:

The labeling des 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.