510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY ONLY TEMPLATE

A. 510(k) Number:

k093910

B. Purpose for Submission:

New device

C. Measurand:

Not applicable - blood collection system

D. Type of Test:

Not applicable

E. Applicant:

Guangzhou Improve Medical Instruments Co., Ltd.

F. Proprietary and Established Names:

IMPROVACUTER® Gel & Clot Activator Tube

G. Regulatory Information:

1. Regulation section:

   21CFR 862.1675 (Blood specimen collection devices)

2. Classification:

   Class II

3. Product code:

   JKA

4. Panel:

   75 (Chemistry)

H. Intended Use:

1. Intended use(s):

   See Indication for use below

2. Indication(s) for use:

   IMPROVACUTER Gel & Clot Activator Tube is a single use tube used to collect, transport, separate, and process venous blood specimens to obtain serum for clinical chemistry and immunology assays. It is used in settings where a venous blood sample is collected by a trained healthcare worker. For *in vitro* diagnostic use.

3. Special conditions for use statement(s):

   Prescription Use only.

   These blood collection tubes are not recommended for Therapeutic drug monitoring (TDM), blood banking and infectious disease testing.

4. Special instrument requirements:

   Specific analyzers used to evaluate the device are listed in the labeling and below in section M. 2. a. method comparison.

I. Device Description:

The IMPROVACUTER Gel & Clot Activator Tube is sterile, plastic, evacuated blood collection tube. The tube consists of (1) a closure assembly, (2) a silica clot activator, (3) a barrier gel and (4) a plastic tube. The specimens are used for clinical laboratory assays involving the use of patient serum.

The IMPROVACUTER Gel & Clot Activator Tube is a 13 x 100 mm, 5.0 mL, and plastic evacuated tube with either a gold conventional closure or a gray safety cap. The interior of the tube wall is coated with clot activator to promote rapid clotting. The tube contains a gel barrier polymer at the tube bottom. The density of this material causes it to move upward during centrifugation to the serum-clot interface, where it forms a barrier separating serum from the clot. Serum may be aspirated directly from the collection tube, eliminating the need to transfer to another container. The tube interior is sterile and the product is for single use only.

J. Substantial Equivalence Information:

1. Predicate device name(s):

   BD Vacutainer® Gel & Clot Activator Tube

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

k023075

3. Comparison with predicate:

Similarities and Differences between the candidate device and the predicate device

Items	**BD Vacutainer® Tube (Predicate device-k023075)**	**Improvacuter Gel & Clot Activator Tube (Candidate device)**
Intended use	Single use tube used to collect, separate, transport, and process venous blood specimens to obtain serum for chemistry determinations for *in vitro* diagnostic use. It is used in settings where a venous blood sample is collected by a trained healthcare worker.	Same
Limitations	It is recommended for use with Therapeutic drug monitoring.	Not to be used for Therapeutic drug monitoring, blood banking and infectious disease.
TUBE COMPARISON		
Tube Dimension	13 x 75 mm	13x75 mm, 13 x 100 mm
Draw Volume	3.5 mL	3.0 mL, 5.0 mL
Closure	Conventional rubber closure	Conventional rubber closure (with and without safety cap)
Clot Activator	Silica	Same
Clotting Time	30 minutes	Same
Materials	Plastic	Same
Tube Shelf Life	12 months	Same
Tube Sterility	Sterile	Same

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

1. CLSI Guideline H1-A5, Evacuated Tubes and Additives for Venous Blood Specimen Collection
2. CLSI Guideline H3-A6, Procedures for the Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture
3. CLSI Guideline H18-A3, Procedures for the processing and Handling of Blood Specimens
4. ISO 11137-1 Sterilization of Health Care Products Radiation Part 1- Requirements for the

development, validation and routine control of a sterilization process for medical devices
5. ISO 11137-2 Sterilization of Health Care Products Radiation Part 2- Establishing the sterilization dose
6. ISO 11137-3 Sterilization of Health Care Products Radiation Part 3- Guidance on dosimetric aspects
7. CLSI Guideline EP9-A2, Method Comparison and Bias Estimation Using Patient Samples

L. Test Principle:

The IMPROVACUTER Gel & Clot Activator Tube (IMP tube) is intended to be placed inside either a holder or an adapter of a blood collection system. Once the vein of the patient has been penetrated using a standard needle, the tube is pushed fully into the needle holder so that the non-patient's end of the needle pierces the rubber septum of the stopper of the tube. The tube uses a controlled vacuum to pull a specific volume of blood into the sterile interior of the tube. The pressure differential caused the venous blood to flow into the tube. Once pressure is equalized, the blood flow ceases and the tube is withdrawn from the needle holder or needle. After blood has been drawn, the tube shall be immediately inverted gently for 5 to 8 times to mix the blood with the additives, and then allowed to clot completely. The recommended minimum clotting time is 30 minutes. Once clotting is complete, the tube is to be centrifuged for 10 minutes (when using a swing bucket centrifuge) or 15 minutes (when using a fixed angle centrifuge), at RCF (g force) of 1500-2200.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. Precision/Reproducibility:

Precision studies were performed in conjunctions with the method comparison studies at two external hospital sites. Within-lot precision study and between-lot precision study were performed separately. Testing were performed using twenty apparently healthy subjects per study. For within-lot precision study, each subject has a venous blood collection into four tubes: two IMP tubes with the same lot number and two BD tubes with the same lot number. For between-lot precision study, each subject has a venous blood collection into four tubes: two IMP tubes with different lot numbers and two BD tubes with different lot numbers. Each tube was tested in duplicates for each of the 38 analytes and on multiple different instrument platforms. Results (within-lot and between-lot precision) on one representative instrument platform are summarized in the tables below:

Table 1. Within Lot precision on ROCHE PPI for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
1	ALT(U/L)	24.56	0.37	1.51%	0.85%	2.17%
2	AST(U/L)	20.72	1.03	4.97%	2.79%	7.15%
3	ALP(U/L)	62.62	2.38	3.80%	2.13%	5.47%

4	GGT(U/L)	34.45	0.56	1.63%	0.92%	2.34%
5	TP(g/L)	66.88	0.32	0.48%	0.27%	0.69%
6	ALB(g/L)	37.88	0.39	1.03%	0.58%	1.48%
7	TBIL(umol/L)	11.36	0.25	2.20%	1.24%	3.16%
8	DBIL(umol/L)	9.48	0.2	2.11%	1.19%	3.03%
9	BUN(mmol/L)	4.02	0.17	4.23%	2.38%	6.08%
10	CREAT(umol/L)	67.25	1.99	2.96%	1.66%	4.26%
11	UA(umol/L)	285.05	6.4	2.25%	1.26%	3.24%
12	GLU(mmol/L)	4.62	0.15	3.25%	1.83%	4.67%
13	CHOL(mmol/L)	4.75	0.14	2.95%	1.66%	4.24%
14	TG(mmol/L)	0.91	0.02	2.20%	1.24%	3.16%
15	Apo-A1(g/L)	1.23	0.02	1.63%	0.92%	2.34%
16	Apo-B(g/L)	0.73	0.02	2.74%	1.54%	3.94%
17	K(mmol/L)	4	0.09	2.25%	1.26%	3.24%
18	Na(mmol/L)	135.34	0.7	0.52%	0.29%	0.75%
19	Cl(mmol/L)	99.57	0.29	0.29%	0.16%	0.42%
20	Ca(mmol/L)	2.31	0.02	0.87%	0.49%	1.25%
21	P(mmol/L)	1.14	0.02	1.75%	0.98%	2.52%
22	Mg(mmol/L)	0.88	0.01	1.14%	0.64%	1.64%
23	CK(U/L)	72.51	2.94	4.05%	2.28%	5.82%
24	CK-MB(U/L)	14.36	0.7	4.87%	2.74%	7.00%
25	CRP(mg/L)	2.88	0.13	4.51%	2.53%	6.49%
26	IgG(g/L)	11.57	0.23	1.99%	1.12%	2.86%
27	IgA(g/L)	2.23	0.05	2.24%	1.26%	3.22%
28	IgM(g/L)	1.14	0.03	2.63%	1.48%	3.78%
29	C3(g/L)	1.01	0.04	3.96%	2.22%	5.70%
30	C4(g/L)	0.33	0.01	3.03%	1.70%	4.36%
31	RF(IU/ml)	4.06	0.1	2.46%	1.38%	3.54%

Table 2. Within Lot precision on Abbott I2000 for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
32	Free T4(pmol/L)	10.98	0.35	3.19%	1.79%	4.59%
33	TSH(uIU/ml)	4.14	0.05	1.21%	0.68%	1.74%
34	Prolactin(mIU/L)	818.52	23.53	2.87%	1.61%	4.13%
35	HCG(IU/L)	1.01	0.04	3.96%	2.22%	5.70%
36	Ferritin(ng/ml)	170.37	2.32	1.36%	0.76%	1.96%

Table 3. Within Lot precision on Abbott AxSym for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
37	cTnI(ng/ml)	0.278	0.01	3.60%	2.02%	5.18%

Table 4. Within Lot precision on UNICAP for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
38	IgE(IU/ml)	111.67	3.15	2.82%	1.58%	4.06%

Table 5. Between-Lot precision on ROCHE PPI for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
1	ALT(U/L)	19.92	0.67	3.36%	1.89%	4.83%
2	AST(U/L)	20.78	0.9	4.33%	2.43%	6.23%
3	ALP(U/L)	58.94	2.07	3.51%	1.97%	5.05%
4	GGT(U/L)	27.68	0.97	3.50%	1.97%	5.03%
5	TP(g/L)	66.39	0.75	1.13%	0.63%	1.63%
6	ALB(g/L)	39.08	1	2.56%	1.44%	3.68%
7	TBIL(umol/L)	11.46	0.41	3.58%	2.01%	5.15%
8	DBIL(umol/L)	6.28	0.2	3.18%	1.79%	4.57%
9	BUN(mmol/L)	4.45	0.18	4.04%	2.27%	5.81%
10	CREAT(umol/L)	69.65	3.32	4.77%	2.68%	6.86%
11	UA(umol/L)	276.35	10.14	3.67%	2.06%	5.28%
12	GLU(mmol/L)	4.92	0.17	3.46%	1.94%	4.98%
13	CHOL(mmol/L)	4.55	0.2	4.40%	2.47%	6.33%
14	TG(mmol/L)	0.83	0.03	3.61%	2.03%	5.19%
15	Apo-A1(g/L)	1.22	0.03	2.46%	1.38%	3.54%
16	Apo-B(g/L)	0.76	0.02	2.63%	1.48%	3.78%
17	K(mmol/L)	3.96	0.14	3.54%	1.99%	5.09%
18	Na(mmol/L)	137.49	0.94	0.68%	0.38%	0.98%
19	Cl(mmol/L)	100.96	1.07	1.06%	0.60%	1.52%
20	Ca(mmol/L)	2.23	0.04	1.79%	1.01%	2.57%
21	P(mmol/L)	1.09	0.03	2.75%	1.54%	3.96%
22	Mg(mmol/L)	0.89	0.03	3.37%	1.89%	4.85%
23	CK(U/L)	72.92	1.96	2.69%	1.51%	3.87%
24	CK-MB(U/L)	14.35	0.65	4.53%	2.54%	6.52%
25	CRP(mg/L)	3.44	0.17	4.94%	2.77%	7.11%
26	IgG(g/L)	11.58	0.4	3.45%	1.94%	4.96%
27	IgA(g/L)	2.22	0.08	3.60%	2.02%	5.18%
28	IgM(g/L)	1.06	0.05	4.72%	2.65%	6.79%
29	C3(g/L)	1.04	0.05	4.81%	2.70%	6.92%
30	C4(g/L)	0.3	0.01	3.33%	1.87%	4.79%
31	RF(IU/ml)	3.73	0.29	7%	3.93%	9.98%

Table 6. Between-Lot precision on Abbott i2000 for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
32	Free T4(pmol/L)	12.41	0.51	4.11%	2.31%	5.91%
33	TSH(uIU/ml)	2.94	0.06	2.04%	1.15%	2.93%

34	Prolactin(mIU/L)	566.27	22.96	4.05%	2.28%	5.82%
35	HCG(IU/L)	0.93	0.04	4.30%	2.42%	6.18%
36	Ferritin(ng/ml)	175.07	5.34	3.05%	1.71%	4.39%

Table 7. Between-Lot precision on Abbott Axsym for IMP tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
37	cTnI(ng/ml)	0.25	0.01	4%	2.25%	5.75%

Table 8. Between-Lot precision on UNICAP for IMPROVACUTER® Gel & Clot Activator Tube

No	Analyte/Unit	mean	SD	CV(%)	95% LCL	95% UCL
38	IgE(IU/ml)	106.68	2.88	2.70%	1.52%	3.88%

Results of the predicate type tube, BD SST, were very similar to the candidate tube type.

b. Linearity/assay reportable range:

Not applicable.

c. Traceability, Stability, Expected values (controls, calibrators, or methods):

Real time shelf life studies of the IMP tubes showed that the tube is stable for 12 months when stored at 4° to 25°C. The sponsor's acceptance criteria and protocol was provided and found to be acceptable.

To demonstrate analyte stability in the IMP tubes, analyte stability studies were performed at 0 hrs (as control), 24 hrs, 48 hrs after collecting blood into the tubes and stored at 2-8°C and at 22-25°C (in the original blood tubes). Studies were performed in conjunctions with the method comparison studies with 40 subjects. See summary in M.2.a. below.

The results of the study support the sponsor's claimed that the IMP tubes have analyte stability for up to 24 hours when stored at 2-8°C and at 22-25°C except for TBIL.

Additional stability study was performed to evaluate the stability of TBIL and the results provided by the sponsor demonstrated that TBIL is stable up to 20 hours when stored at 22-25°C. This information is provided in the sponsor's package insert. Acceptance criteria for analyte stability was provided and found to be acceptable.

d. Detection limit:

Not applicable.

e. Analytical specificity:

Not applicable.

f. Assay cut-off:

Not applicable.

2. Comparison studies:

a. Method comparison with predicate device:

To demonstrate comparable performance with the predicate device, apparently healthy subjects and patients admitted into hospitals with various diseases were used. Testing was performed at two hospital sites. All subjects in the comparative studies have blood samples collected into the IMP tubes (candidate device) and the BD SST (predicate tubes) at the same time. The specimens were allowed to clot, and the serum was removed for testing immediately after centrifugation according to the instructions provided in the labeling. Evaluations were performed on a selective common chemistry analytes, immunology analytes, and serological analytes on multiple instrument platforms. A total of 41 analytes were evaluated and demonstrated comparable results between the IMP tubes and the BD SST tubes. Summary of the results (linear regressions correlations with 95% confidence intervals) on one representative platform with the analytes and instruments evaluated are provided in the tables below:

Analyte	Instrument(s)	Slope (95% CI)	Intercept (95% CI)
Total Protein	1,2	0.9825 [0.9504,1.0146]	1.2333 [-1.0015,3.4681]
Albumin	1,2	0.9919 [0.9689,1.0149]	0.3486 [-0.5711,1.2683]
Total Bilirubin	1,2	0.9822 [0.9727,0.9917]	0.2313 [0.04,0.4225]
Direct Bilirubin	1,2	0.9957 [0.9894,1.002]	0.019 [-0.0408,0.0787]
AST	1,2	0.9977 [0.9913,1.0041]	-0.0575 [-0.4783,0.3632]
ALT	1,2	1.0011 [0.9949,1.0073]	0.1762 [0.2279,0.5803]
ALP	1,2	1.0021 [0.9842,1.0201]	-0.9865[2.5229,0.5498]
GGT	1,2	0.9983 [0.9927,1.004]	0.1038 [-0.3709,0.5785]
Cholesterol	1,2	0.9926 [0.9659,1.0194]	0.0379 [-0.097,0.1729]
Potassium	1,2	0.9668 [0.9104,1.0231]	0.1074 [-0.1132,0.328]
Glucose	1,2	0.9702 [0.9469,0.9935]	0.1541 [0.0131,0.295]
Creatinine	1,2	1.0064 [1.0016,1.0113]	1.0737 [-0.1026,2.25]
Calcium	1,2	1.0002 [0.963,1.0374]	0.0066 [-0.076,0.0892]
Chloride	1,2	0.9627 [0.8248,1.1006]	3.8046 [-10.212,17.8211]
CK	1,2	0.9999 [0.9981,1.0017]	-0.1745 [-1.4679,1.1268]
Magnesium	1,2	0.9622 [0.9281,0.9963]	0.0377 [0.0037,0.0717]
Phosphorous	1,2	0.9676 [0.9359,0.9992]	0.039 [-0.0006,0.0786]

Triglyceride	1,2	1.007 [0.9925,1.0216]	-0.0139 [-0.0389,0.011]
Blood Urea Nitrogen	1,2	0.9761 [0.9631,0.9891]	0.1211 [0.0117,0.2305]
Sodium	1,2	0.9897 [0.9285,1.0509]	1.3178 [-7.2216,9.8573]
Uric acid	1,2	0.9926 [0.9725,1.0128]	2.7184 [-4.5122,9.949]
Apolipoproteins A-I	1,2	0.9759 [0.9404,1.0113]	0.0267 [-0.0186,0.0719]
Apolipoproteins B	1,2	0.9904 [0.9579,1.0229]	0.0081 [-0.0211,0.0373]
CRP	1,2	0.9967 [0.9935,0.9999]	0.0108 [-0.108,0.1297]
Rheumatoid Factor	1,2	1.0008 [0.9933,1.0082]	0.035 [-0.1444,0.2145]
C3	1,2	0.9826 [0.9399,1.0252]	0.0299 [-0.0201,0.0799]
C4	1,2	0.9954 [0.9731,1.0177]	0.0031 [-0.0053,0.0115]
IgG	1,2	0.9746 [0.9405,1.0088]	0.2698 [-0.2017,0.7413]
IgA	1,2	0.9882 [0.9719,1.0044]	0.0238 [-0.0276,0.0751]
IgM	1,2	0.9975 [0.9816,1.0135]	0.0101 [-0.0138,0.034]
CK-MB	1,2	1.0032 [0.9982,1.0082]	-0.0646 [-0.2639,0.1348]
HCG	3,5	1.0144 [1.0068,1.0219]	-23.8817 [-118.0077,70.2442]
TSH	3,8	1.0065 [1.0016,1.0114]	-0.0307 [-0.0754,0.0141]
Free T4	3,8	1.0017 [0.9833,1.02]	-0.0974 [-0.3983,0.2035]
Prolactin	3,8	1.0133 [1.0047,1.022]	-1.9078 [-13.028,9.2124]
Ferritin	3,6	1.0054 [0.9919,1.0189]	-1.1726 [-4.6876,2.3424]
IgE	6,7	1.0081 [0.9975,1.0188]	-0.8948 [-2.7409,0.9512]
Troponin	4,5	0.9992 [0.9858,1.0126]	0.002 [-0.0067,0.0106]
CMV-IgG	9,10	See table below	
CMV-IgM	9,10	See table below	
VZV-IgG	9,10	See table below	

The slopes of the linear regression for all the analytes on all the platforms ranged from 0.9503 to 1.0155.

Concordance Table for anti-CMV IgG and IgM, anti-VZV-IgG (Qualitative tests)

Test	Agreement between IMP and BD tubes for positive results	Agreement between IMP and BD tubes for negative results
CMV-IgG	100%	100%
CMV-IgM	100%	100%
VZV- IgG	100%	100%

Instrument(s):

1: Roche Modular PPI
2: Beckman DXC 800
3: Abbott I2000

4: Abbott AxSym
5: Beckman Access Ⅱ
6: Roche E170
7: UNICAP Immuno CAP
8: Bayer Centaur
9: Anthos Microplate Reader
10: Bio-Tec Microplate Reader ELX800

Summary of all the method comparison studies:

Study 1: 127 adult subjects were recruited and tested in hospital site 1. Testing was performed in that hospital laboratory. Chemistry results were generated for 31 general chemistry analytes on a Roche PPI instrument and 5 immunoassay analytes on an Abbott I2000 instrument. Troponin I result was generated on an Abbott AxSym instrument and IgE result was generated on a UNICAP analyzer. Three serological analytes (CMV IgG, IgM and VZV-IgG) were generated on an Anthos micro-plate reader.

Study 2: 125 adult subjects were recruited and tested in hospital site 2. Testing was performed in that hospital laboratory. Chemistry results were generated for 31 general chemistry analytes on a Beckman DxC 800 instrument and 3 immunoassay analytes on a Bayer Centaur. Troponin I and hCG results were generated on a Beckman Access II instrument. Ferritin and IgE results were generated on a Roche E170 analyzer. Three serological analytes (CMV IgG, IgM and VZV-IgG) were generated on an ELX 800 micro-plate reader.

b. Matrix comparison:

Not applicable. These blood collection tubes are for serum only.

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:

Not applicable

N. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Part 809.10.

O. Conclusion:

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