



Platelet Reactivity Test

Instructions for Use



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INTENDED USE

The VerifyNow® PRUtest® is a whole blood test used in the laboratory or point-of-care* setting to measure the level of platelet P2Y12 receptor blockade. For *in vitro* diagnostic use. For professional use only.

* Approval for use in the point-of-care setting may not be available in all countries.

PRODUCT DESCRIPTION

The VerifyNow PRUtest measures platelet aggregation using the VerifyNow System. The VerifyNow System is a turbidimetric based optical detection system, which measures platelet-induced aggregation. The system consists of an instrument, a disposable test device and quality control materials. See Figure 1 for representation of the PRUtest device. Quality control measures include an instrument based electronic quality control (EQC), two levels of wet quality controls (WQC), and internal quality controls. The instrument controls all test sequencing, temperature, and reagent-sample mixing and performs self-diagnostics. The degree of platelet function is determined and the result is displayed.

The PRUtest device contains a lyophilized preparation of human fibrinogen-coated beads, platelet activators, and buffer. The patient sample is (citrate) anticoagulated whole blood, which is automatically dispensed from the blood collection tube into the test device by the instrument, with no blood handling required by the user.

PRINCIPLE OF THE TEST

The VerifyNow PRUtest is designed to measure platelet P2Y12 receptor blockade. Substances known to specifically block the P2Y12 receptor include the thienopyridine class of drugs, including clopidogrel. The test is based upon the ability of activated platelets to bind fibrinogen. Fibrinogen-coated microparticles aggregate in whole blood in proportion to the number of expressed platelet GP IIb/IIIa receptors. The rate of microbead aggregation is more rapid and reproducible if platelets are activated; therefore the reagents adenosine-5-diphosphate and prostaglandin E1 (ADP/PGE1) are incorporated into the test channel to induce platelet activation without fibrin formation. The reagent is formulated to specifically measure P2Y12-mediated platelet aggregation. Light transmittance increases as activated platelets bind and aggregate fibrinogen-coated beads. The instrument measures this change in optical signal and reports results in P2Y12 Reaction Units (PRU).

Clopidogrel and prasugrel are pro-drugs, which are each metabolized *in vivo* to their active metabolites. The metabolism of clopidogrel occurs through a cytochrome P450-dependent pathway, while prasugrel is metabolized by carboxylesterase (hCE)-2 and other cytochrome P enzymes.¹ The antithrombotic effects of P2Y12 receptor inhibiting drugs can vary in individual patients due to differences in conversion to their active metabolites, as well as other factors.^{2,3}

P2Y12 PLATELET RECEPTOR SPECIFICITY

Activation of platelet aggregation is mediated by two receptors located on platelets, P2Y1 and P2Y12. As depicted in Figure 2, both receptors are activated by ADP and lead to the final common pathway that mediates platelet aggregation, i.e., activation of glycoprotein IIb/IIIa receptors.

The VerifyNow PRUTest measures P2Y12 receptor mediated platelet aggregation and test results are not influenced by non-specific platelet aggregation mediated through P2Y1. To accomplish the goal of having a test with reduced non-specific aggregation, the VerifyNow PRUTest uses an additive (PGE1) in addition to ADP to make the test more sensitive and specific for the effects of ADP mediated by the P2Y12 receptor.

MATERIALS PROVIDED

VerifyNow PRUTest devices individually sealed in foil pouches. Each test device contains lyophilized fibrinogen-coated beads, ADP, bovine serum albumin, PGE1 and buffer. Test device should remain sealed in the foil pouch until ready for use to prevent damage by humidity.

REAGENT STORAGE AND HANDLING

Store unopened devices at 15–25°C (59–77°F). The PRUTest product is stable under these conditions until the date indicated on the pouch and box.

MATERIALS REQUIRED BUT NOT PROVIDED

- Greiner Bio-One VACUETTE® partial fill blood collection tubes (2 mL fill volume) containing 3.2% sodium citrate, catalog #454322 or #454323 (high altitude); or Nipro catalog #NP-CW0185-1 blood collection tube (1.8 mL) containing 3.2% sodium citrate.
- VerifyNow Instrument with Electronic Quality Control (EQC).
- VerifyNow wet quality control (WQC), 6-Pack – Catalog #85047

PRECAUTIONS

- For *in vitro* diagnostic use only.
- The VerifyNow Instrument and its components should only be used as directed in the User Manual.
- Do not use the VerifyNow PRUTest device or WQC materials beyond the expiration date.
- All patient samples should be handled as if capable of transmitting disease. Universal precautions should be followed.
- Reagents are manufactured with a material purified from human plasma that was found negative for all communicable diseases tested, including HIV-1, HIV-2, Hepatitis B surface antigen (HBsAg) and Hepatitis C (HCV). Handle test devices as biohazardous material and dispose of in an appropriate manner.

SAMPLE COLLECTION AND HANDLING

Instructions for Sample Collection from Indwelling Venous Catheters:

1. Whole blood samples that are obtained from an indwelling catheter should be collected after sufficient discard (approximately 5 mL) has been drawn to clear the line. Ensure indwelling catheter is free of clots.
2. Transfer blood to the blood collection tube immediately after collection.
3. Gently invert the sample tube at least 5 times to ensure complete mixing of the contents.
4. Blood must set a minimum of 10 minutes after collection before assay but no longer than 4 hours.

Instructions for Collecting Peripheral Samples:

1. Whole blood may be collected from venous sites using a 21-gauge or larger needle in an appropriate blood collection tube.
2. Blood samples should be obtained from an extremity free of peripheral venous infusions.
3. Collect a discard tube first (approximately 2 mL).
4. Gently invert the sample tube at least 5 times to ensure complete mixing of the contents.
5. Blood must set a minimum of 10 minutes after collection before assay but no longer than 4 hours.

SAMPLE COLLECTION PRECAUTIONS

- Collection of fresh whole blood samples for use with the VerifyNow Instrument requires an appropriate collection device.
- If a CBC is to be drawn at the same time as a sample for VerifyNow PRUTest, fill the CBC tube last.
- Do not freeze or refrigerate samples.
- Collect whole blood samples with care to avoid hemolysis or contamination by tissue factors. Samples with evidence of clotting should not be used.
- Ensure collection tubes are filled to the indicated fill volumes. At altitudes greater than 2,500 feet above sea level, blood collection tubes may not fill to the specified volume, which results in an incorrect ratio of blood to anticoagulant. Users at these elevations should refer to their facility's blood collection protocols for instructions to properly fill blood collection tubes.
- Avoid use of a rocker or pneumatic tube transport system.
- Samples should be collected and handled according to the institution's policies and procedures pertaining to biohazardous material.

TEST PROCEDURE

1. Refer to the VerifyNow System User Manual for complete operating instructions.
2. Open the foil pouch and remove the PRUTest device. Test devices should only be handled using the finger grip (See Figure 1).
3. Remove the protective sheath from the needle by pulling directly up on the sheath. Do not twist the sheath as this may remove the needle.
4. At the instrument prompt, insert the PRUTest device into the instrument.

5. At the instrument prompt, invert the sample tube at least 5 times, and insert onto the needle in the test device. Close the test port cover.
6. The instrument will run the test and display the result in less than three minutes.

CAUTION: Sample is under pressure. Do not remove blood collection tube from test device. Only remove test device from the instrument after the assay is completed.

7. Remove the test device by grasping the finger grip and pulling straight up. Do not remove the blood collection tube from the test device. Dispose of the entire test device/sample tube in appropriate biohazard waste container.

REPORTED RESULTS

The VerifyNow PRUtest reports results in P2Y12 Reaction Units (PRU), which reflects the amount of P2Y12 receptor-mediated aggregation specific to platelets. A PRU result is calculated based upon the rate and extent of platelet aggregation recorded in the channel containing the platelet agonist, ADP.

Health care personnel can manually calculate the percentage of platelet aggregation inhibition (percent reduction from baseline) for a given patient receiving drug treatment with a P2Y12 receptor inhibitor. To do so, a baseline PRUtest measurement must be done prior to initiating drug therapy. The percent inhibition calculation is as follows:

$$\text{Percent inhibition} = \frac{(\text{Baseline PRU} - \text{Post-treatment PRU})}{\text{Baseline PRU}} \times 100$$

INSTRUMENT MESSAGES

Under certain conditions, a test run may be aborted. In such cases, the instrument will display an Error or Attention message. Please refer to the VerifyNow User Manual for a more detailed explanation of these messages.

CALIBRATION

VerifyNow PRUtest devices are calibrated at the factory. This calibration information is contained in the barcode on the pouch of each test device. The barcode must be scanned whenever a new lot of test devices is to be tested. If a new lot of test devices is being used, the instrument will prompt the user by displaying a barcode icon after the test device is inserted.

- At the prompt, place the test device pouch in front of the barcode reader found on the left side of the instrument, so that the barcode on the pouch lines up with the barcode reader.
- An audible beep will be heard when the instrument receives the required information.
- The user needs only to perform this action once per lot.

QUALITY CONTROL

Instrument Electronic Controls

- To ensure the VerifyNow instrument performs to specifications, the manufacturer recommends that an Electronic Quality Control (EQC) be run once per day. This reusable device verifies instrument optics, pneumatics and reagent mixing.
- The internal control in the instrument automatically verifies sample filling, correct fluid transfer and mixing. It also monitors the electronic and mechanical components.

Test Device Controls

- Two levels of quality control are incorporated into each test device to identify invalid test runs caused by random errors, reagent degradation, or inappropriate blood samples. Before platelet activation and fibrinogen binding begin, the negative internal control performs a test for non-specific aggregation. During the active phase of the test, the positive internal control channel monitors the reaction and calculates Control Units, which must fall within specified limits. A failure of the negative or positive control displays an “error” message by the VerifyNow Instrument, and no PRU result is reported.

Wet Quality Controls

- Wet Quality Controls (WQC) are available and supplied separately (with an accompanying package insert) for verifying the integrity of the VerifyNow System. The two levels of VerifyNow PRU Test controls (WQC Level 1 and WQC Level 2) are designed to be used as part of a laboratory quality control program.
- The WQC materials when stored at room temperature are stable until the marked expiration date. The WQC Level 1 control is a pre-mixed diluent vial requiring no additional preparation and the WQC Level 2 control requires mixing of same diluent vial with a reagent pellet to achieve the Level 2 control. The manufacturer recommends that both WQC Level 1 and WQC Level 2 be run once each time a new lot or a new shipment of VerifyNow PRU Test kits is received or at minimum every 30 days.

TEST LIMITATIONS

- Blood should be collected from a freely flowing venipuncture to maintain the integrity of the specimen. After the blood sample is collected, wait 10 minutes before performing PRU Test. Samples assayed prior to 10 minutes or four or more hours after collection may result in spurious PRU values or errors messages, e.g., “attention” or “error” messages.
- The lyophilized reagent is hygroscopic and can degrade after prolonged exposure to room air. Therefore, reagents should be used within 10 hours after they are removed from the foil pouch.
- When results are not within the expected limits, the possibility of improper sample collection or handling should be investigated. Repeat the test using a new test device and sample.
- Patients with inherited platelet disorders such as von Willebrand Factor Deficiency, Glanzmann Thrombasthenia and Bernard-Soulier Syndrome have not been studied with the VerifyNow PRU Test. The VerifyNow PRU Test is not intended for use in patients with these types of platelet disorders.

- Assay performance was not affected by hematocrit values between 33–52%, and platelet count values between 119,000–502,000/ μ L. Patient samples having hematocrit values outside of this range may generate an Error 28 message. Please refer to the Verify Now System User Manual for further details.
- Patients who have been treated with Glycoprotein IIb/IIIa inhibitor drugs should not be tested with the PRUTest until platelet function has recovered. For such patients, the recovery period after drug administration is discontinued is approximately 14 days for abciximab (ReoPro[®]) and up to 48 hours for eptifibatide (Integrilin[®]) and tirofiban (Aggrastat[®]). The time to recovery of platelet function varies among individuals and is not affected by renal dysfunction.
- VerifyNow PRUTest results should be interpreted in conjunction with other clinical and laboratory data available to the clinician. Unexpected test results should be repeated.

INTERFERING SUBSTANCES

Substances listed in the following table showed no interference with PRUtest results when evaluated at the concentrations listed.

<u>Interferent tested</u>	<u>Concentration</u>
Triglycerides	37 µM
A3P5P2 ¹	100 µM
Acetaminophen	1.32 mM
Betamethasone	64 µM
Caffeine	306 µM
Captopril	23 µM
Catechin	86 µM
Celecoxib	8.5 µg/mL
Cilostazol	60 µM
Cimetidine	79 µM
DMSO ²	0.11%
Dipyridamole	20 µM
Diltiazem	15 µM
Ethanol	87 mM
Fish oil	32 mg/dL
Glucosamine HCl	9.4 µM
Low-molecular weight heparin	1.833 U/mL
Hydrochlorothiazide	20 µM
Ibuprofen	2.4 µM
Insulin	3 ng/mL
Lidocaine	51 µM
Nitroglycerin	0.1 µg/mL
Norfluoxetine	7.17 µM
Norverapamil	4.5 µM
Omeprazole	20 mg oral
Oxypurinol	99 µM
Pravastatin	56 µM
Propranolol	7.7 µM
Salicylic acid	4.3 mM
Streptokinase	400 U/mL
Theophylline	220 mM
L-Thyroxine	32 nM
α-Tocopherol	58 µM
Warfarin sodium	32 µM

¹ A3P5P2 = putative thiamine-phosphate pyrophosphorylase

² DMSO = dimethyl sulfoxide

SERVICE

The VerifyNow Instrument is not intended to be serviced by the user. Instruments in need of repair are required to be returned to Accriva Diagnostics. If there are problems related to the VerifyNow System, contact Accriva Diagnostics Customer Support.

PERFORMANCE CHARACTERISTICS

The VerifyNow PRUtest was evaluated in normal-healthy donors, acute coronary syndrome (ACS) patients not receiving any P2Y12 inhibitor drug, and patients receiving dual antiplatelet therapy (clopidogrel and aspirin) for cardiovascular disorders. Clopidogrel is a drug known to specifically block the platelet P2Y12 ADP receptor.^{4,5} The unit of measurement for the VerifyNow PRUtest is P2Y12 Reaction Units (PRU), which reflects the rate and extent of P2Y12 receptor-mediated aggregation specific to platelets binding over a defined period of time with fibrinogen coated beads in the PRUtest device.

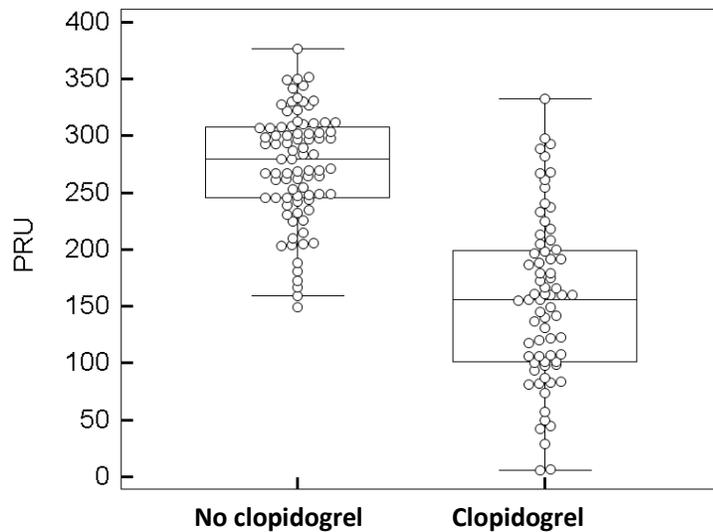
Reference range

A reference range study was conducted in 152 healthy donors by performing platelet function testing using VerifyNow PRUtest. The data were evaluated as recommended in EP28-A3c “Defining, Establishing and Verifying Reference Intervals in the Clinical Laboratory; Approved Guideline – Third Edition.” The reference range determined from this study, expressed as the central 95% confidence interval of the mean, is 182–335 PRU. The data are summarized in the table below.

N	Mean	SD	<u>95% confidence interval (CI)</u>	
	PRU	PRU	Lower limit (95%CI)	Upper limit (95% CI)
152	266	42	182 (116–197)	335 (324–354)

Expected PRUtest values in the intended-use population

PRU was measured in two groups of ACS patients: 1) 84 patients that were not receiving a P2Y12 receptor inhibiting drug, and 2) 71 patients with ACS receiving dual treatment with aspirin (ASA) and clopidogrel. The data were evaluated as recommended in EP28-A3c “Defining, Establishing and Verifying Reference Intervals in the Clinical Laboratory; Approved Guideline – Third Edition.” The range of values is expressed as the central 95% Confidence Interval of the mean. Data and box and whisker plot depicting the data are shown below. The mean \pm SD clopidogrel dose was 79 ± 28 mg per day in the clopidogrel plus aspirin group. The mean \pm SD aspirin doses in the no clopidogrel and clopidogrel groups were 167 ± 117 and 137 ± 103 mg per day, respectively.



	<u>Clopidogrel</u>	
	No	Yes
N	84	71
Mean ± SD	274 ± 48	156 ± 73
<u>Lower and upper ranges (95% CI)</u>		
Lower	180 (160–200)	6 (0–34)
Upper	376 (358–395)	300 (269–329)

Method comparison

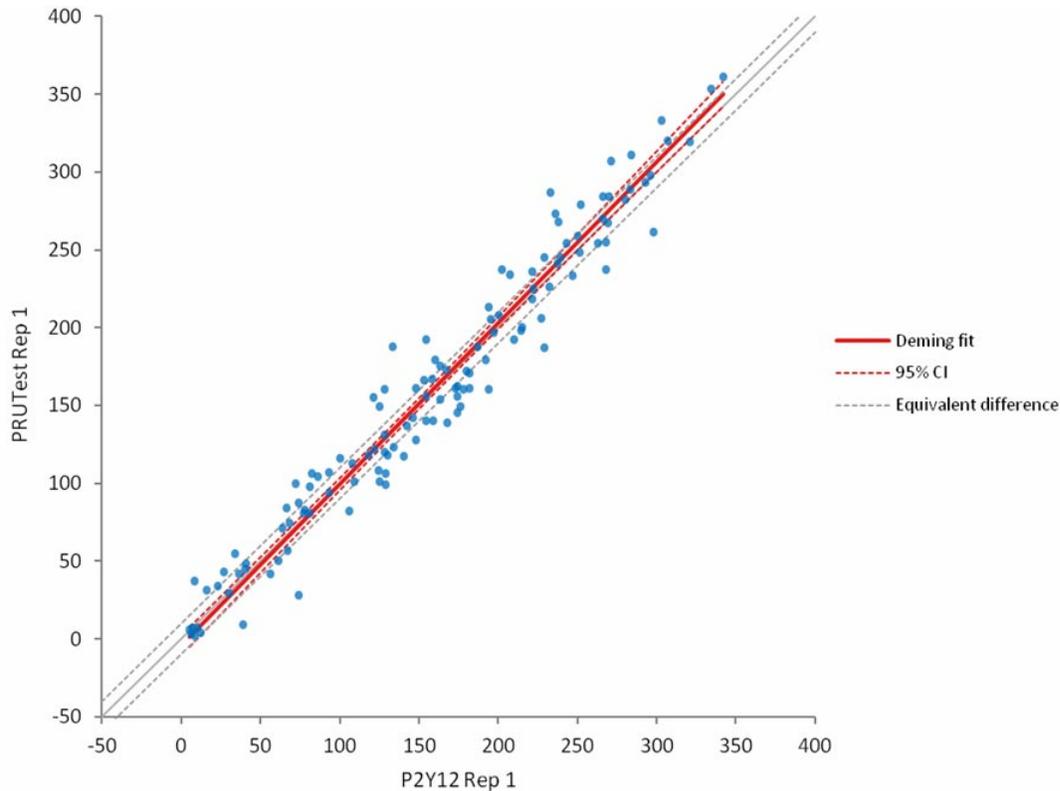
PRU measurements were determined in split whole blood samples obtained from 119 acute coronary syndrome (ACS) subjects and assessed at three separate test sites with VerifyNow PRUTest and P2Y12 test devices. Samples were run in duplicate using four VerifyNow PRUTest instruments and three VerifyNow P2Y12 instruments with a single device lot for each instrument. Data from the first replicate measured with each method were evaluated as recommended in EP09-A2 "Method Comparison and Bias Estimation Using Patient Samples; Approved Guideline - Second Edition." Tabular data and a Deming regression plot depicting the results appear below.

Device	N	Mean (PRU)	SD		P value
			(PRU)	95% CI	
P2Y12	119	161	87	8–308	NS
PRUTest	119	162	90	6–321	

N	Method	Slope (95% CI)	Slope p-value	Intercept (95% CI)	Correlation Coefficient R
119	Ordinary Least Squares	1.01 (0.97–1.05)	0.56	-0.77 (-8.00–6.50)	0.98
119	Ordinary Deming	1.04 (1.00–1.07)	0.07	-4.57 (-11.2–2.05)	0.98

There is no statistically significant difference between PRU results generated by the VerifyNow PRUTest and the VerifyNow P2Y12 test methods. This indicates that PRU results assayed with VerifyNow PRUTest are substantially equivalent to PRU test results assayed with the predicate VerifyNow P2Y12 test. A Bland-Altman plot showed that the mean bias between the two methods over the range of values was 1.3% (graph not shown).

Slope 1.035 (0.997–1.073); Intercept -4.57 (-11.2–2.05); r = 0.976



PRECISION

Precision for Wet Quality Control (WQC) Level 1

VerifyNow PRU Test wet quality control (WQC) Level 1 is a negative control (blank) from which no aggregation is expected. WQC Level 1 simulates a patient sample with highly inhibited platelets, which should not produce a significant aggregation profile. The WQC level 1 is designed to identify fibrinogen coated latex pellets that have lost effectivity, either by denaturation or some other method of degradation. The acceptance criterion for WQC Level I is a PRU value < 30.

Between lot precision for Wet Quality Control (WQC) Level 2

The precision of VerifyNow PRU Test WQC Level 2 was determined by testing samples with three device lots on three instruments by three operators. Samples were run in duplicate and testing was performed over a period of 20 non-consecutive days. Precision estimates were determined in accordance with CLSI guidance EP05-A2, “Evaluation of Precision Performance of Quantitative Measurement Methods; Approved Guideline – Second Edition.” The acceptance criterion for WQC Level 2 precision is a %CV ≤ 10%. For VerifyNow PRU Test WQC Level 2, the components of and total variability in this study did not exceed 7.4%.

N	Mean PRU	Within-run		Between-run		Between-day		Between-instrument		Total	
		SD	%CV	SD	%CV	SD	%CV	SD	%CV	SD	%CV
240	300.5	13.6	4.5	7.7	2.5	8.3	2.8	13.5	4.5	22.2	7.4

Between-instrument precision for Wet Quality Control (WQC) Level 2

Between-instrument precision for the VerifyNow PRUtest was assessed using a single lot of WQC Level 2 assayed on three instruments, twice a day, in duplicate over a period of six non-consecutive days. The acceptance criterion for WQC Level 2 is a %CV ≤ 10%. For VerifyNow PRUtest WQC Level 2, the components of and total variability did not exceed 8.0%.

N	Mean PRU	Within-run		Between-run		Between-day		Between-instrument		Total	
		SD	%CV	SD	%CV	SD	%CV	SD	%CV	SD	%CV
72	302.7	22.6	7.5	0.0	0.0	8.5	2.8	0.0	0.0	24.2	8.0

Whole blood precision using samples from donors

The precision of the VerifyNow PRUtest was assessed using whole blood samples from eight donor subjects, six of whom were receiving clopidogrel with or without aspirin. Two studies were performed. The first study assessed within-run, between-run, between-day and between-lot variability in eight donors. The second study assessed within-run, between-run, between-day and between-instrument variability in seven donors. Samples from each donor were assayed twice a day, in duplicate, using three device lots on three VerifyNow PRU instruments over a period of five non-consecutive days. The acceptance criterion for within-run, between-lot and between-instrument precision in whole blood samples was a %CV ≤ 10%. For VerifyNow PRUtest results in whole blood samples, within-run, between-run, between-lot and between-instrument precision did not exceed 10% within the medical decision range of 95–208 PRU.⁶

NOTE: In the clinical setting where the VerifyNow PRUtest is used, there are no acceptance criteria for between-day and total variation.

Whole blood precision – multiple lot experiment

ID	Rx ¹	Days	Runs	Reps	Mean	Within-run	Between-run	Between-day	Between-lot				
					PRU	SD	%CV	SD	%CV	SD	%CV	SD	%CV
					Acceptance criteria:		<10	<10	N/A ²	<10			
1	2	5	1	30	64	4.7	7.4	---	---	9.6	15.0	0.0 ³	0.0
2	0	10	2	118	244	10.4	4.2	0.0	0.0	21.9	9.0	0.0	0.0
3	1	5	2	60	162	6.3	3.9	5.1	3.1	17.7	10.9	0.0	0.0
4	1	5	2	30	190	12.0	6.3	---	---	15.1	7.9	0.0	0.0
5	0	10	2	120	289	11.2	3.9	7.7	2.7	27.0	9.3	0.0	0.0
6	2	5	1	30	221	8.9	4.0	---	---	17.0	7.7	0.0	0.0
7	1	10	2	114	216	13.0	6.0	7.3	3.4	16.5	7.6	0.0	0.0
8	2	5	1	30	163	10.9	6.7	---	---	13.3	8.2	0.0	0.0

Whole blood precision – multiple instrument experiment

ID	Rx ¹	Days	Runs	Reps	Mean	Within-run	Between-run	Between-day	Between-Instrument				
					PRU	SD	%CV	SD	%CV	SD	%CV	SD	%CV
					Acceptance criteria:		<10	<10	N/A ²		<10	<10	
1	2	5	1	30	67	7.3	10.8	---	---	9.3	13.8	0.0 ³	0.0
2	0	8	2	89	253	13.6	5.4	0.0	0.0	20.4	8.1	9.3	3.7
3	1	5	2	60	160	9.3	5.8	4.1	2.5	18.1	11.3	3.6	2.3
4 ⁴	1	0	0	0	---	---	---	---	---	---	---	---	---
5	0	9	2	101	290	10.7	3.7	5.4	1.9	21.4	7.4	11.4	3.9
6	2	5	1	30	229	7.9	3.5	---	---	14.4	6.3	8.1	3.5
7	1	5	2	54	231	14.7	6.4	12.1	5.3	9.2	4.0	7.9	3.4
8	2	5	1	30	160	11.2	7.0	---	---	11.6	7.3	0.0	0.0

Key: ¹ 0 = healthy, no treatment; 1 = dual therapy (clopidogrel plus aspirin); 2 = healthy, given clopidogrel 75 mg/day;

² N/A Not applicable as acceptance criteria for this parameter is undefined as explained in the text;

³ Between-lot SD of 0 and %CV of 0 can be observed when the contribution of one source of variability is very small relative to other sources of variability, or if all of the sample elements are the same;

⁴ Donor 4 had insufficient blood volume to allow for inclusion in the multiple instrument experiment

STABILITY

Sample waiting time and sample stability

Sample stability and sample wait time studies were conducted to determine the appropriate values. Sample wait time was determined to be 10 minutes, meaning that a blood sample must not be assayed for a minimum of 10 minutes after collection by venipuncture. Sample stability was determined to be four hours, meaning that the blood sample must be assayed within four hours from the time of blood draw.

Open-pouch device stability

Whole blood samples from healthy donors and WQC Level 2 were tested at intervals with VerifyNow PRUtest devices that were exposed to high levels of relative humidity. The acceptance criterion for stability was defined as percent recovery ≥ 90 to $\leq 110\%$ of the baseline PRU. Results demonstrated acceptable percent recovery of VerifyNow PRUtest values in whole blood after exposure to 61-73% RH and 21-24°C temperatures for 10 hours. PRU results with WQC Level 2 remained within the allowable range for 10 hours under the same conditions. Thus once the device pouch has been opened, the PRUtest device should be used within 10 hours of opening of the pouch.

Figure 1: PRUtest device

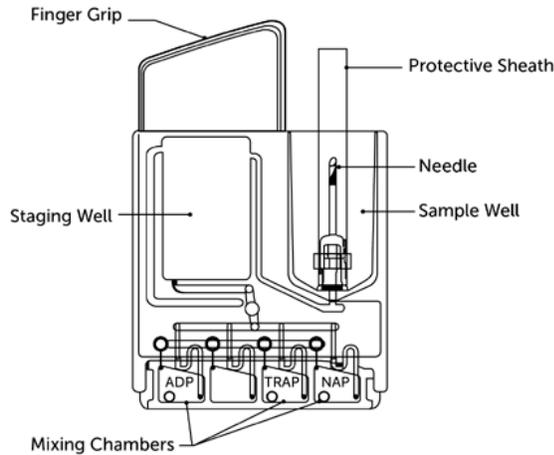
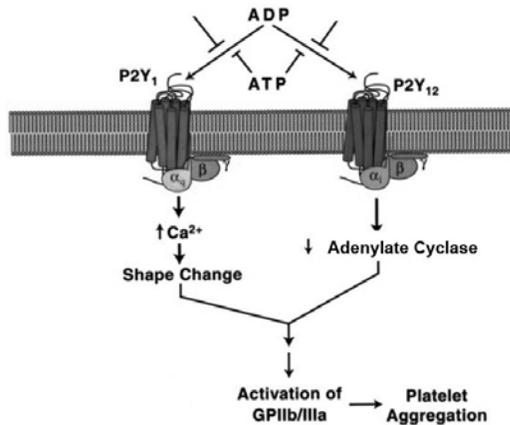


Figure 2: Mechanism of ADP-induced platelet aggregation



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Explanation of Symbols

	Lot Number
	Catalog Number
	<i>In Vitro</i> Diagnostic Use
	Manufacturer
	Use By
	Temperature Limits
	Caution: Consult accompanying documents
	Contains sufficient for 25 tests
	CAUTION: US Federal Law restricts this device to prescription only
	Authorized representative in the European Community
	Biological Risks
	Do not re-use
	Consult instructions for use



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U.S. Pat. D 409.758 and Others Pending