CHAPTER IV

RESULTS AND DISCUSSION

The preparation of reduced phenolphthalein reagent

The reduced phenolphthalein reagent was prepared by following the Kastle-Meyer method The modified method was done by changing the chemical compositions and the heating method (reflux, boiling). The appearance and final volume are summarized in Table 2.

Methods	Chemical compositions					% of phenolp.	Heat	Reagent appearance	Volume	Storage	% phenolp. in product
	Phenolphthalein	KOH	NaOH	Reducing	Distilled Water						
Original method	2.0 g	20.0 g	-	Zinc dust 20.0 g	100 ml	2%	Reflux 2-3 hr.,*	Pale yellow.	95 ml	In the amber bottle 2-8 °C	2.10%
Method 1	2.0 g	10.0 g	-	Zinc dust 5.0 g	250ml	0.8%	Boil 2-3 hr.*	Amber-yellow	120 ml	In the amber bottle 2-8 °C	1.66%
Method 2	1.0 g	10.0 g	-	Zinc dust 20.0 g	50 ml	2%	Boil 1 hr*	amber-yellow	30 ml.	In the amber bottle 2-8 °C	3.33%
Method 3	1.0 g	-	10.0 g	Zinc dust 5.0 g	250 ml	0.4 %	Reflux 2-3 hr*	Pale yellow.	240 ml.	In the amber bottle 2-8 °C	0.42%
Method 4	2.0 g	20.0 g	-	Zinc dust 20.0	50 ml	4%	Reflux 45 min*	Yellow	48 ml.	Add ethanol 1:2 (ethanol : stock solution)** In the amber bottle,	2.77%
Method 5	1.0 g	10.0 g	-	Copper 10 .0 g.	250 ml	0.4%	Boil 2-3 hr*	The crystal is pink	_	NA	NA
Method 6	1.0 g	10.0 g	_	Nickel 10.0 g	250 ml	0.4%	Boil 2-3 hr*	The crystal is pink	-	NA	NA

* Until the solution changes to colorless ** Add Ethanol 24 ml

The preparation of the reduced phenolphthalein reagent was done in 6 methods and found that method 1-4 can react with hemoglobin in the blood. The method 5 and 6 can not use because copper and nickel are not the reducing agent and can not absorb oxygen, so, they cannot change phenolphthalein to reduced form. The preparation method 1 and 2 with boiling process, the loss of water make a reagent in high concentration, while the method 4 added ethanol to adjust the volume and polarity of the reagent to the appropriate for using.

Validation of reduced phenolphthalein reagent obtained from the 6 methods

Sensitivity of the reduced phenolphthalein from modified method

Sensitivity of the reduced phenolphthalein was performed in 20 runs and started with undiluted whole blood that had a hematocrit (Hct) of 41.7 % and hemoglobin (Hb) of 640 microgram. Sensitivity was determined by which method gave a high positive result. It was found that method 4 gave a positive result with 95% of blood dilution at ratio $1{:}10^4$. The concentration of phenolphthalein appropriate reaction makes the clear result. For method 2 reactions occurs very fast, the color disappear in a short time. It did not suitable to use. The results are shown in table3

The sensitivity of the reduced phenolphthalein reagent for both dry and fresh blood were $1{:}10^4$ dilutions, this result is comparable correlated with previous studies [8, 9, 25, 26] This reduced phenolphthalein method was high precision with whole blood positive controls and negative controls testing gave correct results in all cases. This is consistent with the study of Richard F. That analytic sensitivity and precision of reduce phenolphthalein test. They detected hemoglobin in blood dilutions between 1:1,000 and 1:10,000 or between 0.0786 and 0.786 microgram. [21] But the conflict with the study of Getter and Kaye. The comparisons of sensitivity and specificity of reagents for blood tests between the Guaiac test Benzedrine test, Orthotolidin and Phenolphthalein was $1{:}10^4$, $1{:}10^6$ and $1{:}10^7$ in fresh blood and $1{:}10^6$ in dry blood. But this study, do not require concentration of hemoglobin. [19]

Table 4 Within run precision of Blood testing (n=20)

Sample types	Hb. (μg)	Original		Method 1		Method 2		Method 3		Method 4	
		+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)
Undiluted whole blood	640	20/20 (100)	0/20 (0)	20/20 (100)	20/20 (100)	20/20 (100)	20/20 (100)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
0.9% NaCl	0	0/20 (0)	20/20 (100)	0/20 (0)	0/20 (0)	0/20 (0)	0/20 (0)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)
$1:10^3$ blood diluted	0.64	20/20 (100)	0/20 (0)	19/20 (95)	1/20 (5)	20/20 (100)	0/20 (0)	18/20 (90)	2/20 (10)	20/20 (100)	0/20 (0)
$1:10^4$ blood diluted	0.064	16/20 (80)	4/20 (20)	15/20 (75)	5/20 (25)	16/20 (80)	4/20 (20)	15/20 (75)	5/20 (25)	19/20 (95)	1/20 (5)

+Ve mean Positive, -Ve mean Negative

Table 3 Sensitivity of reduced phenolphthalein testing (n=20)

Sample types	Hb. μg	Original		Method 1		Method 2		Method 3		Method 4	
		+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)
Undiluted whole blood	640	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
0.9% NaCl	0	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)
$1:10^1$ blood diluted	64	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
$1:10^2$ blood diluted	6.4	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
$1:10^3$ blood diluted	0.64	20/20 (100)	0/20 (0)	19/20 (95)	1/20 (5)	20/20 (100)	0/20 (0)	18/20 (90)	2/20 (10)	20/20 (100)	0/20 (0)
$1:10^4$ blood diluted	0.064	16/20 (80)	4/20 (20)	15/20 (75)	5/20 (25)	16/20 (80)	4/20 (20)	15/20 (75)	5/20 (25)	19/20 (95)	1/20 (5)
$1:10^5$ blood diluted	0.0064	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	4/20 (20)	16/20 (80)	0/20 (0)	20/20 (100)	5/20 (25)	15/20 (75)
$1:10^6$ blood diluted	0.00064	20/0 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)	20/0 (0)	20/20 (100)

+Ve means Positive, -Ve means Negative

Sample	Hb. (µg)	Original		Method 1		Method 2		Method 3		Method 4	
		+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)
Undiluted whole blood	640	20/20 (100)	0/20 (0)	20/20 (100)	20/20 (100)	20/20 (100)	20/20 (100)	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
0.9% NaCl	0	0/20 (0)	20/20 (100)	0/20 (0)	0/20 (0)	0/20 (0)	0/20 (0)	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)
$1:10^3$ blood diluted	0.64	20/20 (100)	0/20 (0)	19/20 (95)	1/20 (5)	20/20 (100)	0/20 (0)	18/20 (90)	2/20 (10)	20/20 (100)	0/20 (0)
$1:10^4$ blood diluted	0.064	16/20 (80)	4/20 (20)	15/20 (75)	5/20 (25)	16/20 (80)	4/20 (20)	15/20 (75)	5/20 (25)	19/20 (95)	1/20 (5)

+Ve mean Positive result, -Ve mean Negative result

The precision of the reduced phenolphthalein from modified methods test

Whole blood used as positive control and 0.9% NaCl used as negative control, the dilution at 10^3 and 10^4 of diluted blood was used in the evaluations of precisions. Within day precision was tested using 20 runs per day (Table 4) and between day precision was test 20 samples per day on 20 consecutive days (Table 5). The best all of the modified methods testing of reduced phenolphthalein prepared because both of within day and between days it had one hundreds percentage of precision for $1:10^3$ of blood dilutions and 95 % in$1:10^4$ blood dilutions of precision. For positive control it positive result in all cases and negative result in all cases. For the original was 80%, and commercial test kits 95% in$1:10^4$ blood dilutions of precision.

The precisions of reduce phenolphthalein with undiluted blood. Consistent with studies of bring the ref to the previous section Louie, F, et al. [21] that used commercial test kit positive control test with report one hundred percent of precision. For precision of all methods tests both within day and between days theirs were highly reproducible and positive result in whole blood control, negative result in normal saline control in all cases.

The specificity of the reduced phenolphthalein from the modified methods test

Determine the specificity of the test reduced phenolphthalein. We selected samples that have not hemoglobin components. The assign experiments were sited into three groups, 5 cleaning agents 2 fruit juice and 4vegetable juice. Whole blood and normal saline was used as positive and negative controls. Specificity results were showed in Table 6. The method 3 gave a good specificity at 97.5% among the modified methods. It was found false positive 15% in Cabbage juice, 5% in Melon juice. The specificity of method 4 was 96.26 %. It was found false positive 30% in Cabbage juice. For the Original method it was 96.25 % of specificity and found false positive 20% in Cabbage juice, 10% in Papaya juice. This is consistent with studies of Glaister J.and Shanan S [26, 30]

Type of Samples	Number of sample	Original		Method 1		Method 2		Method 3		Method 4	
		+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)	+ Ve (%)	-Ve (%)
Whole Blood (positive control)	20	100	0	100	0	100	0	100	0	100	0
0.9% NaCl (negative control)	20	0	100	0	100	0	100	0	100	0	100
Tomato juice	20	0	100	0	100	0	100	0	100	0	100
Cabbage juice	20	20	80	50	50	20	80	25	75	20	80
Papaya juice	20	10	90	40	60	20	80	0	100	10	90
Melon juice	20	0	100	0	100	0	100	0	100	0	100
Lemon juice	20	0	100	0	100	0	100	0	100	0	100
Sodium chloride (POSE- AID)	20	0	100	0	100	0	100	0	100	0	100
70% alcohol	20	0	100	0	100	0	100	0	100	0	100
Detergent (Dishwashing liquid)	20	0	100	0	100	0	100	0	100	0	100

+Ve mean Positive result, -Ve mean Negative result

The stability of reduced phenolphthalein reagent

Stability of the reduce phenolphthalein testing were compared between the original method and modified methods (Figure 2.) The method 4 was the best among all of the modified methods when the test was done in every month for 1 year. One hundred percent of whole blood tested gave positive and one hundred percent of 0.9% NaCl gave negative result. For 1: 10^4 of blood dilution is the best method 4 it positive 90-95%.at blood dilute at $1:10^4$.

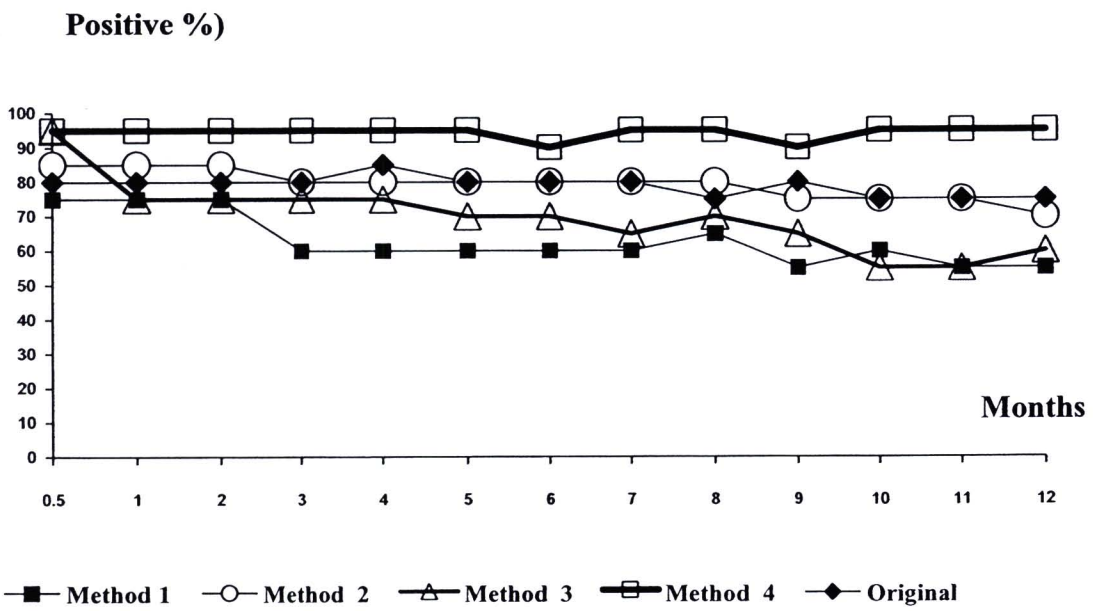

Figure 2 Stability of the modified reduced phenolphthalein methods preparation testing in $1:10^4$blood dilution

Sample degradation testing

Sample degradation was tested using the reduced phenolphthalein between the original method and modified methods in 20 days of sample (Figure 2-3). The positive results gave positive 85- 95 % at blood dilution of $1:10^4$.

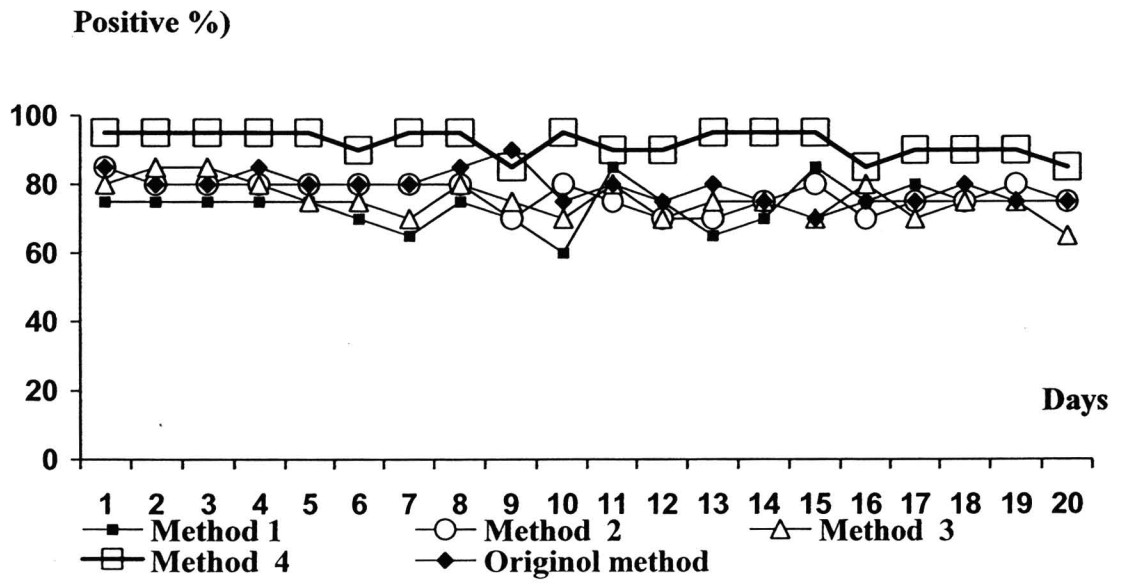

Figure 3 Reduced phenolphthalein testing on sample degradation testing obtained from 1:10^4 of diluted blood

The modified reduced phenolphthalein reagent method 4 was the highest effectiveness with sensitivity 95 % in blood dilution 1:10^4. The modified reduced phenolphthalein method 4 showed stability during12 month and can detect both of fresh blood and dry blood

Investigation of sample degradation it had one hundred percent of whole blood to have blood tested positive when dry blood sample in 1- 20 days. For 1:10^4 bloods dilution had a positive result between 85- 100 % when detectable the modified method of reduce phenolphthalein preparation test. Otherwise it had a long time of stability at 1 year, when keep reagent at 2-8 °C. When we comparison sensitivity, precision, specificity, between the new intervention of reduce phenolphthalein preparation, original, and commercial test kits. The result found that the detection of sensitivity of the modified method reduce phenolphthalein testing was 95%, the original was 80%, and commercial test kits 95 % at 1:10^4 blood dilution For investigation of sample degradation testing of all methods one hundred percent of whole blood and 1:10^3 blood dilution to have blood tested positive when dry blood sample in 20 days.

For $1:10^4$ bloods dilution the modified method had a positive between 85-95%, the original method had a positive between 70-80% and the commercial test kits had a positive between 80-100% in 1-20 days. For stability testing of all methods one hundred percent positive result of whole and negative result of normal saline the modified method was positive 95% in blood dilution $1:10^4$and the original method was positive 80 %.

The most effectiveness of reduced phenolphthalein reagent obtained from all modified method was method 4. This method had the highest effectiveness over other preparation methods with sensitivity at 95 -100 % of blood dilutions between1:1000 and 1:10,000 or between 0.064 μg and 0.64 μg hemoglobin, high reproducibility for within day and between day runs and had specific 96.26. %. As found in the previous study [13] tests for the detection of occult blood. Method 4 was composed of phenolphthalein 2.0 g, potassium hydroxide 20.0 g, distilled water 50 ml. and zinc dust 20 g. Ratios were 1: 10: 10 Reflux time was 45 minutes and added 1 part of ethanol into 2 parts of reduced phenolphthalein solution then stored a reagent in an amber bottle and kept in refrigerate at 2-8° C and pH of each reagent was at 9-10

Comparisons of reduced phenolphthalein reagent among the new modified methods and commercial test kit

The modified method and commercial test kit have sensitivity at 95% in $1:10^4$ of blood dilutions. All method gave one hundred percent positive of whole blood (positive control) and one hundred percent negative of 0.9% NaCl (negative control (Table 7).

Table 7 Sensitivity of reduced phenolphthalein among a new modified method, and commercial test kit (n= 20)

sample	Hb. (µg)	Phenolphthalein Test kits		Phenolphthalein modified method	
		+Ve (%)	-Ve (%)	+Ve (%)	-Ve (%)
Whole Blood	640	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
0.9% NaCl	0	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)
Blood dilution 1: 10^4	0.064	19/20 (95)	1 /20 (5)	19/20 (95)	1 /20 (5)

+Ve mean Positive result, -Ve mean Negative result

Table 8 within day and between days precision of reduced phenolphthalein among a new modified method and commercial test kit (n= 20)

sample	Hb. (µg)	Phenolphthalein Test kits		Phenolphthalein modified method	
		+Ve (%)	-Ve (%)	+Ve (%)	-Ve (%)
Whole Blood	640	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
0.9% NaCl	6.40	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)
1: 10^4 Blood dilution	0.064	19/20 (95)	1 /20 (5)	19/20 (95)	1 /20 (5)

+Ve mean Positive result, -Ve mean Negative result

The precision of phenolphthalein between the best modified methods and commercial test kit for within day and between days were positive with whole blood (positive control) and negative with 0.9%NaCl (negative control) in 20 run (100%). For $1:10^4$ blood dilutions the reagent had 95 % in precision. The precision of reduced phenolphthalein modified preparation method and commercial test kit the both had precision 95 % in $1:10^4$ blood dilutions of within day and between days, one hundred percent positive of whole blood and negative of NaCl. Both of within day and between days don't have difference. (Table 8) From Table 7-8, found that both methods have high precision for no difference.

Table 9 Specificity of reduced phenolphthalein among a modified method, and commercial test kit(n=160)

sample	Hb. (μg)	Phenolphthalein Test kits		Phenolphthalein modified method	
		+Ve (%)	-Ve (%)	+Ve (%)	-Ve (%)
Undiluted Blood	640	20/20 (100)	0/20 (0)	20/20 (100)	0/20 (0)
0.9% NaCl	0	0/20 (0)	20/20 (100)	0/20 (0)	20/20 (100)
Substances Detergents.	0	0/60 (0)	60/60 (100)	0/60 (0)	60/60 (100)
Fruit juice	0	0/80 (0)	80/80 (100)	0/80 (0)	80/80 (100)
Vegetable juice	0	5/20 (25)	15/20 (75)	6/20 (30)	14/20 (70)
Total		5/160	155/160	6/160	154/160

+Ve mean Positive result, -Ve mean Negative result

From the specificity testing and comparisons of reduced phenolphthalein reagent between modified preparation method and commercial test kit showed table 9. The Phenolphthalein modified method had specificity 96.26 % but found false positive 30 in vegetable. For phenolphthalein test kits It had specificity 96.87 % and

found false positive 25 % in vegetable. Both methods have positive and negative control it had one hundred percent positive and negative results. The two methods were positive to cabbage and fruit juice. A good laboratory or medical devices should not be contaminated with these things. The positive results can be explained that the contamination should be blood on the device or enzymes in some vegetable can make a false positive test. Other non-blood substances which give positive result are some fruit extracts or any other peroxidase-like substances. [26, 30] But vegetables juice has little or no chances to contamination on the medical devices. For specificity, we used samples without hemoglobin knowledge and analysis results, to avoid a biased interpretation of results. The preparation person and the tester are different ones.

The reduced phenolphthalein was presumptive test. This reagent test has some limitations. When the results showed positive that is not as true blood, to read the test results within the specified period, due to leave for cause interpretation errors. Oxygen gas interfered the testing.

The reduced phenolphthalein reagent best preparation of six study methods

The new reduced phenolphthalein test kit was composed of phenolphthalein 2.0 g, potassium hydroxide 20.0 g, distilled water 50 ml. and zinc dust 20 g. Ratios were 1: 10: 10 Reflux time was 45 minutes until the color disappear and added 1 part ethanol into 2 parts of reduced phenolphthalein solution then stored a reagent in an amber bottle and kept in refrigerate at 2-8°C pH of the final reagent were 9-10.

Figure 4 The new reduced phenolphthalein test kit

The compositions of a new test kit were listed below.

The components in a reduced phenolphthalein test kit

1. Reduced phenolphthalein 25 ml.
2. 95 % Ethanol 25 ml.
3. 3 % Hydrogenperoxide 25 ml.
4. Swab 100 pcs.
5. Plastic Tube 12x75 50 pcs.
6. Quality controls
   - 6.1. Positive controls 2 level (low & high level) 2 bottles
   - 6.2 Negative control 1 bottle
7. Interpretation card reading
8. Packing insert of procedure. Procedures were described below.

Labeling of the new test kit

Assay procedures

Step 1 dips 95 % ethyl alcohol, take the swab wiping on the area to test, put the swab in test tube.

Step 2 drop 2-3 of reduced phenolphthalein in test tube.

Step 3 drop 1-2 of 3% hydrogen peroxide

Step 4 closed the tube and read the result within 10 seconds.

Interpretations

Positive result was the changing from colorless to pink. Sample was contaminated with blood or hemoglobin substances.

Negative was read when colorless still appear in 10 seconds. No contamination of blood or hemoglobin substances on samples. Found that the new test kit interpretation of simple reaction clear.

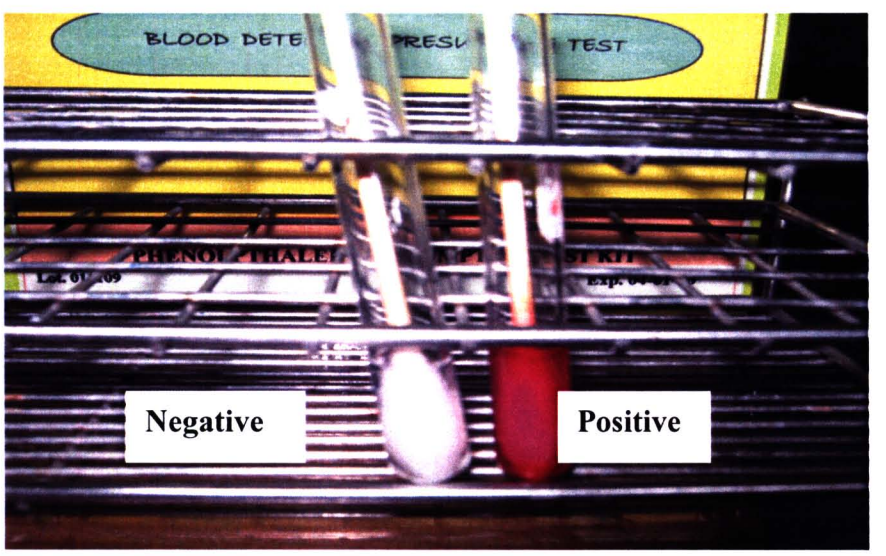

Figure 5 The negative and positive result of the new test kit

The satisfaction of test kit products

We sent the new reduced phenolphthalein test kit to laboratory to perform the trial in Pichit and Uttaradit Thailand and together with the evaluation of product satisfactions of 80 sets. The question was retuned 50 sets.

General information of questionnaire was showed in table 10-11

Table 10 Gender and education (n=50)

Sex	Educational background			
	Lower the bachelor's degree	Bachelor's degree	Higher than a bachelor's degree	Total
Female	3(16.67)	14 (77.77)	1 (5.56)	18 (36.00)
Male	7 (21.88)	22 (68.75)	3 (9.37)	32 (64.00)
Total	10 (20)	36 (72.00)	4 (8.00)	50 (100.00)

Table 11 The studied personnel group

Personnel group	Amount	Percentage (%)
Medical laboratory technician	15	30
Medical profession scientist	7	14
Medical technician	25	50
Other	3	6
Total	50	100

The majority products used are mostly male. Education degree was medical technician followed by medical scientist. Data shown in (Table 10-11)

Table 12 A new reduced phenolphthalein reagent test kit satisfaction (n =50)

Details	Production satisfaction level			
	Percentage	Mean	Standard deviates	Contentment level
The convenience in using tests	92.0	4.22	0.58	Very good
Reading reaction has the clearness	93.1	4.24	0.59	Very good
The difficulty of easy interpretation	90.8	4.20	0.60	Very good
Necessary or useful to use the reagent	92.8	3.74	1.08	Good
Performance of the reagent	91.7	3.96	0.49	Good
The satisfaction in the reagent generally	93.8	3.94	0.31	Good

Satisfaction of user on the new reagent test kit

The result of satisfactions level was found that, the experimenter uses the reduced phenolphthalein, were satisfaction of convenience in using tests Good to excellent level of 92.0 percent (mean =4.22 SD=0.58) and 93.1 percent of clearing results (mean =4.24 SD 0.59). This test kit have easy difficulty of the interpretation, had 90.8 percent (mean =4.20 (SD=0.60 Their have the satisfactions in the reagent test kit generally had 93.8 percent (mean 3.94 SD=0.31) they are think to have the necessity or, the advantage in using reagent test kit had 92.8 percent (mean 3.74, SD1.08).They are comments that should be used as a measure of blood contamination on medical devices.

Survey of blood contaminations on glucose meters and hematology analyzer

The questionnaires were sent to person who uses glucose meters and hematology analyzer in hospitals and primary care units in Pichit and Uttaradit.The results was shown in Table 14. The picture of glucose meter is showed in Figure 6 and the models used in this study were showed in figure 7.

Table 13 Survey of blood contamination on glucose meters

Institution	Number of questionnaires sent.	Number of questionnaire replies	percentage
hospitals	50	34	68
community primary care units	100	74	74
Total	150	108	60

Figure 6 Glucose meters

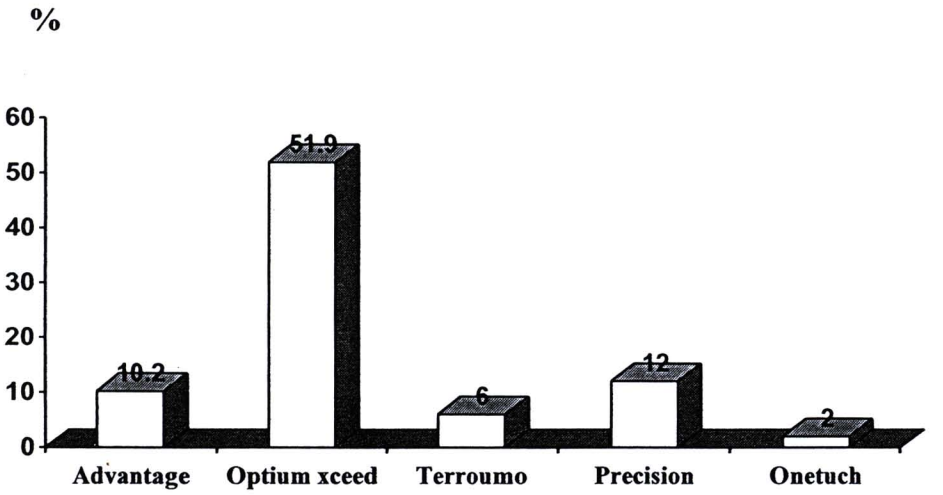

Figure 7 Glucose meters model used in this study

In total 108 glucose meters used in hospitals and primary care units 51.9 % (56/108) used Medisense Optium xceed brand. The other brand was Accucheck precision, and Advantage.

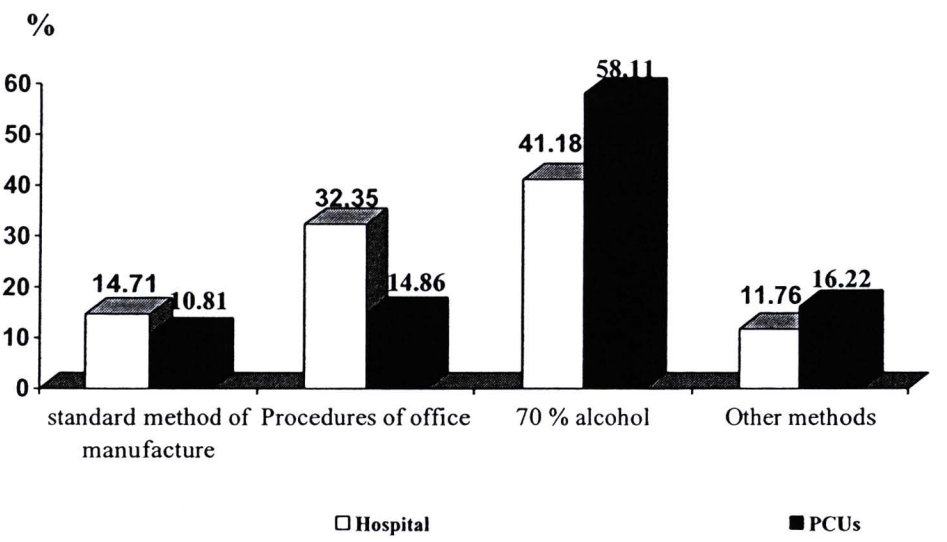

Figure 8 The Cleaning method of Glucose meter

Glucose meter used in the hospitals and primary care unit clean the devices with 70% alcohol, the office procedures, and the standard method of manufacture guide other methods, the data was showed in figure

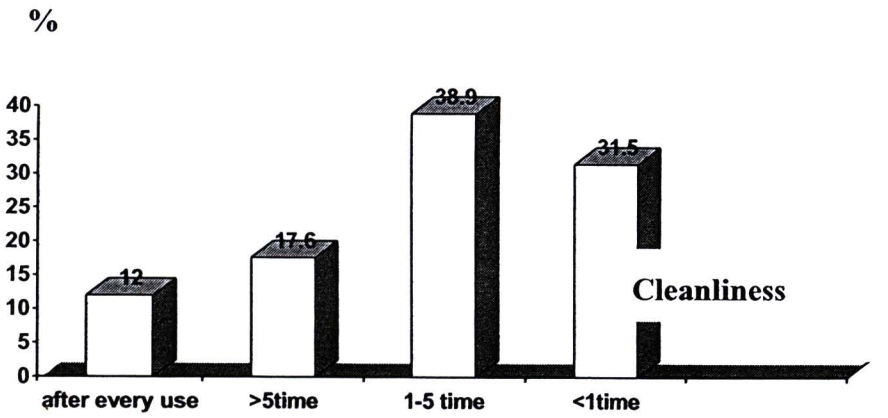

Figure 9 The cleaning time of Glucose meter users

The frequencies of cleaning on glucose meter were studied. The cleaning was 38.9 % (42/108) for cleaning 1-5 times per day 31.5 % were cleaned when blood contamination or less than 1 time per day, 17.6% clean more than 1 times per day 12 % clean after every use data was showed in figure 9

The glove wearing was 55.6 % (60/108) and sometime wear glove, 42.6 % (46/108) (Figure 10)

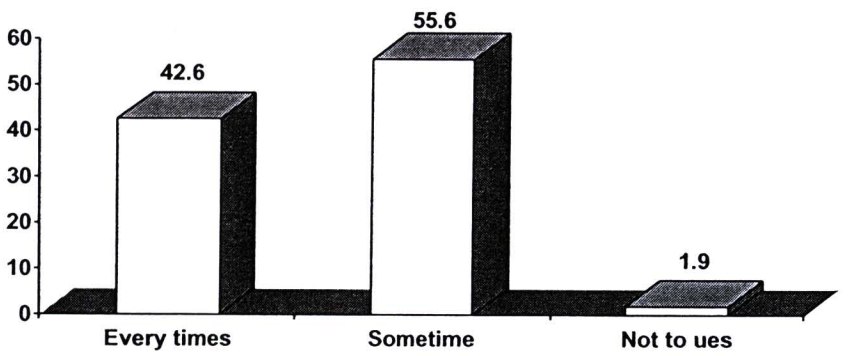

Figure 10 The gloves wearing when worked with the meter

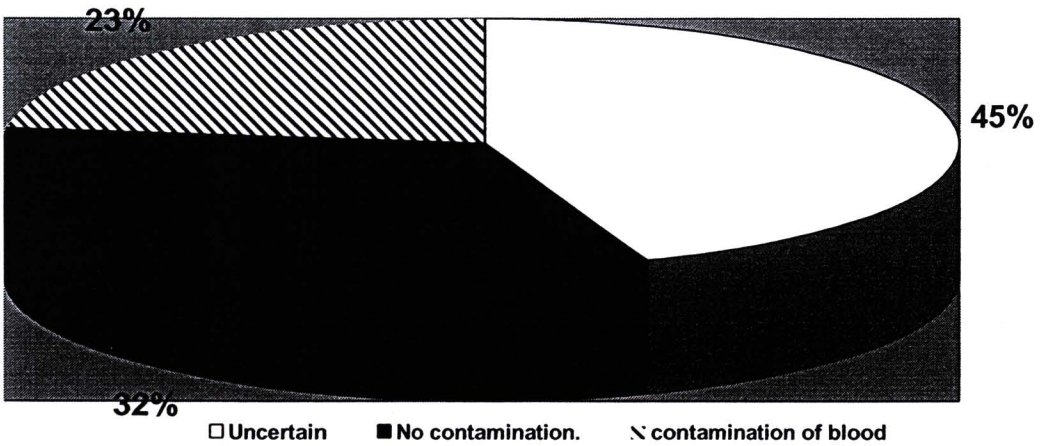

Figure 11 The comments of the use glucose meter that contamination of blood

From inquiring data about blood contaminated on, glucose meters. Found that users were not sure that the blood contaminated equivalent to 45 percent, 32 percent thought no blood contaminated and only 23 percent thought that the only contamination. The attitudes of users still that the invisible is not contaminated. It could not focus and protect of protection for use.

Blood contamination on glucose

This study used the reduced phenolphthalein for detection blood contamination on glucose meters and hematology analyzer, and survey the frequency of blood contamination on glucose meters and automatic hematology analyzer in community hospitals and primary care units (PCU)

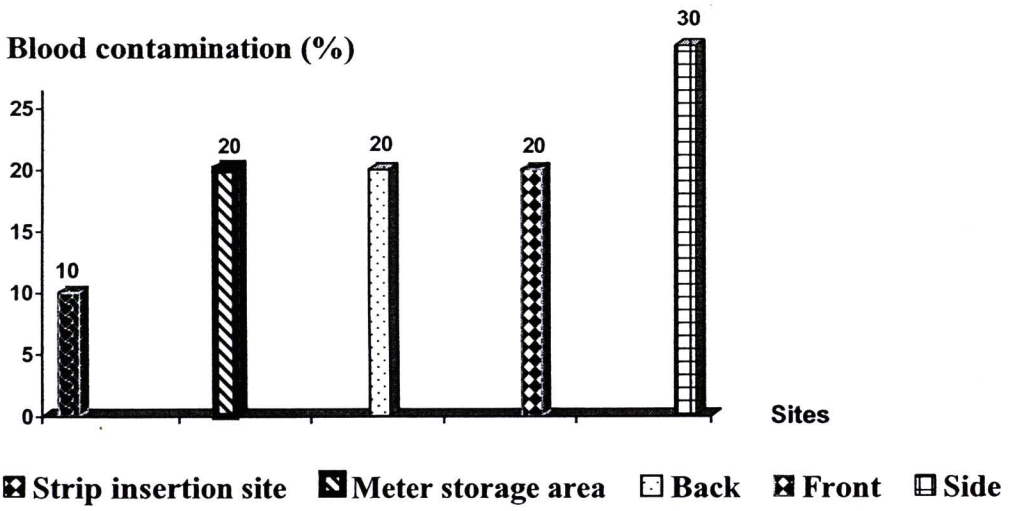

Figure 12 Blood contamination on glucose meters

A total 108 points with community hospitals (n=34) and primary care units (n=74) in Pichit and Uttaradit Province. was Sixty of these glucose meters exhibited blood contamination 54.62 % (59/108) the most of blood contamination was found on the side of 30 % these glucose meters. For Meter storage area, Back, and Front found blood contamination equal 20 % (Figure12).

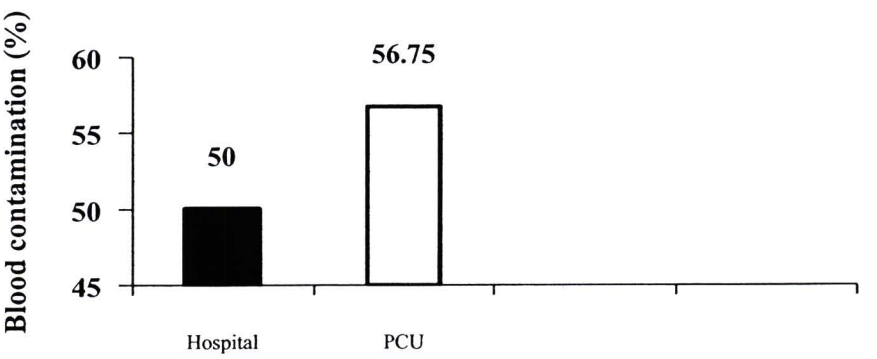

Figure 13 The comparison of blood contaminate on glucose meter between hospital and PCU

There were 50.0% (17/34) of glucose meters from hospital and 56.75 % (42/74) of glucose meters from PCU that were contaminated (Figure 13).

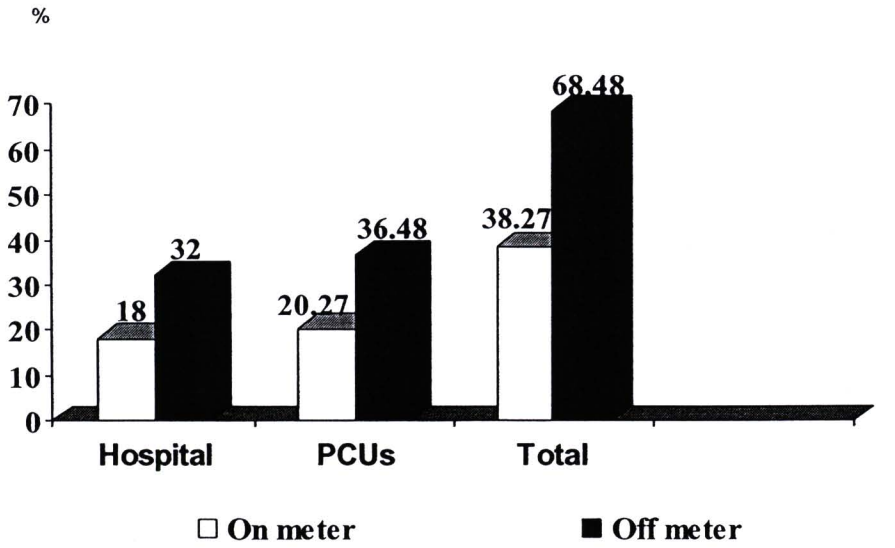

Figure 14 Percentages of glucose meters whit blood contamination by instrument test format.

There were the percentages of on meter and off meter systems with blood contamination. Found 18%of on meter test strip, 32% for off meter test strip dosing systems in community hospitals, and 20.27% of on meter test strip, 36.48% for off meter test strip dosing systems in primary care units.

Survey of blood contamination on hematology analyzers

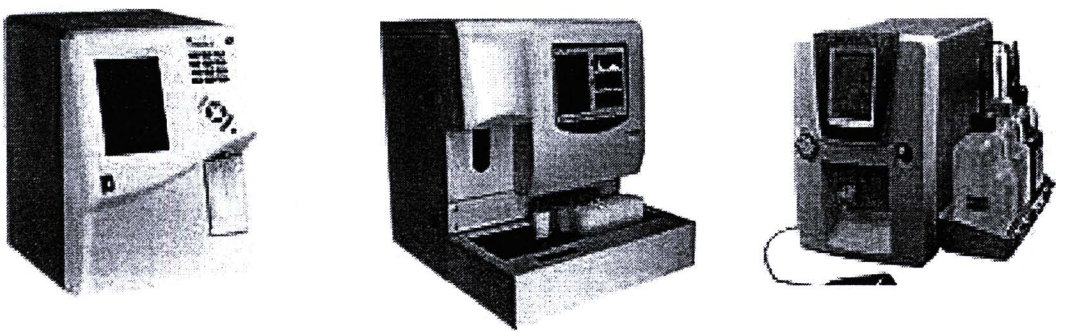

Figure 15 Hematology Analyzers

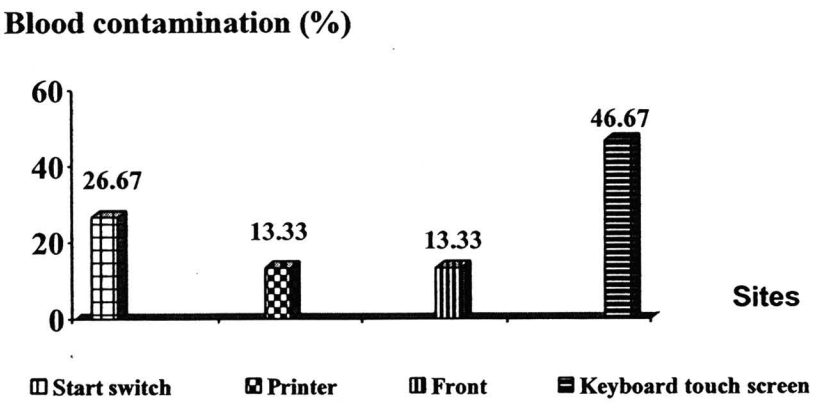

Figure 16 Blood contaminations on hematology analyzer

The blood contamination on hematology analyzer was tested. A total 15 points in community hospitals (n=15) in Pichit and Uttaradit Province. Eighth of these automatic analyzer exhibited blood contamination of 53.33 % (8/15) The most of blood contamination was found on the Keyboard touch screen 46.67% (7/15) Then Start switch, 26.66 %(4/15) percentages and, Printer, which, equal to, Front, 13.33 %(2/15) (Figure 16)

The survey of blood contamination on glucose meters showed significant frequency of contaminated on glucose meters and automatic analyzer. High contamination percentage in our study was found on the side surface of the meters. The results are comparable with the previous study that found overall, meters were contaminated on outside surfaces. The presence of hemoglobin does not indicate infectivity. However, the presence of blood indicates a potential risk for exposure to infectious agents. [21, 31] Many factors are involved in blood contamination, such as user knowledge, glucose meter cleaning, and the cleaning method used. Wearing protective attire, such as gloves, is also important for user protection from infectious agents.

Analysis of data from the questionnaires showed that most of the glucose meter. To wear gloves at work is sometimes. Also found that 1.9% does not wear gloves. Found that people like on meter systems more than off meter systems and found that the system is off meter, frequency of blood contamination than systems on

meter, For the cleaning of glucose meters most of the 70% alcohol, will be followed by the standard method of cleaning the office. Glucose meters for cleaning, most of the 70% alcohol will be followed by the standard method of cleaning the office. The mane percentage of surveyed glucose meters with blood contamination, found that the number of daily cleaning effect of blood contamination. For use automatic analyzer hematology most will wear gloves every time. The result was also analyzed with respect to frequencies of cleaning glucose meter Found that less than 1 cleaning per day, or know when the contamination of blood 17.5 % .

Suggestion of further study

In this study, preparation reagent concentration changes only phenolphthalein. Using of KOH or NaOH in the excess amount found that reduced phenolphthalein reagents are different, such as reaction time, a clear example of the reaction. Further study should try to modify the substance used to dissolve phenolphthalein with verify of concentrations of alkali agents such as KOH or NaOH.

We recommend focused on point of care testing, the equipment in dentistry room, or the equipment in an ambulance, surveillance and monitoring protocols that used to reduce instrument contamination. There protocols should comply with hospital infection control policies and disinfection procedures to help reduce the frequency of blood contaminated instruments. By reducing the number of contaminated instruments would reduced the potential risk for exposure and possibly reduced the spread of infectious agent to patients and hospital staff.