

CHAPTER III

RESULTS



Reproducibility of whole blood cholinesterase activity

A blood sample of thai blood donors was simultaneously determined 20 times for cholinesterase activity and the result is shown in Table 4. A mean value \pm one standard deviation of cholinesterase in whole blood was found to be 8.90 ± 0.63 I.U. with a range of 8.20 to 10.39 I.U.

Reproducibility of serum cholinesterase activity

A normal serum sample was simultaneously determined 20 times for serum cholinesterase activity. A mean value \pm one standard deviation of enzyme activity was found to be 2.67 ± 0.12 I.U. (range 2.43 to 2.89 I.U.) with a standard error of 0.02 I.U. The individual values of this study are shown in Table 5.

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Table 4 The reproducibility study of cholinesterase activity in the same pooled blood sample.

No.	Activity of cholinesterase (I.U.)	No.	Activity of cholinesterase (I.U.)
1	8.40	11	9.07
2	8.78	12	9.46
3	9.30	13	8.47
4	8.10	14	8.47
5	8.05	15	8.47
6	10.39	16	8.14
7	9.46	17	9.37
8	9.79	18	8.64
9	8.61	19	9.53
10	9.13	20	8.49

Mean (\bar{X}) = 8.90

Standard deviation (S.D.) = 0.63

Standare error (S.E.) = 0.14

Coefficient of variance (C.V.) = 7.08%

Table 5 The reproducibility of serum cholinesterase activity in a same pooled serum.

No.	Activity of cholinesterase (I.U.)	No.	Activity of cholinesterase (I.U.)
1	2.79	11	2.71
2	2.73	12	2.43
3	2.65	13	2.52
4	2.89	14	2.67
5	2.65	15	2.57
6	2.89	16	2.57
7	2.71	17	2.86
8	2.48	18	2.67
9	2.73	19	2.75
10	2.64	20	2.67

Mean (\bar{X}) = 2.64
 Standard deviation (S.D.) = 0.12
 Standard error (S.E.) = 0.02
 Coefficient of variance (C.V.) = 4.49%

Recovery of added acetylcholinesterase in blood

Standard acetylcholinesterase enzyme was diluted with distilled water to the final concentrations of 0.5-3 I.U./ml solution. A blood sample with the known amount of acetylcholinesterase activity in whole blood was mixed with the different amount of 25 μ l of standard acetylcholinesterase solution to the final concentration of 11.62 to 23.83 I.U. Acetylcholinesterase activity in these sample were estimated and compared with the theoretical values. The percentage of recovery was calculated from a formular.

$$\text{Percentage recovery} = \frac{\text{Determined value}}{\text{Theoretical value}} \times 100$$

The results of the recovery experiments are shown in Table 6.

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Table 6 Percentage recovery after adding the known amount of the standard acetylcholinesterase solutions into a blood sample.

	Theoretical value (I.U.)	Duplicated determined value (I.U.)	Percentage recovery
Total volume of 3 ml buffer with 5 µl blood and 25 µl of			
0.5 I.U./ml standard	11.62	11.36, 11.48	97.76, 98.83
0.75 I.U./ml standard	12.84	12.27, 12.27	95.56, 95.56
1.0 I.U./ml standard	14.06	14.09, 14.34	100.21, 101.97
1.25 I.U./ml standard	15.29	14.67, 14.58	95.95, 95.39
1.5 I.U./ml standard	16.51	15.76, 15.99	95.46, 96.85
2.0 I.U./ml standard	18.95	19.30, 19.81	101.83, 104.56
2.5 I.U./ml standard	21.40	21.57, 22.55	100.80, 105.36
3.0 I.U./ml standard	23.83	22.36, 23.13	93.82, 97.04

$$\bar{X} = 98.55$$

$$S.D. = 3.51$$

$$C.V. = 3.56\%$$

Recovery of added acetylcholinesterase in serum

A standard acetylcholinesterase enzyme was mixed with distilled water to the final concentration of 2-20 I.U. These solutions were determined for enzyme activities. The percentage recovery was calculated and the results of the recovery experiments are shown in Table 7.

Table 7 Percentage recovery of the known amount of standard acetylcholinesterase solution.

Theoretical value (I.U.)	Duplicate determined value (I.U.)	Percentage recovery
2.0	2.1, 2.0	105, 100
2.5	2.5, 2.4	100, 96
5.0	4.8, 4.9	96, 98
6.0	6.1, 6.5	102, 108
7.5	7.2, 7.1	96, 95
10.0	9.0, 9.6	90, 96
12.0	12.3, 12.2	103, 102
15.0	13.2, 13.8	88, 92
18.0	17.0, 17.8	94, 99
20.0	19.2, 18.0	96, 90

$$\begin{aligned} \bar{X} &= 97.3 \\ \text{S.D.} &= 5.16 \\ \text{S.E.} &= 1.15 \\ \text{C.V.} &= 5.31\% \end{aligned}$$

Studies on the stability of acetylcholinesterase and pseudochoolinesterase in blood and serum

Cholinesterase activity in the same blood and sera samples of 3 Thai blood donors were determined after 0, 1, 5, 8, 15, 20, 30 days of storage in the refrigerator. The values were expressed as the percentage of the initial value by the following formula.

$$\text{Percentage of zero time} = \frac{\text{Cholinesterase activity at that time } t}{\text{Cholinesterase activity at zero time}} \times 100$$

The result of these studies are shown in Table 8 and Fig. 2.

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Table 8 The effect of storage on cholinesterase activity in serum, and red blood cells in 3 samples are expressed as the percentage of the zero times.

	Time (days)						
	1	2	5	8	15	20	30
whole blood $\bar{X} \pm S.E.$	100	106.11 ± 1.33	103.98 ± 2.62	114.33 ± 4.76	110.35 ± 3.89	102.23 ± 3.34	100.21 ± 3.84
serum $\bar{X} \pm S.E.$	100	104.80 ± 0.80	109.51 ± 1.70	98.26 ± 5.74	104.91 ± 10.72	95.58 ± 10.72	96.43 ± 15.48
red cell $\bar{X} \pm S.E.$	100	102.31 ± 1.99	102.17 ± 3.18	115.33 ± 7.28	109.97 ± 6.15	102.63 ± 4.71	99.70 ± 1.36

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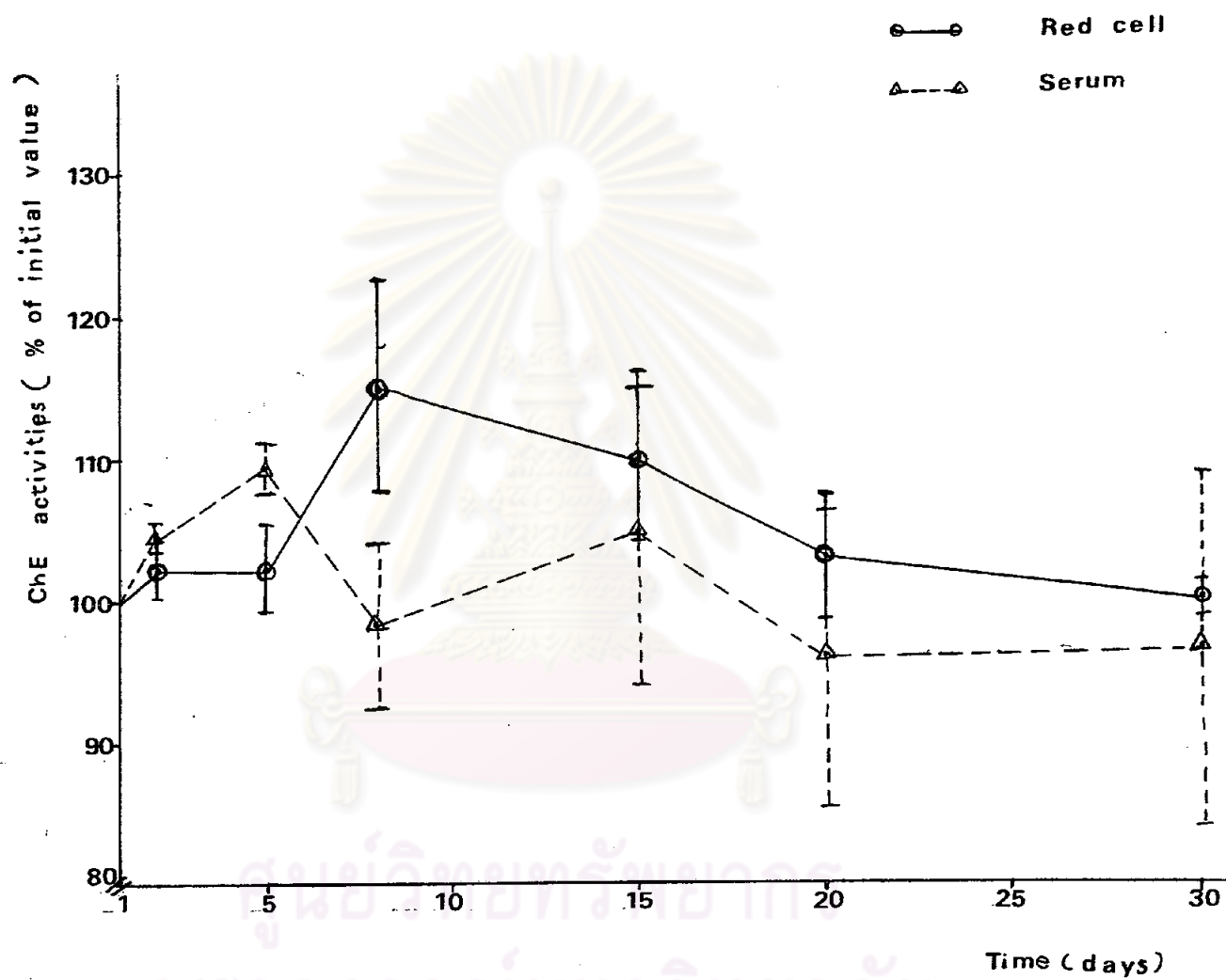


Fig. 2. Showing the stability of serum and red cell cholinesterase.

Cholinesterase activities in serum and red blood cells of Thai blood donors

Results of whole blood cholinesterase, serum cholinesterase and red cell cholinesterase activities in 50 male blood donors are shown in Table 9. The average values \pm one standard deviation of serum cholinesterase and red cell cholinesterase activity were found to be 3.13 ± 0.69 I.U. (range 1.62 to 4.49 I.U.), and 20.93 ± 3.55 (range 13.85 to 33.50 I.U.) respectively. Results of whole blood, serum cholinesterase and red cell cholinesterase activities in 50 female blood donors are shown in Table 10. The mean value \pm one standard deviation of serum cholinesterase and red cell cholinesterase were found to be 3.00 ± 0.73 I.U. (range 1.70 to 4.32 I.U.), and 21.63 ± 3.35 I.U. (range 12.73 to 27.27 I.U.) respectively.

There is no significant difference ($P > 0.05$) between the mean values of serum cholinesterase and red cell cholinesterase in males and females blood donor as shown in Table 11.

The frequency distribution of serum cholinesterase and red cell cholinesterase in 100 Thai blood donors are shown in Fig. 3 and Fig. 4 respectively.

Table 9 Cholinesterase activities in whole blood, serum, and red blood cell in 50 male blood donors.

Blood donor No.	Age (years)	Blood group	Hct. (%)	Cholinesterase in W.B. (I.U.)	Cholinesterase in serum(I.U.)	Cholinesterase in red cell (I.U.)
1	35	B	41	11.14	3.15	23.09
2	22	O	48	10.77	3.35	18.81
3	27	A	40	11.81	2.65	25.55
4	41	B	43	9.55	4.06	16.83
5	35	B	46	10.45	3.12	19.07
6	22	B	41	9.57	2.72	19.45
7	30	O	45	10.28	3.68	18.35
8	28	A	47	13.44	2.91	25.31
9	26	O	39	12.56	3.11	27.32
10	45	A	50	10.58	2.16	19.00
11	48	A	41	11.63	3.04	24.00
12	28	AB	41	11.26	3.57	22.34
13	36	O	39	15.10	3.34	33.50
14	36	B	37	8.62	3.67	17.04
15	28	A	48	13.39	3.96	23.60
16	36	O	47.5	9.33	2.38	17.02
17	33	B	42.5	9.62	2.54	19.20
18	26	O	45	10.65	3.01	19.98
19	34	O	46.5	11.06	3.15	20.11
20	20	B	48	11.70	2.27	21.91
21	27	B	53.5	12.75	4.02	20.34
22	30	O	49	12.44	4.17	21.05
23	22	B	54	10.40	3.12	16.60
24	32	B	43	10.17	3.41	19.11
25	28	A	49	8.80	2.05	15.82
26	19	B	47	9.78	2.61	17.87
27	30	O	43.5	12.96	4.87	23.47
28	39	A	41	10.15	3.42	19.83
29	35	A	43	10.58	4.01	19.27

Table 9 (continued)

Blood donor No.	Age (years)	Blood group	Hct. (%)	Cholinesterase in W.B. (I.U.)	Cholinesterase in serum(I.U.)	Cholinesterase in red cell (I.U.)
30	27	O	45.5	11.80	3.34	21.93
31	30	B	48	11.69	3.16	20.94
32	42	A	43	11.44	3.16	22.41
33	24	B	44	10.73	4.00	19.28
34	27	A	42.5	10.73	2.35	22.06
35	33	B	42	13.99	4.01	27.77
36	38	A	46	11.04	2.89	20.61
37	38	O	41	11.90	4.49	22.56
38	32	A	41	12.14	2.38	26.19
39	19	O	43.5	9.76	2.56	19.11
40	41	O	40.40	11.14	3.55	22.52
41	40	O	44	11.33	1.62	23.64
42	19	B	41	9.68	2.30	20.29
43	25	AB	46	7.76	2.58	13.85
44	39	O	44	9.07	2.56	17.34
45	36	B	41	10.82	2.93	22.19
46	39	B	46.5	12.75	2.18	24.91
47	24	O	48	11.89	3.81	20.64
48	43	B	44	8.20	2.44	15.55
49	45	O	43	10.63	3.85	19.62
50	28	B	40	9.30	3.25	18.39
range	19-49		37-50	7.76-15.10	1.62-4.87	13.85-33.50
Mean	31.46		44.20	10.96	3.13	20.93
S. D.	7.57		3.63	1.50	0.69	3.55
S. E.	1.07		0.50	0.21	0.09	0.50

Table 10 Cholinesterase activity in whole blood, serum, and red blood cell in 50 female blood donors.

Blood donor No.	Age (yrs)	Blood group	Hct. (%)	Cholinesterase in W.B. (I.U.)	Cholinesterase in serum(I.U.)	Cholinesterase in red cell (I.U.)
1	29	A	45	10.81	2.43	21.04
2	24	B	40	9.63	3.24	19.20
3	30	AB	41	11.65	3.10	23.96
4	23	B	42.50	9.75	6.30	14.42
5	39	B	42.50	12.81	2.56	26.68
6	30	B	38	8.96	2.29	19.84
7	35	O	40	9.87	3.13	19.97
8	33	A	40	10.39	2.91	21.60
9	21	O	41.50	11.51	3.70	22.52
10	19	A	37	9.90	2.85	21.91
11	19	B	37	10.06	3.39	21.42
12	53	O	34.50	9.66	3.18	21.97
13	26	A	35	8.67	3.00	19.20
14	23	-	36	8.34	2.38	25.30
15	28	O	30.50	8.99	3.21	22.17
16	25	O	30	8.69	2.84	22.34
17	23	B	36.50	10.71	3.75	22.81
18	28	-	36.50	7.32	1.86	16.81
19	27	-	26	8.68	4.32	21.08
20	26	O	36.50	11.18	2.97	25.48
21	21	-	31	6.11	3.14	12.73
22	24	B	26	9.13	2.76	27.27
23	19	O	30	9.28	3.30	23.24
24	20	O	29.50	8.15	3.57	19.09
25	26	O	32	9.24	3.55	21.34
26	19	A	38.50	9.94	2.59	21.67
27	22	O	39.00	8.00	2.65	16.41
28	21	-	36.50	11.25	21799	25.96
29	22	A	34.50	10.69	3.11	25.08

Table 10 (continued)

Blood donor No.	Age (years)	Blood group	Hct. (%)	Cholinesterase in W.B. (I.U.)	Cholinesterase in serum(I.U.)	Cholinesterase in red cell (I.U.)
30	22	A	36.50	10.39	3.39	22.56
31	36	B	33.00	10.71	3.61	25.11
32	22	-	24.50	9.32	3.63	27.04
33	24	-	30.00	8.21	3.88	18.29
34	19	A	35.50	10.89	2.62	25.93
35	28	-	25.50	10.22	2.15	24.88
36	22	A	33.50	6.29	2.21	14.37
37	23	O	34.00	8.24	2.69	19.02
38	42	B	34.00	9.48	2.44	23.13
39	22	B	38.00	10.63	3.99	21.47
40	22	-	39.00	8.14	2.48	17.02
41	23	-	37.50	9.57	1.70	22.68
42	28	O	31.00	9.71	2.40	25.96
43	22	B	34.00	10.26	2.83	24.69
44	54	O	35.50	8.99	2.47	20.82
45	24	O	36.50	9.33	2.55	21.12
46	20	B	34.00	8.31	2.40	19.78
47	51	B	43.00	12.51	3.67	24.24
48	35	AB	39.50	9.23	2.30	19.85
49	29	B	39.50	9.20	2.90	18.86
50	38	B	43.50	11.58	3.16	22.52
Range	19-54		26-45	6.11-12.51	1.70-6.30	12.73-27.27
Mean	27.22		35.61	9.61	3.00	21.63
S.D.	8.56		4.83	1.37	0.73	3.35
S.E.	1.21		0.68	0.19	0.10	11.25

Table 11 The mean \pm SD of Cholinesterase activity in serum, whole blood and red blood cells in Thai blood donors. Ranges are in parenthesis.

Sex	No.	Mean SD		
		ChE in WB (I.U.)	ChE in serum (I.U.)	AChe In red cell (I.U.)
Male	50	10.97 \pm 1.49 (7.76-15.10)	3.13 \pm 0.69 (1.62-4.87)	20.93 \pm 3.52 (13.85-33.50)
Female	50	9.61 \pm 1.58 (6.11-12.51)	3.07 \pm 0.73 (1.70-6.30)	21.64 \pm 3.32 (12.73-27.27)
Total	100	10.29 \pm 1.58 (6.11-15.10)	3.07 \pm 0.71 (1.62-6.30)	21.28 \pm 3.45 (12.73-33.50)

t-test: Cholinesterase activity in whole blood, serum and red cell of male vs female, $P > 0.05$.

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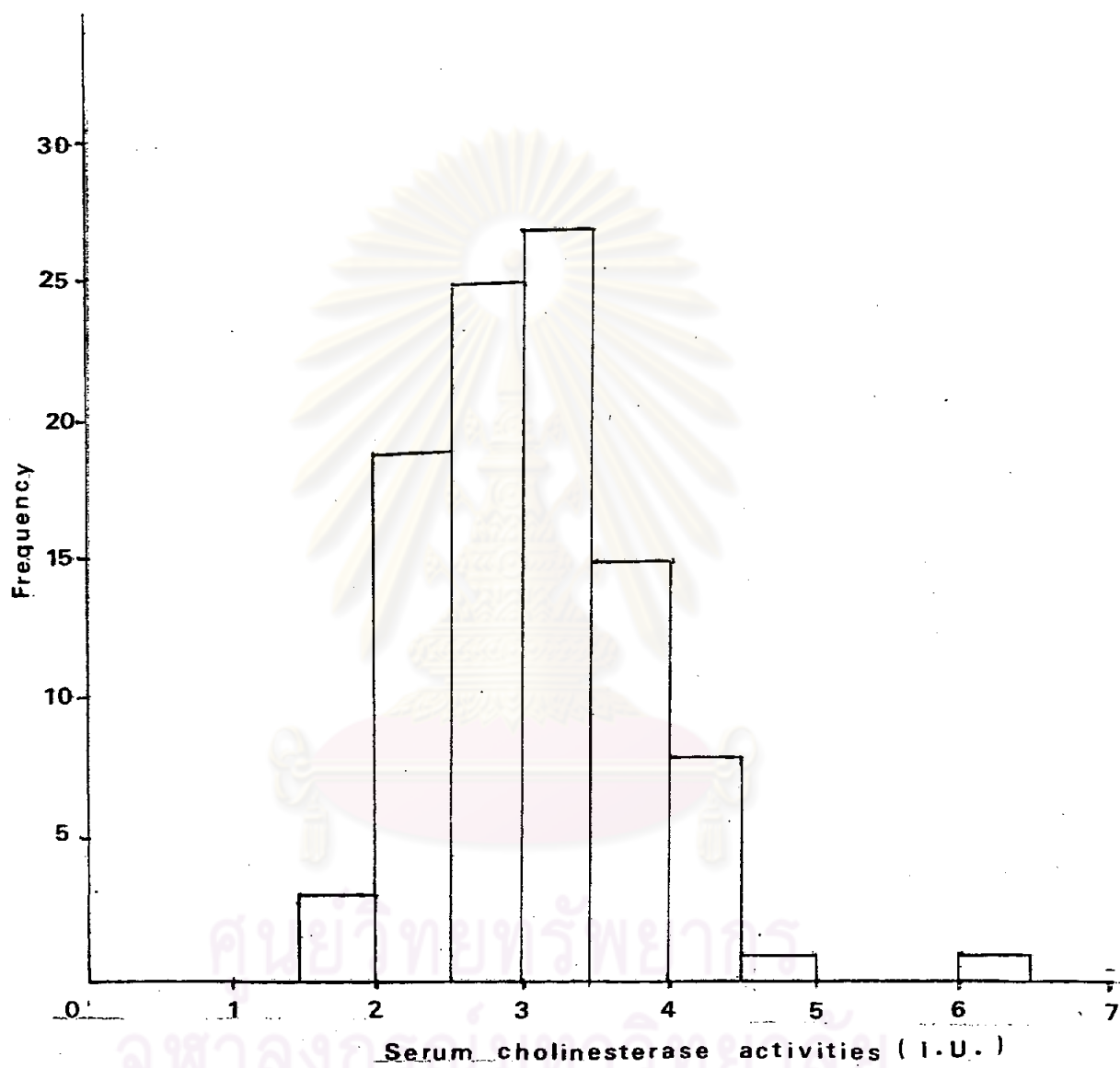


Fig. 3 The frequency distribution of serum cholinesterase activities in 100 Thai blood donors .

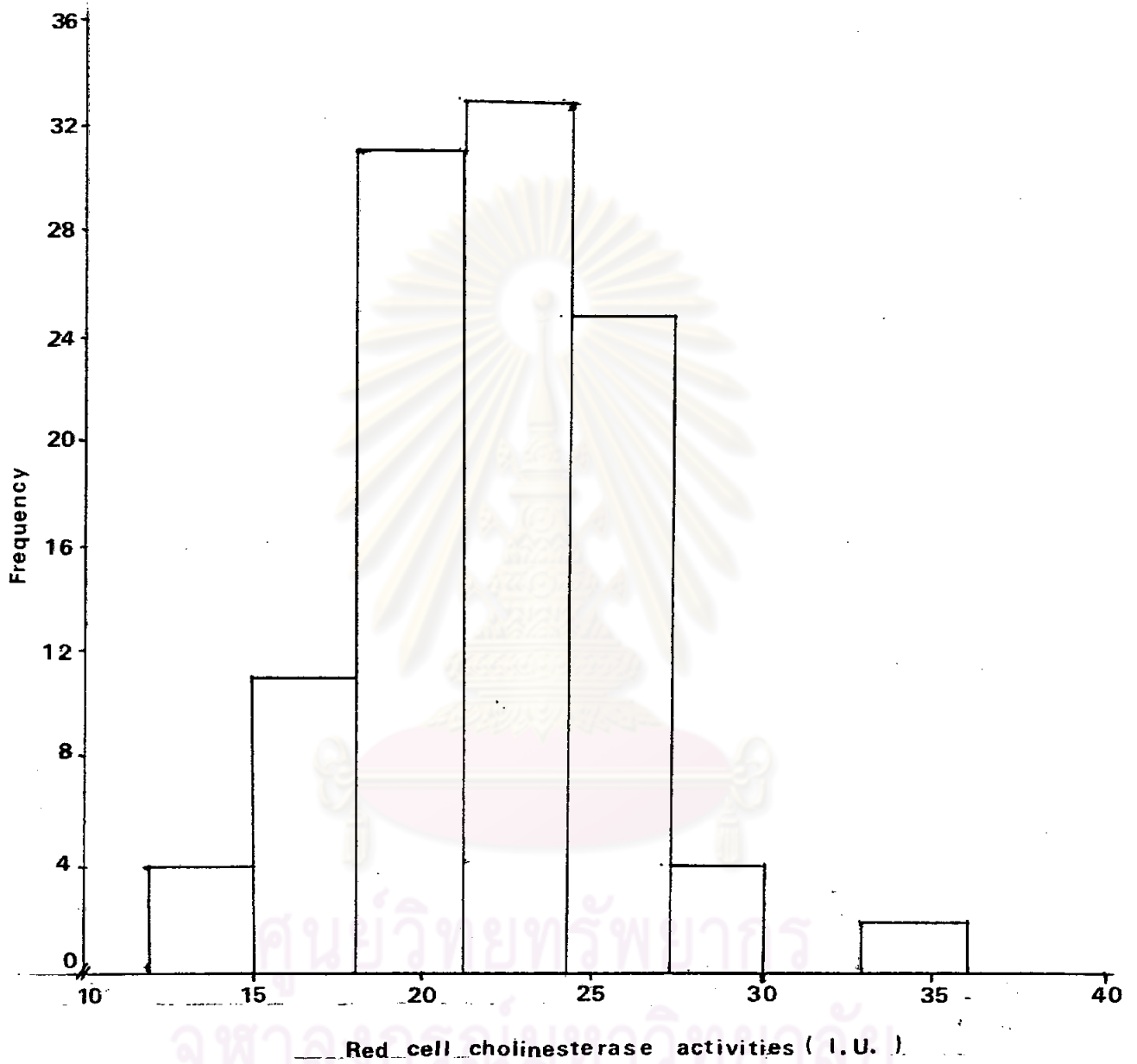


Fig.4 The frequency distribution of red cell cholinesterase activities in 100 Thai blood donors .

Cholinesterase levels in people exposed to insecticides

Results of cholinesterase levels in whole blood, serum and red blood cell in 36 occupational exposures to organophosphate insecticide are shown in Table 12. Only 25 workers (69.44%) had normal values of serum cholinesterase levels and 11 workers (30.56%) had low values of serum cholinesterase levels. Four out of these 36 workers (11.11%) had lower red cell cholinesterase levels than the normal subjects and 32 workers (88.89%) had normal values. The mean values \pm S.D. of serum cholinesterase and red cell cholinesterase were found to be 2.21 ± 0.78 I.U. (range 0.74-3.92 I.U.) and 21.05 ± 3.57 I.U. (range 10.03-27.57 I.U.) respectively. The mean value of serum cholinesterase in these subjects was highly significantly lower ($P < 0.0005$) than that of the normal subjects. There was no significant difference ($P > 0.05$) between the mean values of red cell cholinesterase in these workers and the normal subjects.

Results of serum cholinesterase and red cell cholinesterase levels in 22 people not directly exposed to insecticides are shown in Table 13. 21 workers (95.5%) had normal serum cholinesterase levels and only 1 worker (4.5%) had low serum cholinesterase level. Five out of these 22 workers (22.5%) had lower red cell cholinesterase level than that of the normal subjects and 17 workers (77.5%) had normal values. The mean values \pm S.D. of serum cholinesterase and red cell cholinesterase were found to be 2.72 ± 0.67 I.U. (range 1.57-3.95 I.U.) and 19.92 ± 3.29 I.U. (range 13.39-25.46 I.U.) respectively. The mean values of serum cholinesterase level was highly significantly

lower ($P < 0.01$) than of the normal subjects. There was no significant difference ($P > 0.05$) between the mean value of red cell cholinesterase in these 22 workers and the normal subjects.

There were no significant difference ($P > 0.05$) between the mean values of whole blood cholinesterase and red cell cholinesterase activities in directly exposed group and the nondirectly exposed group. However, the mean value of serum cholinesterase in the directly exposures was highly significantly lower ($P < 0.01$) than of the nondirectly exposures.

There was no relationship between serum or red cell cholinesterase activities and the duration of insecticide exposure as shown in Fig. 5. These findings indicated that the duration of exposure had no direct effect on serum or red cell cholinesterase activities in these workers in the present study.

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Table 12 Cholinesterase activity in whole blood, Serum, and red blood cell in 36 workers who directly exposed to organo-phosphate insecticide.

No.	Sex	Age (years)	Act. (%)	working years	ChE in W.B. (I.U.)	ChE in serum (I.U.)	ChE in red cell (I.U.)
1	F	29	37.2	9	10.46	2.77	23.45
2	F	28	36.5	8	10.31	2.78	23.40
3	F	28	32	8	6.98	1.90	17.79
4	F	39	33.5	2	9.57	1.13	26.33
5	F	29	31.5	2	8.71	1.95	23.26
6	F	19	35.5	6	9.28	3.18	20.37
7	F	31	34.5	10	10.16	3.25	23.27
8	F	28	38	6	6.84	1.86	14.98
9	F	27	36	6	9.20	2.60	20.93
10	F	40	35	12	7.85	3.39	16.15
11	F	31	38	7	9.59	3.92	18.93
12	F	26	30	4	7.67	1.91	21.78
13	F	46	33	4	8.66	2.20	21.80
14	F	47	36	10	9.20	3.39	19.54
15	F	30	38.5	9	10.00	1.96	22.85
16	F	31	39	3	10.10	2.55	27.57
17	F	25	39	8	7.73	1.33	17.75
18	F	51	36	10	9.65	3.03	21.41
19	F	20	32	5	7.22	1.47	19.43
20	M	24	41.2	5	8.94	1.37	19.42
21	M	43	40	6	10.58	1.61	24.03
22	M	30	44.5	5	11.00	1.08	23.38
23	M	20	38	3	9.91	1.70	23.30
24	M	26	42.5	1	8.14	1.41	17.85
25	M	34	47	7	10.72	0.74	21.96
26	M	20	37.5	3	7.37	2.04	16.25
27	M	19	33.5	2	10.31	2.51	25.80
28	M	29	36	3	9.95	1.82	24.41

Table 12 (continued)

No.	Sex	Age (years)	Hct. (%)	working years	ChE in W.B. (I.U.)	ChE in serum (I.U.)	ChE in red cell (I.U.)
29	M	41	36.5	1	10.25	1.92	24.73
30	M	36	37.5	8	5.04	1.79	10.03
31	M	41	43	0.4	10.68	3.55	20.14
32	M	41	38	6	9.17	2.85	19.48
33	M	27	41	2	10.06	1.72	22.05
34	M	23	41	5	8.39	1.70	18.01
35	M	28	27	6	9.02	2.95	25.44
36	M	33	34	6	8.28	2.15	20.18
Range		19-51	32-47	0.4-12	5.04-11.00	0.74-3.92	10.03-27.57
\bar{X}		31.11	36.92	5.51	9.08	2.21	21.05
S.D.		8.34	4.11	2.95	1.34	0.78	3.57
S.E.		1.39	0.68	0.49	0.22	0.13	0.59

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Table 13 Cholinesterase activity in whole blood, serum, and red blood cell in 22 workers who did not directly exposed to organophosphate insecticide.

No.	Sex	Age (years)	Hct. (%)	Working years	ChE in W.B. (I.U.)	ChE in serum (I.U.)	ChE in red cell (I.U.)
1	F	41	35	6	9.34	2.06	22.85
2	F	27	35	6	8.86	1.57	22.40
3	F	29	36	6	8.88	1.82	21.42
4	F	40	41	2	8.31	2.67	16.44
5	M	39	43.2	5	9.53	2.64	18.50
6	M	21	43.5	1	9.48	2.45	18.61
7	M	38	40	4	11.58	2.32	25.46
8	M	32	41.8	8	9.41	1.89	19.89
9	M	36	39	6	10.04	2.30	22.13
10	M	30	38.3	7	10.25	2.37	22.96
11	M	41	36.5	2	11.07	3.07	24.99
12	M	36	38	7	9.45	2.61	20.15
13	M	26	41	4	9.74	3.16	19.21
14	M	24	39	3	10.17	2.30	22.46
15	M	38	40.5	3	10.60	3.76	20.64
16	M	43	40	2	10.30	3.24	20.90
17	M	31	44.7	6	7.90	2.52	14.59
18	M	34	38.7	2.5	8.75	3.95	16.35
19	M	30	40	6	7.34	3.32	13.39
20	M	29	42.5	6	10.77	2.91	21.40
21	M	28	47.5	3	8.35	2.82	14.47
22	M	35	38	5	9.83	4.13	19.14
Range		21-41	35-47.5	1-7	7.9-11.07	1.57-3.95	13.39-25.46
\bar{X}		33.09	40.0	4.56	9.54	2.72	19.92
S.D.		6.07	3.10	1.98	1.04	0.67	3.29
S.E.		1.29	0.66	0.42	0.22	0.14	0.70

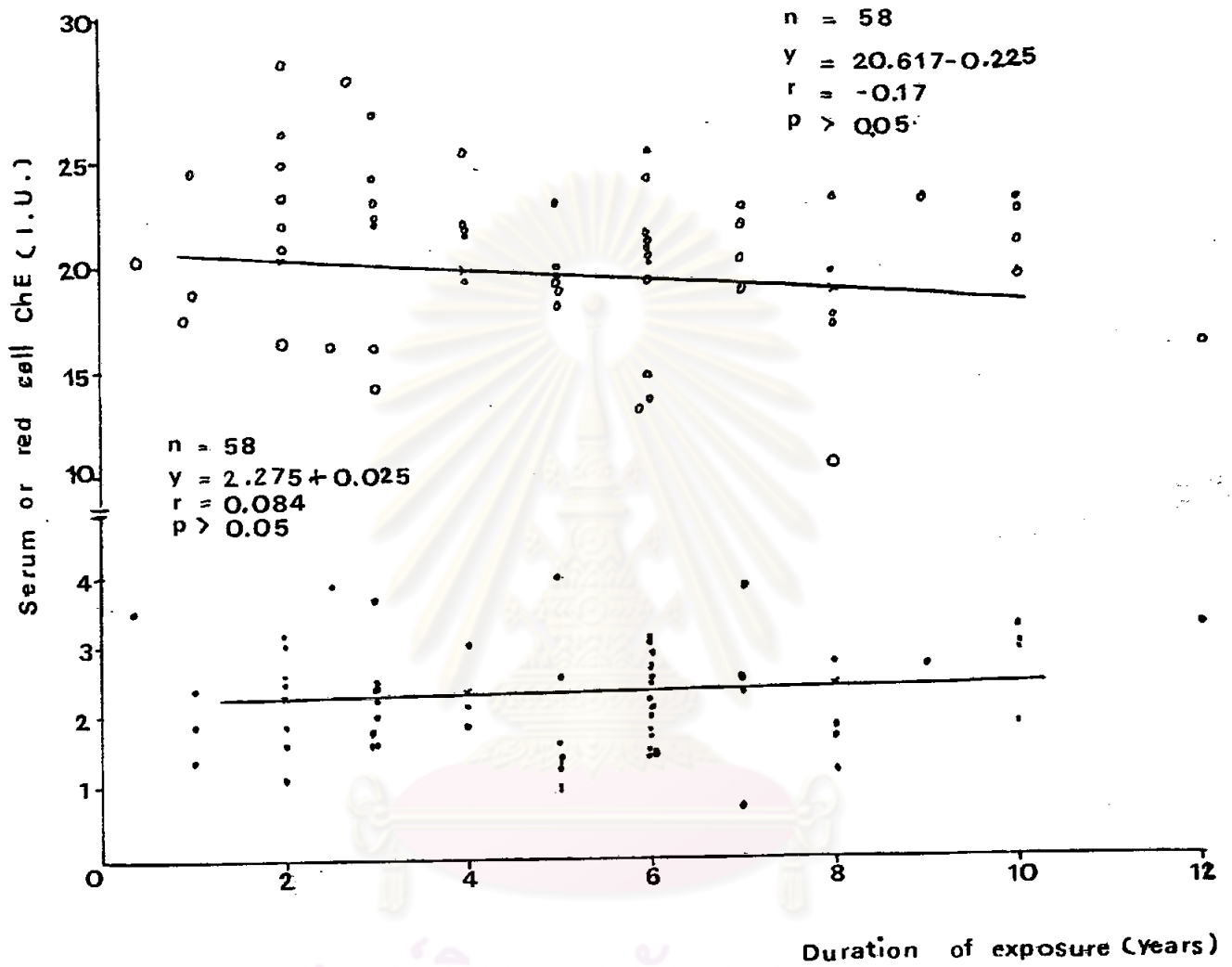


Fig. 5 Showing the relationship between serum and red cell cholinesterase activities and the duration of exposure in workers in a insecticide factory .

Cholinesterase activities in patients with acute anticholinesterase insecticide poisoning.

The studies were performed on 11 patients with acute poisoning from anticholinesterase insecticide admitted in Chulalongkorn Hospital. 6 of 11 patients were carbamate insecticide poisoning. There is only one patients who ingested organophosphorus insecticide died and 10 patients were recover after treatment. The results of cholinesterase activity in serum and red blood cell both before and after treatments, and duration of admission are shown in Table 14. These patients ingested insecticides for committing suicide but the case No. 3 was the only one patient who exposed to organophosphate by absorption from the respiratory tract and eyes. The summation of signs and symptoms occurred are shown in Table 15.

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Table 14 Cholinesterase activity in 11 patients with acute anticholinesterase insecticides poisoning.

Case No.	Sex	Age	Serum		AChE		days ^a	Treatments	Complications	days ^b
			before	after	before	after				
1	F	22	0	0	-	-	-	Atropine, Symptomatic treatment	Pneumonia Cardiac congestion	2
2	M	21	0.04	0.16	-	-	4	Atropine, 2 PAM Gastric lavage	-	4
3	M	18	0.02	-	-	-	-	Atropine	-	6
4	F	20	0.17	0.45	-	-	8	Atropine, 2 PAM Gastric lavage Tracheostomy	Pneumonia	31
5	M	20	0.30	0.26	-	-	1	Atropine, 2 PAM Gastric lavage	-	5
6	M	39	0	0.26	0.25	0.48	6	Atropine, 2 PAM Transquilizer	History of cirrhosis pneumonia	28
7	F	26	0.55	-	2.01	-	-	Atropine, force diuresis	-	4
8	M	28	1.78	-	-	-	-	Atropine Transquilizer	Atropine psychosis	6

Table 14 (Continued)

Case No.	Sex	Age	Serum ChE		AChE		days ^a	Treatments	Complications	days ^b
			before	after	before	after				
9	M	19	0.64	1.88	-	-	4	Atropine Transquillizer	-	14
10	M	21	0.09	0.72	-	-	3	Atropine	Nervous	3
11	F	18	1.09	-	-	-	-	Atropine, diuresis	-	2

Note Case No. 1-6, are organophosphate poisoning and cases No. 7-11 are carbamate poisoning.

a = days between before and after treatments

b = days of admission in hospital

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Table 15 Signs and symptoms in 11 patients with anticholinesterase poisoning.

Sign or Symptoms	No of patients showing signs listed at left		
	Organophosphate poisoning	Carbamate poisoning	Total
weakness	3	3	6
nausea and vomiting	3	1	4
dizziness	1	1	2
excessive salivation	5	5	10
dyspnoea	5	1	6
miosis	6	3	9
muscle fasciculations	5	5	10
fever	1	-	1
diarrhoea	2	-	2
unconsciousness	3	1	4
abdominal pain	1	-	1
cyanosis	1	-	1
death	1	-	1

In 6 patients with organophosphate poisoning and 5 patients with carbamate poisoning.

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Cholinesterase activities in patients with infectious hepatitis.

The results of serum cholinesterase activity in 35 patients with infectious hepatitis are shown in Table 16. Fourteen patients (41.18%) had normal values of serum cholinesterase and twenty one patients (58.82%) had low serum cholinesterase. The mean value \pm S.D. of serum cholinesterase activity was found to be 2.15 ± 0.73 I.U. (range 0.57 to 3.81 I.U.) which was highly significantly lower ($P < 0.001$) than that of the normal subjects.

Results of serum cholinesterase activities determined weekly from seven patients with infectious hepatitis for 3-4 weeks is shown in Table 17 and Fig. 6.



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Table 16 Serum cholinesterase activity in 35 patients with hepatitis.

Patient No.	Sex	ChE activity (I.U.)
1	M	2.71
2	M	2.86
3	M	2.39
4	M	1.64
5	M	0.71
6	M	2.58
7	M	1.51
8	M	1.10
9	M	2.16
10	M	2.15
11	M	2.90
12	M	3.32
13	M	1.90
14	M	2.01
15	M	1.65
16	M	2.12
17	M	2.91
18	M	2.22
19	M	3.10
20	M	3.20
21	M	1.63
22	M	2.95
23	M	3.81
24	M	1.51
25	M	1.96
26	F	1.90
27	F	2.19
28	F	1.22
29	F	1.64
30	F	2.47
31	F	2.03

Table 16 (continued)

Patient No.	Sex	ChE activity (I.U.)
32	F	0.57
33	F	2.69
34	F	1.47
35	F	1.9
Range		0.57-3.81
\bar{X}		2.14
S.D.		0.73
S.E.		0.12

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Table 17 Serum cholinesterase activity in 7 patients with infectious hepatitis expressed as the percentage of the first of admission.

Patient No.	No of week after admission				
	0	1	2	3	4
1	100	108.22	63.47	110.96	-
2	100	-	130.54	-	-
3	100	74.59	140.98	139.89	177.87
4	100	-	156.95	-	-
5	100	100.53	116.84	-	-
6	100	-	76.96	-	73.94
7	100	205.66	184.91	-	-
\bar{X}	100	122.25	124.38	125.43	125.91
S.D.	0	49.74	39.74	20.46	51.97
S.E.	0	28.72	15.02	14.47	36.75

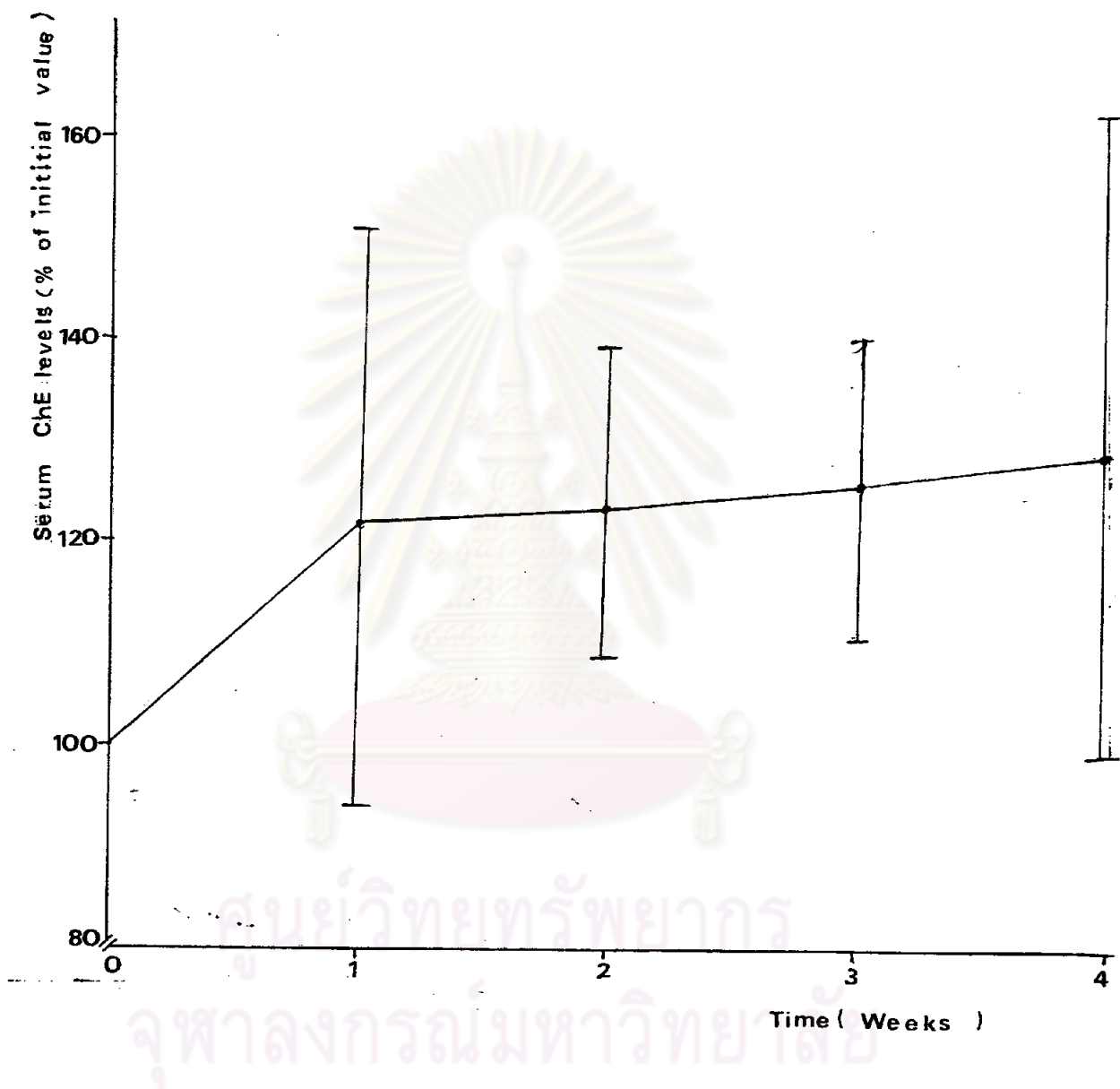


Fig. 6 Showing the mean \pm S.E. of serum cholinesterase levels in 7 patients with infectious hepatitis during 4 week admission in hospital.

Cholinesterase activities in patients with malaria.

Results of serum cholinesterase activities in 57 patients with falciparum malaria are shown in Table 18. 37 patients (64.91%) of patients with falciparum malaria had normal serum cholinesterase activity and 20 patients (35.09%) had low serum cholinesterase activity. The mean value \pm S.D. of serum cholinesterase activity in these patients was found to be 2.65 ± 0.77 I.U. (range 0.81-4.55 I.U.) which was significantly lower ($P < 0.05$) than that of the normal subjects.

Results of serum cholinesterase activity in 6 patients with falciparum malaria during their hospitalization for 5 weeks were shown in Table 19. Figure 7 illustrated the alterations of serum cholinesterase and expressed as the percentage of the first week, it is apparent that the low serum cholinesterase increased quickly and reached the normal levels within the 4th week.

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Table 18 Serum cholinesterase activity in 57 patients with falciparum malaria.

Patient No.	Sex	ChE activity (I.U.)
1	F	1.91
2	F	2.67
3	F	2.91
4	F	2.89
5	F	3.23
6	F	2.28
7	F	2.91
8	F	4.46
9	M	2.39
10	M	2.40
11	M	1.90
12	M	2.06
13	M	2.25
14	F	2.45
15	F	1.60
16	F	3.26
17	F	3.95
18	F	2.03
19	F	2.47
20	F	1.90
21	F	3.02
22	F	2.50
23	F	1.95
24	F	3.72
25	F	1.17
26	M	1.56
27	M	3.86
28	M	1.76



Table 18 (continued)

Patient No.	Sex	ChE activity (I.U.)
29	M	3.74
30	M	2.13
31	M	2.44
32	M	2.61
33	F	3.50
34	F	3.92
35	M	2.15
36	F	2.47
37	M	2.92
38	M	2.97
39	M	3.03
40	M	1.89
41	M	1.82
42	M	2.99
43	M	2.72
44	M	3.33
45	M	2.53
46	M	3.19
47	M	1.99
48	M	4.55
49	M	3.20
50	M	2.72
51	M	2.99
52	M	2.76
53	M	1.75
54	M	3.53
55	F	0.81

Table 18 (continued)

Patient No.	Sex	ChE activity (I.U.)
56	F	2.47
57	M	2.67
Range		0.81-4.55
\bar{X}		2.65
S.D.		0.77
S.E		0.10

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Table 19 Serum cholinesterase activity in 6 patients with malarial infection expressed as the percentage of the first week of admission.

Patients	No of week after admission					
	0	1	2	3	4	5
1	100	188.48	128.27	188.48	216.75	-
2	100	139.70	125.47	115.73	142.70	-
3	100	92.03	105.49	103.85	89.56	-
4	100	42.92	78.13	86.25	109.79	118.33
5	100	151.56	180.44	190.22	176.89	194.67
6	100	89.74	141.03	164.10	162.82	242.31
\bar{X}	100	117.41	126.47	141.44	149.75	185.10
S.D.	0	47.74	31.37	41.28	42.16	51.06
S.E.	0	21.35	14.03	18.46	18.86	29.48

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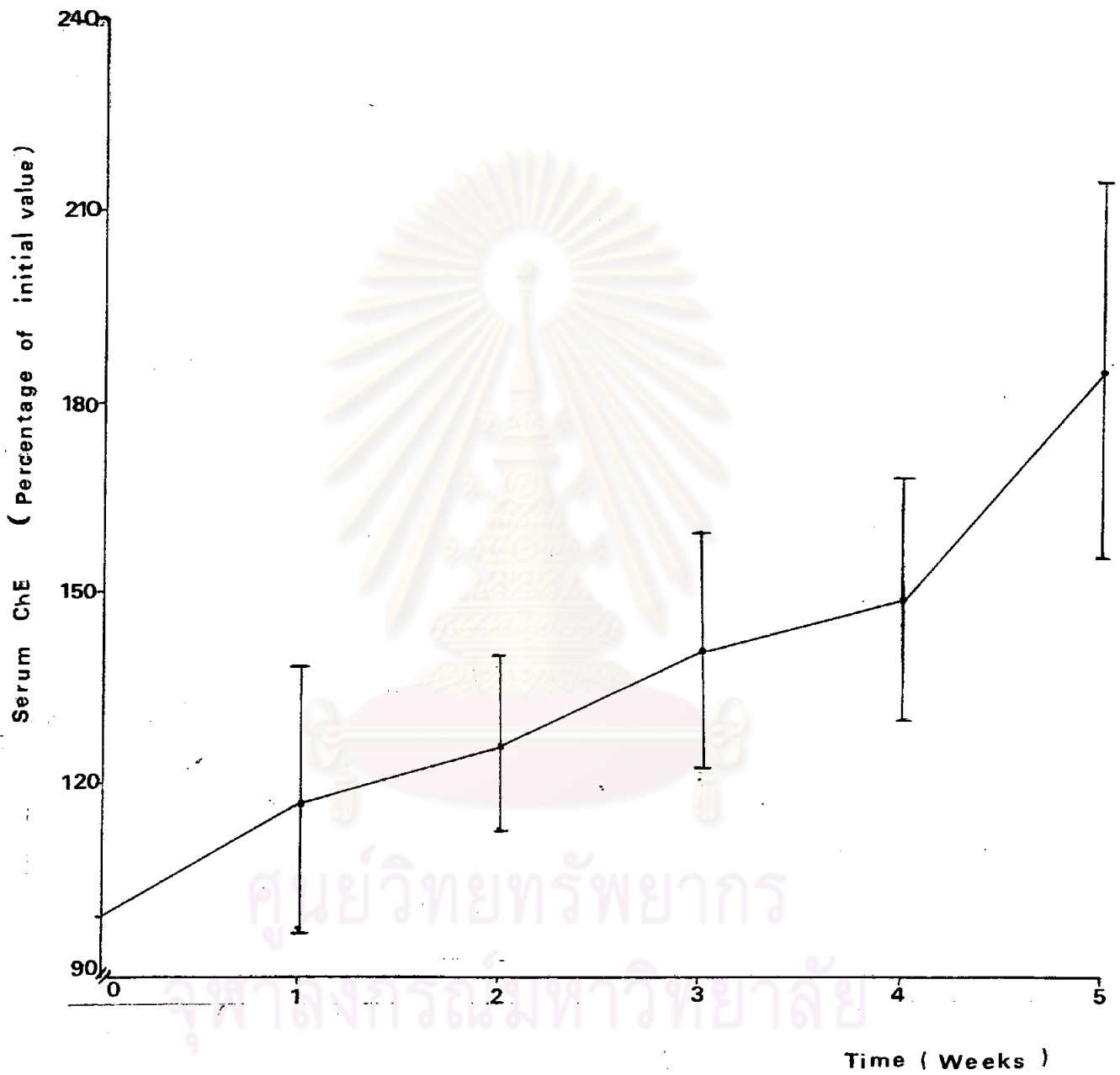


Fig. 7. Showing the mean \pm S.E. of serum cholinesterase levels in 6 patients with falciparum malaria during 5 week admission in hospital.

Cholinesterase activity in patients with thalassemia.

Table 20 shows the result of serum cholinesterase in 27 β /E thalassemia patients. 9 patients (33.33%) had normal values of serum cholinesterase and 18 patients (66.67%) had low values. Four out of 11 patients (36.36%) had normal red cell cholinesterase activities and other 7 patients had elevated values. The mean values \pm S.D. of serum cholinesterase and red cell cholinesterase in these patients were 2.17 ± 1.17 I.U. (range 0.80-5.23 I.U.) and 29.77 ± 11.11 I.U. (range 17.99-52.67 I.U.) respectively. The mean values of serum cholinesterase activity was significantly lower ($P < 0.0005$) than that of the normal subjects and the mean values of red cell cholinesterase was significantly higher ($P < 0.0005$) than that of the normal subjects.

The results of serum cholinesterase activity in 8 patients with Hb-H thalassemia were shown in Table 21. 3 patients (37.50%) had normal serum cholinesterase and 5 patients (62.50%) had low values. The mean values was 2.11 ± 1.10 I.U. (range 0.83-4.40 I.U.) which was significantly lower ($P < 0.0005$) than that of the normal values.

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Table 20 Cholinesterase activity in serum and red blood cell in 30 patients with β /E thalassemia.

Patient No.	Sex	Hct. (%)	ChE in W.B. (I.U.)	ChE in serum (I.U.)	ChE in red cell (I.U.)
1	M	18	10.74	2.79	46.96
2	M	15	6.72	2.79	29.54
3	M	25	8.44	3.29	23.89
4	M	17	5.20	1.82	21.68
5	M	23	10.97	5.23	30.18
6	M	18	10.82	1.60	19.27
7	M	12	3.84	1.33	22.28
8	M	18	7.20	1.58	32.85
9	F	23	10.97	5.23	30.18
10	F	18	10.82	1.63	52.67
11	F	27	7.11	3.08	17.99
12	M	-	-	1.10	-
13	M	-	-	1.81	-
14	M	-	-	2.98	-
15	M	-	-	1.42	-
16	M	-	-	0.80	-
17	M	-	-	2.07	-
18	M	-	-	2.16	-
19	M	-	-	0.88	-
20	M	-	-	1.33	-
21	M	-	-	2.78	-
22	F	-	-	2.00	-
23	F	-	-	0.96	-
24	F	-	-	0.86	-

Table 20 (continued)

Patient No.	Sex	Hct. (%)	ChE in W.B. (I.U.)	ChE in serum (I.U.)	ChE in red cell (I.U.)
25	F	-	-	3.56	-
26	F	-	-	1.54	-
27	F	-	-	2.23	-
N			11	27	11
Range		12-27	3.84-10.97	0.80-5.23	17.99-52.67
\bar{X}		19.45	8.43	2.17	29.77
S.D.		4.50	2.59	1.17	11.11
S.E.		1.35	0.78	0.22	3.35



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Table 21 Serum cholinesterase activity in 8 patients with Hb-H thalassemia.

Patient No.	Sex	ChE activity (I.U.)
1	F	2.74
2	F	2.17
3	M	1.49
4	F	0.83
5	M	1.63
6	M	1.31
7	M	2.33
8	M	4.40
\bar{X}		2.11
S.D.		1.10
S.E.		0.39
Range		0.83-4.40

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Cholinesterase activity in patients with congenital heart disease.

Result of serum and red cell cholinesterase activities in 17 patients with congenital heart disease is shown in Table 22. 14 out of 17 patients (82.35%) had normal serum cholinesterase and 3 patients (17.65%) had low serum cholinesterase activity. Ten out of these patients (58.82%) had normal values of red cell cholinesterase and 7 patients (41.18%) had low serum cholinesterase activity. The mean values \pm S.D. of serum cholinesterase and red cell cholinesterase in 17 patients with congenital heart disease were found to be 3.10 ± 0.99 I.U. (range 1.98-5.38 I.U.) and 19.75 ± 4.47 I.U. (range 15.69-30.11 I.U.) respectively. There was no significantly difference ($P > 0.05$) between the serum and red cell cholinesterase activities of these patients and those of the normal subjects.

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Table 22 Cholinesterase activity in serum red blood cell in 17 patients with congenital heart disease.

No.	Sex	Hct. (%)	Cholinesterase in W.B. (I.U.)	Cholinesterase in serum(I:U.)	Cholinesterase in red cell (I.U.)
1	F	41	9.72	5.38	15.98
2	F	29	10.03	4.06	24.65
3	F	46	11.02	2.38	21.17
4	F	35	6.94	2.67	14.88
5	F	32	8.08	2.74	19.45
6	F	37	7.74	2.74	16.25
7	F	40	8.18	2.79	16.25
8	F	33	8.41	3.93	17.51
9	F	33	9.58	3.91	21.09
10	F	37	11.91	1.23	30.11
11	F	42	11.07	3.63	23.97
12	M	37	9.23	3.54	18.90
13	M	51	9.57	3.19	15.69
14	M	39	8.79	3.86	16.61
15	M	23.5	7.98	1.98	27.53
16	M	37	8.54	2.01	19.66
17	M	34	7.28	2.66	16.28
Range		23.5-51	6.94-11.91	1.98-5.38	15.69-30.11
\bar{X}		36.85	9.06	3.10	19.75
S.D.		6.35	1.39	0.99	4.47
S.E.		1.54	0.33	0.24	1.08

Cholinesterase activities in pregnant women.

Results of serum and whole blood cholinesterase activities in the first, second, and third trimester of pregnancies are shown in Table 23 and Table 24 respectively. The mean values \pm S.D. of serum cholinesterase of 25 pregnant women in the first, second, and third trimester were 2.09 ± 0.39 I.U. (range 1.35 to 2.67 I.U.), 2.37 ± 0.46 I.U. (range 1.43 to 3.18 I.U.), and 1.92 ± 0.44 I.U. (range 1.10 to 2.55 I.U.) respectively. The mean values of cholinesterase activity in the first, second, and third trimester were significantly lower ($P < 0.0005$) than that of the normal subjects.

The mean values \pm S.D. of whole blood cholinesterase activity in the first trimester, second trimester, and third trimester pregnancies were 8.78 ± 0.85 I.U. (range 7.03 to 9.89 I.U.), 8.38 ± 1.03 I.U. (range 6.18 to 9.37 I.U.), and 9.69 ± 1.37 I.U. (range 8.34 to 12.44 I.U.) respectively. They were also significantly lower ($P < 0.05$) than those of the normal female blood donors.

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Table 23 Serum cholinesterase activities of 25 pregnant women in the first, second and third trimester.

Sample No.	serum cholinesterase activity (I.U.)		
	first trimester	second trimester	third trimester
1	1.35	1.43	1.71
2	2.67	3.18	1.15
3	1.89	2.25	2.51
4	1.61	1.93	1.74
5	1.75	2.68	1.01
6	2.52	2.27	2.55
7	1.85	1.89	2.48
8	1.52	2.43	2.01
9	1.74	2.45	2.26
10	2.18	2.02	1.35
11	1.98	1.69	1.48
12	1.79	2.98	1.87
13	2.47	2.33	1.43
14	1.95	2.55	2.32
15	2.49	1.95	1.34
16	1.71	2.63	1.92
17	2.59	1.67	1.75
18	1.62	2.16	1.75
19	2.36	2.66	2.34
20	2.40	2.60	2.34
21	2.30	2.67	2.32
22	2.16	3.13	2.25
23	2.27	2.13	1.78

Table 23 (continued)

Sample No.	serum cholinesterase activity (I.U.)		
	first trimester	second trimester	third trimester
24	2.52	2.79	2.20
25	2.60	2.83	2.11
\bar{X}	2.09	2.37	1.92
S.D.	0.39	0.46	0.44
S.E.	0.078	0.09	0.09
Range	1.35-2.67	1.43-3.18	1.01-2.55

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Table 24 Cholinesterase activity in whole blood of 10 pregnant

woman in the first, second and third trimester of pregnancy.

Sample No.	Whole blood cholinesterase activity (I.U.)		
	first trimester	second trimester	third trimester
1	8.14	6.18	7.95
2	7.03	9.11	8.34
3	8.65	8.06	9.36
4	9.89	8.31	10.22
5	9.79	9.14	9.95
6	9.15	9.37	9.17
7	8.46	8.35	12.44
8	8.63	8.78	8.35
9	8.59	9.32	11.01
10	9.44	7.19	10.10
\bar{X}	8.78	8.38	9.69
S.D.	0.85	1.03	1.37
S.E.	0.27	0.32	0.43
Range	7.03-9.89	6.18-9.37	7.95-12.44

Table 25 Cholinesterase activities in the first, second, and third trimester of pregnancy.

	Cholinesterase activity (I.U.)		
	first trimester	second trimester	third trimester
Serum cholinesterase			
No. examined	25	25	25
Mean	2.09	2.37	1.92
S.D.	0.39	0.46	0.44
Range	1.35-2.67	1.43-3.18	1.01-2.55
Whole blood ChE			
No. examined	10	10	10
Mean	8.78	8.38	9.69
S.D.	0.85	1.03	1.37
Range	7.03-9.89	6.18-9.37	8.34-12.44

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Cholinesterase activities in blood and serum obtained from umbilical cord of childbirths.

The results of serum, whole blood and red cell cholinesterase activity of 24 samples were shown in Table 26. The mean values \pm S.D. of serum cholinesterase and red cell cholinesterase activities were found to be 2.87 ± 0.64 I.U. (range 1.93-3.85 I.U.), and 12.07 ± 1.72 I.U. (range 9.45-16.45 I.U.) respectively. The mean value of serum cholinesterase activity was not significantly difference ($P > 0.05$) from that of the normal value, but the mean value of red cell cholinesterase was highly significantly lower ($P < 0.0005$) than of that the normal value.



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Table 26 Cholinesterase activity in whole blood, serum, and red blood cell in 24 samples of blood obtained from umbilical cords.

Sample No.	Hct. (%)	ChE in W.B. (I.U.)	ChE in serum (I.U.)	ChE in red cell (I.U.)
1	45	8.58	2.65	15.83
2	48	6.33	2.08	10.94
3	38	5.10	2.09	11.34
4	50	6.54	3.07	10.01
5	43	5.67	2.02	10.51
6	36	5.91	2.15	12.59
7	57	9.18	3.59	13.40
8	45	8.32	3.83	13.81
9	43	8.50	2.50	16.45
10	53	7.26	2.52	11.46
11	51	8.27	3.76	12.60
12	53	6.44	1.93	10.44
13	57	7.07	3.23	9.97
14	56	7.44	2.63	11.22
15	34	6.53	3.85	11.73
16	52	7.47	2.59	11.86
17	48	7.70	3.52	12.23
18	49	6.90	3.25	10.70
19	35	6.16	3.08	11.88
20	42	5.51	2.66	9.45
21	45	7.64	3.50	12.69
22	50	8.06	2.78	13.34
23	46	7.31	2.05	13.48
24	55	8.08	3.54	11.79
Range	34-57	5.10-8.58	1.93-3.85	9.45-16.45
\bar{X}		7.17	2.87	12.07
S.D.		1.08	0.61	1.72
S.E.		0.22	0.13	0.35