

## RESULTS

This study consists of 64 infants and children diagnosed as acute meningitis, and admitted to the Pediatric Department in Alexandria Fever Hospital from November 1998 through July 1999. In addition to 20 control cases.

The diagnosis was suspected by the detailed history and thorough physical examination, and confirmed by lumbar puncture, and the different methods of examining the obtained CSF.

Based on CSF biochemical, cytological, and bacteriological findings, in addition to the preliminary clinical diagnosis, the 64 cases were divided into three groups:

**- Group I (bacterial meningitis):**

This group included 40 patients who had positive CSF smear and/or culture for bacteria.

**- Group II (presumed bacterial meningitis):**

This group included 8 patients who were pretreated with

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**- Group III (non-bacterial meningitis):**

This group included 16 patients with negative smear and culture. Also, the cytological and biochemical findings of CSF were not consistent with bacterial etiology.

**- Group IV (control group):**

20 cases most of them presenting with fever but without any clinical or lab. findings suggestive of meningitis and the others were selected from El-Shatby Surgical ward and El Amiri Pediatric Surgical ward (CSF samples obtained during spinal anaesthesia).

***1- Age and sex distribution:*****Age:**

The youngest patient had only 1 month, and the oldest was 12 years old, with a mean of  $5.09 \pm 3.73$  and a range of 11.92 years.

The age distribution of this series is shown in table (2); the most common age group was less than 3 years. It included 18 patients and 9 controls; a total of 27 (32%).

The most frequent age in our cases was below 1 year; 13 cases (15.5%), and the least was the age between 7 and 8 years; 3 cases (3.6%). Excluding control cases, the most frequent age group of diseased children was between 3 and 6 years (21 child out of 64; 32.8%), followed by the age group below 3 years (18 child; 28%).

### Sex:

Among the total 84 studied cases and controls, 51 (60.7%) were males, and 33 (39.3%) were females, with a male to female ratio of 1.5:1.

The sex distribution of this series is shown in table (3). There were no statistically significant differences between the four studied groups as regards sex distribution. ( $\chi^2 = 0.726$ ,  $P = 0.867$ ,  $P > 0.05$ ).

**Table (2): Age distribution and mean values in the studied groups**

Age groups (years)	Group I (n=40)		Group II (n=8)		Group III (n=16)		Group IV (n=20)		Total (n=84)	
	No.	%	No.	%	No.	%	No.	%	No.	%
3	11	27.5	3	37.5	4	25	9	45	27	32
< 6	14	35	1	12.5	6	37.5	4	20	25	30
< 9	5	12.5	1	12.5	3	18.75	2	10	11	13
- 12	10	25	3	37.5	3	18.75	5	25	21	25
Total	40	100	8	100	16	100	20	100	84	100
Range	1 m-12 y		3 m-12 y		6 m-12 y		6 m-12 y		1 m-12 y	
Mean	5.3821		5.5521		5.3821		4.4967		5.1633	
	3.8881		4.2522		3.8381		3.8763		3.7874	

**Table (3): Distribution of the studied groups according to sex**

Sex	Group I		Group II		Group III		Group IV		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Male	25	62.5	4	50	9	56.25	13	65	51	60.7
Female	15	37.5	4	50	7	43.75	7	35	33	39.3
Total	40	100	8	100	16	100	20	100	84	100
$\chi^2 = 0.726, P = 0.867, P > 0.05, \text{Not Significant}$										

## **2- Clinical presentation:**

The most common mode of presentation was neck rigidity, which occurred in 57 patients (89%). While fever was detected in 54 patients (84.4%), sensorial changes occurred in 49 patients (76.5%), Kernig's sign was detected in 46 patients (71.8%), vomiting occurred in 45 patients (70.3%), Brudzinski's sign in 39 patients (61%), seizures in 29 patients (45.3%), and headache in 24 patients (37.5%).

Less common presenting symptoms were irritability in 16 patients (25%), bulging anterior fontanel in 10 patients (15.6%), petchial rash in 7 patients (11%), and the least common presentation was focal neurological sign which was detected in only 3 patients (4.7%). Frequency of clinical presentation in the studied groups is shown in table (4).

Only Kernig's sign, Brudzinski's sign, and petchial rash

**Table (4): Frequency distribution of symptoms and signs  
in the studied patients (total 64)**

Presenting symptoms & signs	Group I (n = 40)		Group II (n = 8)		Group III (n = 16)		Total (n = 64)	
	No.	%	No.	%	No.	%	No.	%
Neck rigidity	37	92.5	7	87.5	13	81.3	57	89
Fever	34	85	6	75	14	87.5	54	84.4
Sensorial change	34	85	6	75	9	56.3	49	76.5
Kernig's sign	34	85	5	62.5	7	43.8	46	71.8
Vomiting	26	65	7	87.5	12	75	45	70.3
Brudzinski's sign	31	77.5	5	62.5	3	18.8	39	61
Seizures	17	42.5	3	37.5	9	56.3	29	45.3
Headache	13	32.5	5	62.5	6	37.5	24	37.5
Irritability	9	22.5	3	37.5	4	25	16	25
Bulging A.F.	6	15	1	12.5	3	18.8	10	15.6
Petechial rash	7	17.5	-	-	-	-	7	11
Focal neurological sign	-	-	1	12.5	2	12.5	3	4.7

### 3- Findings of CSF examinations:

#### *A- Bacteriological examination of CSF:*

Bacteriological examinations were performed for the obtained CSF samples from all the studied patients, however, the causative organisms (bacteria) were isolated only in patients of group I.

The commonest isolated bacteria were *Neisseria meningitides*, which was isolated in 15 patients (37.5%), followed by *Hemophilus Influenza (Hib)* isolated in 10 patients (25%), *Streptococcus pneumoniae* isolated in 9 patients (22.5%), *Staphylococci* isolated in 3 patients (7.5%), and *E. coli* isolated in 2 patients (5%). Only one patient (2.5%) had three organisms isolated in his CSF culture (*Streptococcus pneumoniae*, *Neisseria meningitides*, and *Candida*). Table (5).

Distribution of patients with acute bacterial meningitis (group I) according to sex and isolated organism is shown in table (6).

**Table (5): Distribution of patients with acute bacterial meningitis (group I) according to isolated bacteria**

Organism	No. of patients	%
Neisseria meningitides	15	37.5
Hemophilus Influenza (Hib)	10	25
Streptococcus pneumoniae	9	22.5
Staphylococci	3	7.5
E. Coli	2	5
Streptococcus pneumoniae, Neisseria meningitides, and Candida	1	2.5
Total	40	100

**Table (6): Distribution of patients according to sex and isolated organism in cases of acute bacterial meningitis (group I)**

Organism	Sex		Female		Total	
	Male					
	No	%	No	%	No	%
Neisseria meningitides	9	60	6	40	15	100
Hemophilus Influenza (Hib)	5	50	5	50	10	100
Streptococcus pneumoniae	8	89	1	11	9	100
Staphylococci	1	33.3	2	66.7	3	100

**(7): Distribution of patients with acute bacterial meningitis (group I) according to age, sex and isolated organism.**

Neisseria meningitides	Hemophilus Influenza		Streptococcus pneumoniae		Staphylococci		E. Coli		Spn.,Nm., Candida	
	No.	%	No.	%%	No.	%	No.	%	No.	%
6.7	7	70	1	11	-	-	2	100	-	-
26.7	3	30	5	56	1	33	-	-	1	100
13.3	-	-	3	33	-	-	-	-	-	-
53.3	-	-	-	-	2	67	-	-	-	-
100	10	100	9	100	3	100	2	100	1	100

*B- Combur9 strip test:*

Combur9 test was used to examine the CSF samples obtained from all of the studied patients to determine the CSF content of glucose, proteins, and leukocytes.

Table (8) shows the results of the combur9 test examination of CSF to determine its glucose content. The table shows the glucose value to be **"negative"** in 8 patients (9.5%), **"<50"** in 43 patients (51.2%), **"50"** in 8 patients (9.5%), and **">50"** in 25 patients (29.8%).

The table, also shows the results of the combur9 test examination of CSF to determine its proteins content. The table shows the proteins value to be **"30"** in 26 patients (31%), **"100"** in 52 patients (62%), and **"500"** in 6 patients (7%).

In addition table (8) shows the results of the combur9 test examination of CSF to determine its leukocytic content. The table shows the leukocytic value to be **"negative"** in 25 patients (29.8%), **"10-25"** in 9 patients (10.7%), **"75"** in 11 patients (13.1%) **"<500"** in 2 patients (2.4%), and **">500"** in 37 patients (44%).

**Table (8): Chemical and cytological results of the studied patients according to Combur9 test of CSF.**

Combur9	Group I		Group II		Group III		Group I		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<b>Protein: mg/dl</b>										
negative	6	15	2	25	-	-	-	-	8	9.5
0	29	72.5	6	75	8	50	-	-	43	51.2
1	-	-	-	-	1	6.25	7	35	8	9.5
2	5	12.5	-	-	7	43.75	13	65	25	29.8
<b>Proteins: mg/dl</b>										
0	-	-	-	-	6	37.5	20	100	26	31
1	35	87.5	7	87.5	10	62.5	-	-	52	62
2	5	12.5	1	12.5	-	-	-	-	6	7
<b>Leukocyte: /mm<sup>3</sup></b>										
0	-	-	-	-	5	31.25	20	100	25	29.8
1-25	-	-	1	12.5	8	50	-	-	9	10.7
25-500	6	15	2	25	3	18.75	-	-	11	13.1
500-1000	2	5	-	-	-	-	-	-	2	2.4
>1000	32	80	5	62.5	-	-	-	-	37	44
<b>WBC ET</b>										
0	-	-	1	12.5	-	-	-	-	1	1.2
+	4	10	2	25	1	6.25	-	-	7	8.3
++	36	90	5	62.5	-	-	-	-	41	48.8
					15	93.75	20	100	35	41.2

**Table (9): Combur9 test performance characteristics.**

		<i>Laboratory</i>		Total
		+VE	-VE	
<i>Combur9</i>	+VE	64	0	64
	-VE	0	20	20
		64	20	84

Sensitivity = 100%

Specificity = 100%

PPV = 100%

NPV = 100%

% of agreement = 100%

## *Results*

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### *C- Biochemical study of CSF:*

Biochemical studies were performed for all the CSF samples obtained from all the studied patients, to estimate its glucose and proteins content. Table (10) shows the mean values of CSF findings (CSF glucose and proteins) among the four studied groups.

### *D- Cytological examination of CSF:*

Cytological studies were performed for all the CSF samples obtained from all the studied patients, to estimate its total and differential leukocytic counts. Table (10) shows the mean values of CSF findings (total and differential leukocytic counts) among the four studied groups.

Comparing the four studied groups of patients, concerning CSF findings, the following revealed: Table (10):

The mean differences were highly significant at the 0.001 level between all groups. The glucose level had the highest level of significance ( $F=46.946$ ,  $P<0.001$ ), compared to proteins levels and total leukocytic count level ( $F=24.088$ ,  $F=2.923$ , respectively).

*Results*

differences at the 0.001 level between: Groups I & III, I & IV, II & III, II & IV. Table (11).

Concerning proteins level mean differences: There were no statistically significant differences between Group I and III, III & IV. There were highly statistically significant differences at the 0.001 level between: Groups I & III, I & IV, II & III, II & IV. Table (11).

As regards total WBC: There were no statistically significant differences between Group I & III, II & III, II & IV, III & IV. There were statistically significant differences at the 0.05 level between: Group I & III, I & IV. Table (11).

### The mean values of CSF chemical findings among the four studied groups

	Group II (n=8)		Group III (n=16)		Group IV (n=20)		Total (n=84)		ANOVA	
	$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D	F	Probability
7.68	11.37	5.65	49.81	11.714	60.95	8.91	35.57	23.06	46.946	.001 ***
26.34	245.87	115.09	55.62	17.49	37.45	6.22	146.52	128.54	24.088	.001 ***
935.6	1236.3	1009.2	40.93	39.57	1.65	1.46	4392.16	13980	2.923	.039 *
9.20	72.62	27.07	4.687	6.539	0.000	0.000	49.26	42.63	416.693	.001 ***
9.51	27.37	27.07	95.31	6.539	50.00	51.29	38.94	41.10	36.388	.001 ***

, S.D : standard deviation \* : significant (  $P < 0.05$  ) \*\*\* : highly significant (  $P < 0.01$  ).

**(11): Comparison between the mean values of chemical CSF findings****among the four studied groups**

Findings	LSD					
	I & II	I & III	I & IV	II & III	II & IV	III & IV
	.055	.001 ***	.001 ***	.001 ***	.001 ***	.021 *
	.443	.001 ***	.001 ***	.001 ***	.001 ***	.570
count c/ $\mu$ l)	.144	.029 *	.018 *	.839	.828	.993
	.001 ***	.001 ***	.001 ***	.001 ***	.001 ***	.193
	.182	.001 ***	.001 ***	.001 ***	.050	.001 ***

\*\*\*: highly significant ( $P < 0.01$ ).ant ( $P < 0.05$ )

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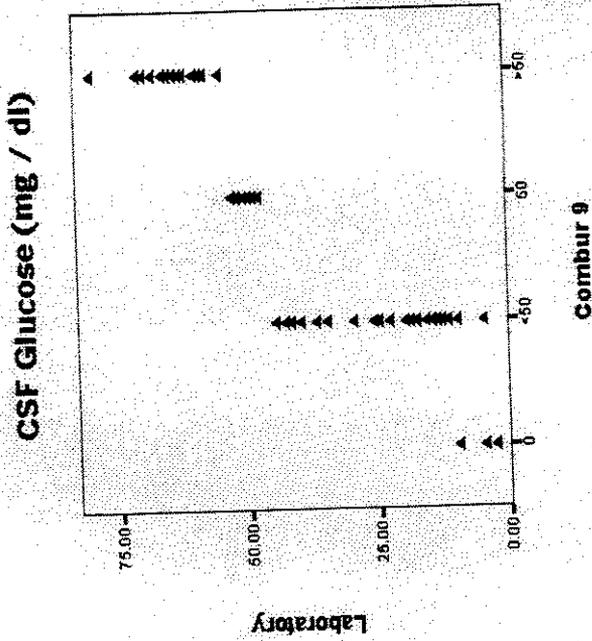
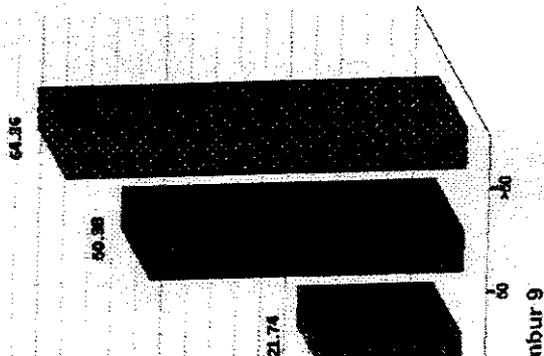
## **Comparison between combur9 test and laboratory CSF findings:**

The relation between the combur9 test and laboratory values for CSF findings (glucose, proteins, and total WBC) is shown in Figures (3,4,5).

Most of the laboratory values fell within the range set by the cut points for glucose, proteins, and total white cell count, giving Kappa 0.972, 0.950, and 0.970 for each respectively.

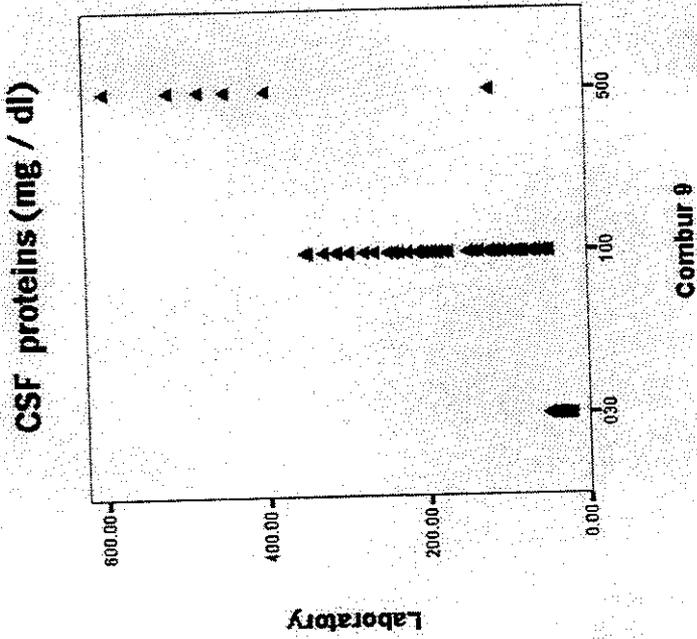
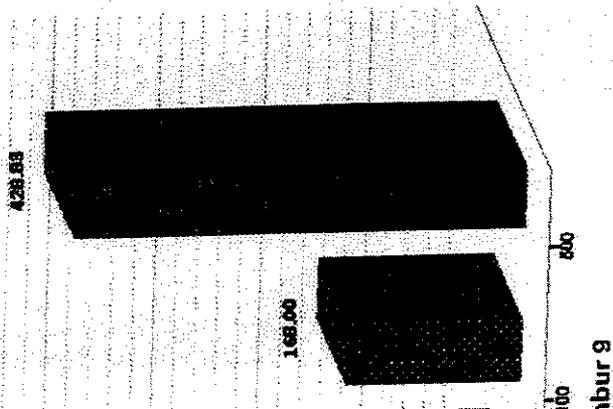
These Kappa values are highly significant  $P < 0.001$ , meaning a very good strength of agreement between the two tests.

Bars show Means



Comparison between laboratory and Combur 9 tests findings in the studied patients and controls (glucose level).

Bars show Means

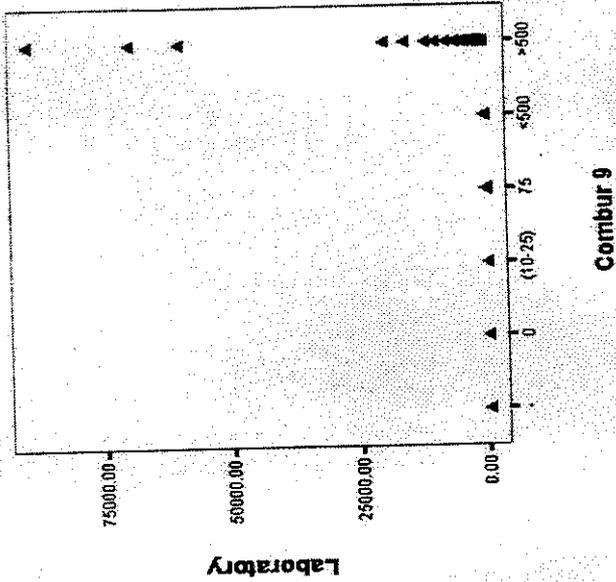


Comparison between laboratory and Combur-9 tests findings in the studied patients and controls (protein levels)

Bars show Means



CSF White Cells (c / uL)



Laboratory

Combur 9

between laboratory and Combur9 tests findings in the studied patients and controls (white cells content).

**Peripheral leukocytic counts:**

Table (12) shows the mean values for peripheral leukocytic counts (total and differential) among the four studied groups.

Comparison between these groups and their statistically significant differences is shown in table (13).

**Table 1: Mean values of peripheral leukocytic counts among the four studied groups**

Group I (n=40)		Group II (n=8)		Group III (n=16)		Group IV (n=20)		Total (n=84)	
$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D	$\bar{x}$	S.D
9888.2	13535.2	17415.8	9617.5	7632.2	1992.4	7054	1631.5	17140	12510.8
78	8.5	70.8	10.4	36.5	18.5	47.2	12.93	66.73	21.31
16.1	7.4	23.8	8.6	57.5	20.2	74.95	17.43	27.42	21.27

standard deviation

b)) Comparison between the mean values of peripheral leukocytic counts among the four studied groups

ANOVA		LSD					
F	Sig.	I & II	I & III	I & IV	II & III	II & IV	III & IV
12.016	.001***	.370	.001***	.001***	.026*	.015*	.863
57.152	.001***	.137	.001***	.001***	.001***	.001***	.011*
47.738	.001***	.141	.001***	.001***	.001***	.001***	.038*

\*\*\*: highly significant (  $P < 0.01$ ).

(  $P < 0.05$ ).

**LET and CSF findings:**

Table (14) shows the mean values of CSF findings according to the results of LET. Patients with positive LET showed statistically higher CSF protein level and lower CSF glucose level than patients with negative LET.

Also, LET positive patients showed a statistically higher CSF total white cell count with PMNL predominance.

Table (15) shows comparison between the mean values of peripheral leukocytic counts with LET results, and their statistical significance.

**Table (14): Comparison of the mean values of CSF results with LET results.**

	LET				T test	Probability		
	Negative (n=15)		Positive (n=49)				Total (n=64)	
	$\bar{x}$	S.D	$\bar{x}$	$\bar{x}$			S.D	
	50.46	11.82	20.65	16.8	27.64	20.20	6.387	.001***
	53.00	14.48	219.67	123.86	180.60	129.61	5.172	.001***
of	33.66	27.78	7518.5	1772.03	5764.2	1575.42	1.627	.019*
	3.66	5.28	83.32	17.02	64.65	37.2	17.772	.001***
	96.33	5.28	16.85	17.12	35.48	37.16	17.634	.001***

\*\*\*: highly significant ( $P < 0.001$ ).

$P < 0.05$ .

Comparison of the mean values of peripheral leukocytic count with LET results.

	LET				T test	Sig.		
	Negative (n=15)		Positive (n=49)				Total (n=64)	
	$\bar{x}$	S.D	$\bar{x}$	S.D			$\bar{x}$	S.D
WBC cell	7581	2051	20066	12919	17140	12510	3.709	.001***
	38.40	17.51	75.41	13.39	66.73	21.31	8.694	.001***
%	55.46	19.15	18.83	12.88	27.42	21.27	8.536	.001***

Highly significant ( $P < 0.01$ ).

**Validation parameters of LET:**

Validation parameters of LET in the diagnosis of CSF PMNL, leukocytosis, and bacterial meningitis are shown in tables (16, 17).

Table (16), shows the validation parameters of LET in the diagnosis of CSF PMNL leukocytosis. The sensitivity, and specificity were 98%, 100% respectively. The PPV, and NPV were 100%, 93.3%, respectively, While the % of agreement was 98%.

Table (17), shows the validation parameters of LET in the diagnosis of CSF acute bacterial and presumed bacterial meningitis. The sensitivity, and specificity were 100%, 93.75% respectively. The PPV, and NPV were 97.95%, 100% respectively, while the % of agreement was 98.4%.