DISCUSSION

Interest in the meningococcus has waxed and waned with the epidemics due to this micro-organism. During waves of cerebrospinal fever, (epidemic), intensive study of the incriminated organism has been made whereas during the years inbetween, other pathogens have crowded such studies into the background. Such wave of meningococcal meningitis has brought substantial contribution to knowledge, but continuity was lacking, and there has been little consolidation of the information gained. These throughs between the peaks of interest in the meningococcus are probably responsible, in part, for the tendency of new groups of workers in the field to overlook the background of information accumulated during past years by their predecessors (Brencham, 1953).

Meningococcal disease has been the focus of increasing attention recently due to the changing patterns and the apparent rise in its incidence in several parts of the world where it was not considered previously as a public health problem (Peltola et al, 1984).
During non-epidemic period the persons in a given population who harbour meningococci in their throat (carriers), are responsible for spread of infection to the susceptible groups, like army recruits, children, etc (Fraser et al, 1973). So it is rational to find out meningococcal carriage & serogroups of isolated in the population to prevent future outbreaks by administering proper chemoprophylaxis or by immunoprophylaxis for isolated serogroups.

Chapin (1910) said, 'Probably the most important discovery bearing on preventive medicine since the demonstration of the bacterial origin of disease is that the diseased germs frequently invade the body without causing disease'. This principle of healthy carriage is strikingly seen in meningococcal infection where large numbers may be harbouring the organism and
and yet only one in several thousands develops the disease.

Meningococcal meningitis is not a notifiable disease in our country. Its true incidence therefore is difficult to assess except from the record of hospital admission of sporadic cases.

In the recent past, there had been three localised outbreaks of meningococcal meningitis at the Police Training School, B.N.O. (Table - 1)

**Table 1**

<table>
<thead>
<tr>
<th>Year</th>
<th>Duration</th>
<th>No. of Patients</th>
<th>Deaths</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>1/3 to 18/4</td>
<td>6</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>1978-79</td>
<td>30/12 to 1/2</td>
<td>3</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>1980</td>
<td>6/2 to 20/4</td>
<td>20</td>
<td>4</td>
<td>20%</td>
</tr>
</tbody>
</table>
Such loss of life occurring in supposedly healthy individuals caused alone not only in the general population but also in the medical world. All three outbreaks occurred in P.T.O., Baroda. Only one of them, the last one was studied in detail (Vyas et al, 1980). In all the outbreaks, new recruits were the sufferers. No case occurred in the permanent staff. We do not have knowledge and adequate data of previous epidemics and inter-epidemic periods, as previous two outbreaks have not been investigated fully.

The last outbreak of meningococcal meningitis occurred at P.T.O., Baroda (Vyas et al, 1980). Clinical, bacteriological and epidemiological features of that outbreak were studied in detail. (Vyas et al, 1980)

During the outbreak 20 cases of meningococcal meningitis were admitted from P.T.O. to S.S.C. Hospital Baroda. New recruits were the sufferers. Four recruits died within 48 hours. Other 50 meningitis like cases were admitted from P.T.O., Baroda. Complete bacteriological, biochemical and haematological investigation were carried out in all cases. In 16 cases Gram negative diplococci
were seen during direct smear examination from cerebrospinal fluid. In 13 of these cases meningococci were successfully cultured.

All 20 cases were clinically diagnosed as cases of meningococcal meningitis.

Antibiotic susceptibility showed that all isolates were sensitive to penicillin and sulphadiazine.

The daily routine, diet & other details were investigated by personal interviews of each trainee and permanent staff member. The factors increasing susceptibility of host were studied in good details. The factors like weakness, anaemia, physical exertion leading to fatigue, exposure to cold, paucity of protective clothing and bedding, exposure to privation (lack of comforts), overcrowding, poor ventilation, poor nutrition and unaccustomed environment were studied. The authors believed that the above factors lower the resistance of an individual and as a result meningococci were acquired from the healthy carrier. Chemoprophylactic treatment was given under strict supervision to new recruits. (As shown in fig.I). Occasional
cases of meningitis still continued to appear in the train as, in spite of chemoprophylactic treatment. Hence, as an offshoot of the above study (Vyas et al., 1980), carrier status was studied both in the inmates and permanent staff of P.T.S., Baroda at the decline of outbreaks. (Bixit et al., 1981).

A total of 138 permanent staff and 308 new recruits were studied. (Table - 2). A total of 78 members of permanent staff had meningococci either in their nose or throat. The incidence of meningococcal carrier rate in the permanent staff was 56.8% while it was 6% among recruits. (Table - 3).

Drug susceptibility test was carried out on 116 isolated strains of meningococci. All were susceptible to penicillin while 7/116 strains (6.3%) were found to be resistant to sulphadiazine.

Chemoprophylactic treatment was given to the permanent staff only once, at the beginning of the outbreak (i.e. 9/2/80). The permanent staff was given full course of chemoprophylaxis. However, it was not ascertained that they had really consumed the sulphadiazine.
<table>
<thead>
<tr>
<th>Occupation</th>
<th>Total</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Unskilled Workers</td>
<td>88%</td>
<td>146</td>
<td>14</td>
<td>15</td>
<td>22</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>2. Cooks</td>
<td>61%</td>
<td>71</td>
<td>11</td>
<td>11</td>
<td>17</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>3. Instructors, Higher</td>
<td>50%</td>
<td>66</td>
<td>8</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4. Constable, Head</td>
<td>37%</td>
<td>46</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>5. Police Inspector</td>
<td>35%</td>
<td>44</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>6. Office Superintendent</td>
<td>39%</td>
<td>48</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>7. Coral Superintendent</td>
<td>32%</td>
<td>40</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8. Office, Peon, Public</td>
<td>9%</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9. Doctor, Superintendent</td>
<td>1%</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>62%</td>
<td>78</td>
<td>8</td>
<td>9</td>
<td>13</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>
drug as directed. Later, on close interrogation, it was noticed that some of the permanent staff did not take the sulpha drug as directed. As a result, it seems that some of them continued to harbour the organism in their throat, and were thus responsible for the spread to new recruits resulting in occasional cases of meningitis. It was believed that the trainees were probably getting infected as a result of exposure to the permanent staff.

The incidence of carrier status for meningococci has not been reported during outbreak of meningococcal meningitis in Indian literature, to our knowledge.

In the present study the carrier rate in the permanent staff in 1982, 1983 and 1984 was 10.9%, 26.5% and 23.1% respectively. The carrier rates in the permanent staff and the new recruits during the years 1981 to 1984 are shown in (table - 3).
The differences between the carrier rate of permanent staff and those of new recruits were significant: ( \( P < 0.001 \) (1981), \( P < 0.001 \) (1982), \( P < 0.002 \) (1983), \( P = 0.002 \) (1981)).

Now if we consider the carrier rates in the permanent staff of P.T.S. in 1981 to 1984 which are shown in table No. 3, it will be seen that the carrier rate sharply declined in 1982 (10.9%) but was high in 1983 and 1984 (26.7% & 23.1% respectively).

The early high carriage rate (56.5% in 1980) is probably because of increase in the virulence of organisms and decrease in the resistance of host. Decline of carriage rate later on is probably because of institution...
of regular doses of chemoprophylaxis. Again there is rise in carriage rate probably due to lack of regularity of chemoprophylaxis.

Relation of carrier rate in permanent staff with carrier rate of new recruits in P.T.S.

New recruits of P.T.S. x in 1982, showed 0% carrier rate at the time of entry and 5% carrier rate 3 months after entry). The fact that new recruits belonged to healthy population and had never been exposed to epidemic of meningococcal disease, can explain 0% carriage rate. As the new recruits came in close contact with permanent staff who were carriers, chances of spread of organisms increased and this might have caused infection in more susceptible individuals. Other factors like over crowding over physical exertion, poor nutrition, unhygienic condition etc. increased carrier rate among them.

In the Norwegian navy carrier rate on entry was 43% and rose 54% after 5 weeks (Holten et al, 1971).
While basic rate of 33% was found in groups of U.S. Army recruits, it rose to 80% after 6 weeks. (Artenstein, 1967)
In New Zealand, recruits showed a carrier rate of 27%
on joining, rising to 37% after one month, (Knight, 1972). We do not have comparable data about meningococcal carrier rate for our study, from Indian literature. As per our knowledge, the carrier survey of meningococci has not been done in India so far.

Frasch, in 1964, (Personal communication) described similar outbreak in U.S. military recruits in 1960. In those outbreaks, most of the cases occurred among the new recruits and not among the permanent staff. The carrier rates among the new recruits was quite low (5-10%) upon arrival for training, but then the carrier rate climbed rapidly in the recruits during their training. The high carrier rates were associated with outbreaks largely confined to the recruits population. However, there were often high carriage rates among the permanent staff with no meningococcal disease.

**Role of chemoprophylaxis in reduction of carrier status**

During the last outbreak chemoprophylaxis was given to all the inmates of the P.T.S. (Vyas et al, 1990). The first chemoprophylaxis was given on 10th-12th February 1989 and it was felt that the meningococcal infection of
A HISTOGRAM SHOWING THE MAXIMUM AND MINIMUM TEMPERATURES
RECORDED DURING THE OUTBREAK OF MENINGITIS.

KEY:
- MENINGITIS CASE: "CULTURE POSITIVE"
- MENINGITIS CASE: "CULTURE NEGATIVE"
- MAXIMUM TEMPERATURE
- MINIMUM TEMPERATURE
- DAYS ON WHICH CHROMOPHILICS GIVEN

ENVIROMENTAL TEMPERATURES
IN CENTIGRADES

FEBRUARY - MARCH - APRIL

20 30 40 50 60 70 80
all the inmates would be completely wiped out. However, new cases of meningitis occurred after 10th day of the last course of chemoprophylaxis. It was learnt that the trainees were given on the very first day, all the tablets of sulphadiazine to be consumed over a period of 4 days. Moreover there were many defaulters. Some did not take medicine because of gastric upset, and others did not understand the importance of taking the drug in a proper manner. A second course was given after 15th day, i.e., 25th Feb., 1980. At this time it was ensured that the trainees took the tablets morning and evening (while on the parade ground), in the presence of a senior Police inspector. This ensured that there were no defaulters. In spite of this strict measure cases of meningitis did occur again on 6th March 1980 & subsequently. Both the medical and Police authorities were alarmed at the occurrence of this case and was advised a third chemoprophylactic regime beginning from 9th March, 1980. This did result in a fall in the incidence of cases of meningitis.

As to the carriage rate in permanent staff, there was a sudden decline from 56.5% (1981) to 17.9% (1982).
during 1983 and 1984, it increased (26.5% & 23.1% respectively) (Table - 4).

The reduction in the carrier rate during 1982, as might be due to the regular dose of chemoprophylaxis taken by the permanent staff under strict supervision. They had given 4 tablets/day for 3 days, and it was, the post epidemic period. The staff members were very keen to take the complete course of chemoprophylaxis. But during subsequent years, no clinical case of meningococcal meningitis was encountered. There was increase in the carrier rate during 1983 and remained almost same in subsequent years.

Increase in the carrier rate during 1983-84 was probably due to lack of regularity. There was an impression, as was found to be true on personal interviews, among the permanent staff that, only the trainee recruits needed the chemoprophylactic treatment and not themselves. So they were not taking the tablets regularly.
It was observed that chemoprophylaxis is an effective measure to abolish the incidence of meningococci in the trainees; at the same time it was seen that the permanent staff continued to harbour meningococci. The failure to administer regularly the chemoprophylactic drugs to permanent staff may result in the occurrence of new cases of meningococcal meningitis in future.

Role of carrier rate in permanent staff in occurrence of disease in new recruits:

Now if we consider the carrier rates in the permanent staff of P.T.S. in 1981 to 1984, it will be seen that the carrier rate sharply declined in 1982 (10.9%) but was high in 1983 & 1984 (26.5%) and 23.1% respectively).

In 1960 the incidence of carrier rate was 56.5% (April, 1960), as it was found out that the permanent staff did not regularly take the chemoprophylactic doses, it is reasonable in infer that the carrier rate during the outbreak was at least 56.5% if not higher.
and that was the reason for occurrence of cases in new recruits.

There was not a single case of meningococcal meningitis in 1981-84. The incidence of the carrier rate of the permanent staff was 10.9% to 26.7% during this period. Is it that this rate was not "critical" for starting an outbreak or even for causing occasional case of meningococcal meningitis in new recruits? It is uncertain how much this factor is important because the role of chemoprophylaxis in recruits—strictly supervised—in preventing the disease must be considerable as it was in reducing the carrier status. But considering that cases in new recruits did occur in spite of administering of three courses of chemoprophylaxis to half the batch of new recruits when the carrier rate in permanent staff was 56.5% (or probably more) and also that no case occurred even when these new recruits were given only one course every three months during their stay, the high carrier rate in permanent staff appears to be important in causing disease in new recruits.
Sero-grouping of the strains isolated from patients (recruits) and carriers (permanent staff) would have thrown more light on the role of carrier rate in the permanent staff in causing disease in recruits.

Acquisition of infection:

Fifty three members of the permanent staff were examined in 1982, 1983 and 1984. 8 (15.1%) staff members newly became carriers during 1982-83 and 16 (30.1%) staff members during 1983-84. Thus the rate of acquisition is quite high.

The other studies of acquisition rate concern the population affected by epidemic. (Greenwood et al., 1982; Blackbrough et al., 1964). Here a curious observation is that though the range of carrier rate in the permanent staff is 10.3% to 56.5%, there is not a single case of meningitis in the permanent staff in all the 3 outbreaks since 1973. All cases occurred in new recruits. The importance of soil rather than seed appears emphasised in respect of meningococcal
disease as distinct from meningococcal infection.

**Constant carriers:** In 1982, the number of carriers was 9. Five of the nine carriers remained so in 1983 but not in 1984. Only one cook harboured meningococci in 1982, 1983 and 1984.

**Loss of carrier status:** There were three staff members who were carriers in 1982 but not in 1983. Out of 14 carriers in 1983, 11 did not longer harbour meningococci in 1984.

The carriage rate among permanent staff of S.R.P. Gr.I who reside in the same campus is much lower as compared to permanent staff of P.T.S. The carriage rate in permanent staff of S.R.P., Gr.I was 2.76% while that in permanent staff of P.T.S. was 23.6% during the same period of study in 1984. This is probably because of marked difference between two groups regarding daily routine, overcrowding, strenuous exercise, overexertion, which leads to weakness and anemia, exposure to cold, paucity of protecting cloths, poor ventilation, poor
nutrition. These factors might be contributing to the high carriage rate among permanent staff of P.T.S. and epidemics in the P.T.S. (Dixit et al, 1981).

No marked difference was observed in the carriage rate of new recruits of P.T.S. and S.R.P. GR I. It was 0.3% in the new recruits of P.T.S. and 1.25% in the new recruits of S.R.P. GR I during 1983.

In our study the carriage rate was 0% among medical students and nursing staff. Similar observation was found by Salmi et al (1976). They suggested that hospital staff had less chance of contracting disease. (Poltola, 1984).

Cartwright et al (1986) found that throat swabbing revealed a very low carriage rate of 21.5 meningococci in symptomless contacts. Similar low carriage rate of this organism was found in an extensive swabbing investigation in Somerset after a minor outbreak in 1985-86 (Bowie, 1986). and during investigation of a school outbreak in London (Conn L., Unpublished).

The cause of low carriage rate may be high virulence of the organism and low transmissibility or there may
Fig. II

DISTRIBUTION OF MENINGOCOCCAL SERO GROUPS
IN VARIOUS YEARS

1962 - 1968
B 40%
A 51%

1969
A 90%

1970
A 87%

1971
A 67%
B 33%

1973
A 88%
B 12%

1974 - 1976
A 89%
Z 31%
Y 13%
C 5%
G 10%

Present Study 1984

Others 6%
Z 5%
Y 4%
C 13%
B 11%
after 1976

FAGODA 107686
be low virulence and high transmissibility but with an extremely short period of meningococcal carriage.

(Cartwright et al, 1986).

**SEROGROUPING OF N. meningitidis**

To the best of our knowledge, the serogrouping of the meningococci isolated from the carriers of for that matter from any one else has not been carried out in India. We have studied this during 1984.

In our study, 78 strains were isolated from permanent staff and new recruits of P.C.S. and permanent staff of S.R.C. Gr. I. It was found that 69.15% belonged to serogroup A and 25.6% to serogroup C. Remaining 5.2% strains were not serogroupable.
In the given table, it will be seen that group A strains comprise 75% of total strains isolated from permanent staff, whereas they comprised 50% of strains isolated from new recruits. It is because C group meningococci are more easily transmissible or because they can not sustain themselves for a longer period in the carriers. S.R.E. Gr. 1, had 25% group A strains. So in the known chronic carriers A group predominated, while in the populations where the carrier status is possibly transient, C group predominated. Is this difference because of high transmissibility of C group meningococci and/or their less ability to sustain themselves as chronic carriers. (Table 5)
### Table 4

<table>
<thead>
<tr>
<th>Groups</th>
<th>Sero. A</th>
<th>Sero. C</th>
<th>Ungroupable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Officer Staff of P.T.S.</td>
<td>35</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Officer Staff of P.T.S.</td>
<td>13</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Non Officer Staff of S.R.P.G.I</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Officer Staff of S.R.P.G.I</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>New recruits</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>54</td>
<td>20</td>
<td>4</td>
</tr>
</tbody>
</table>

Sero. group A was predominant in non officer staff of P.T.S. and S.R.P. G.I. (73% & 50%) as compared to officer staff of P.T.S. and S.R.P. G.I (27% and 50%).
We do not have data regarding predominant serogrouping study during previous outbreaks (as no one has done the study) but the major outbreaks occurred due to serogroup A or C in various countries. (Table No. 2).

Usually the strains of meningococci found during interepidemic period—carrier strain may be partly responsible for the next outbreak. (Zollinger et al, 1983), vaccination used in time against these serogroups we can prevent future epidemics.

Thus identification of predominant serogrouping is of definite use in prevention of further epidemics.

Cases of Meningitis at the S.S.G. Hospital, Daroda


During our study, we found that the proportion of meningococcal meningitis to total cases of bacterial meningitis was highly among pediatric age groups (23/244) than in adults. (7/349).
A total of 492 cases of bacterial meningitis were treated in J.C.C. Hospital, Dar-es-Salaam during 1982, 1983 and 1984. Of these, 244 cases from pediatric population and 248 cases from adult population. In all 27 cases of meningococcal meningitis were diagnosed during 1983-84, by directigen slide agglutination method. Eleven of them were diagnosed culturally.

Thirteen of 174 from pediatric population & 6/155 adult group were shown serogroup A while 7/174 from pediatric and 1/155 from adults were shown serogroup C.

All strains were susceptible to both penicillin and sulphadiazine.

Age incidence: Meningococcal meningitis usually occurs during childhood when the child becomes exposed to meningococci for the first time and its resistance is generally low. In adults except in certain situation like close communities, such as military establishment, monsoon hostels etc., the incidence is found to be low.
Greenwood et al. (1979) found that clinical cases occurred most frequently amongst those aged 5-14 years, whilst younger children were less frequently affected.

In Italy the incidence was higher in children under one year & in adult over 25 years of age.

(Cirofolino et al., 1985).

Small outbreaks of a serogroup 5:15 meningococcal disease among Norwegian soldiers was reported in 1985, 129 soldiers were affected, their age group was 23-25 years (Kristianen et al., 1985).

Cartwright et al. (1986), found 65 cases of meningococcal meningitis affecting mainly the teenagers and young adults. These cases clustered in the Stroud district and in the Southern part of Gloucester city during the period between October 1981 to March 1986.

The susceptibility of teenagers to infection may be due to their high level of social activity, which offers an opportunity for transmission of meningococci. This contrasts with the mode of spread of meningococcal in other outbreaks, in which the organisms usually pass
through a family to cause disease in the young children. (Runford et al, 1974; Fairies et al, 1975).

Osol et al (1980), Trissel et al (1974) and also Peltola et al (1984) observed that meningococcal disease is most common in children under school age, and children less than 5 years old accounted for 55% of all cases. In the meningitis belt the incidence reportedly peaks in young school age children. (Whittle et al, 1976; Greenwood et al, 1978 and 1979). During the outbreak of meningococcal meningitis in Yar Talata (Northern Nigeria) 20-25% of the affected population was below 10 years of age, (Blackbrough et al, 1983).

**Sex Variation:** We found the male to female ratio was higher among both the populations, i.e., 1.6:1 in paediatric age group and 2.5:1 in adults.

Similar observation was made by Greenwood et al (1979). He found overall male to female ratio 1.9:1. He also found that amongst those who were less than 10 years of age there was male predominance (1.6:1), and amongst those who were more than 10 years old it was 2.5:1.
SEASONAL VARIATION & MENINGOCOCCAL INCIDENCE

1982

1983

1984

PAEDIATRICS POPULATION

ADULT POPULATION

PAGODA 101680
In the study by Cartwright (1986), male outnumbered females 1:4:1 (38:27).

Meningococcal disease affects the people of both sexes. (Bovra et al., 1977), Greenwood et al. (1978) and Salin et al. (1979) observed a slightly higher incidence among males (i.e., 1:4:1, 1:2:1, 1:8:1 respectively), while Miklosson et al. (1971) reported higher incidence among females in some instances.

Incidence of the disease in boys and girls was similar among 147 children studied in Belgium in 1969-70 (Bormans et al., 1972).

In our study adult population had higher incidence (8.1%) during winter season, and lower incidence during summer (2.1%) while pediatric population showed higher incidence during monsoon (25%) and winter (10%).

The incidence of meningococcal meningitis was high (8.1%) during monsoon among the pediatric age group. (Greenwood et al., 1979). Blackbrough et al. (1982) found higher incidence at the end of dry season and onset of
rain, probably due to low absolute humidity. (3.7%). Now

Davos (1982) observed seasonal fluctuation both in epide-

mic and nonepidemic periods.

The incidence of meningococcal disease varies season-

ally, higher incidence during spring and autumn. This

pattern has been observed during epidemic (Sibelei et al,

1976) and non epidemic period (Her, 1973) The incidence

of meningococcal disease during the years 1967 to 1970

in the U.S. was 1.5 cases/10^5/year, 2.1 cases/10^5/year,

2.3 cases/10^5/year & 1.9 cases/10^5/year during Dec.

to March (respectively).

In Sao Paulo area of Brazil, in 1974 the overall

incidence was 370/10^5/year in 1974 during Oct. to Dec. During

October 1974, 4855 patients with meningitis were treated.

Both serogroup C and group Y epidemics started in May

or June i.e. at the point of transition from rainy to the

dry season during 1971-1974. (Nina et al, 1974, Damros

et al 1974) In upper Volta 1956-57 and in Zaria,

Nigeria in 1977, an epidemic occurred towards the end

of dry season when hematoon (xanthomonas campestris, dusty

dry weather) caused, temperatures were high both during

day and night. (Lapaysonnet, 1963, Greenwood et al, 1978)
Greenwood et al. (1986) suggested that seasonality might be due, in part, to a change in the ratio of clinical cases to symptomless carriers (10:1) rather than to seasonal changes in the frequency of transmission. During an epidemic of group A meningococcal disease in the Gambia in 1982 and 1983, he found that seasonal changes in the number of clinical cases were not accompanied by a change in the rate of acquisition of nasopharyngeal carriage.

Cirofolino et al. (1985) reported that for the past 10 years, in Italy, about 700 cases/year were occurring mostly in winter and early spring.


In Baroda, the first outbreak of meningococcal meningitis occurred in March-1973, affecting 6 inmates of P.I.S. The case fatality rate was 33.3%. After 5 years another outbreak occurred during Dec-1978 to
to Feb. 1979, where 5 inmates were affected & one died. The case fatality rate was 20%, & after one year 
duration large scale epidemic occurred during Feb.-Apr. 1980 where 70 inmates were affected. Thus it is observed 
that most of the cases observed from Nov. to March.

ANTIMICROBIAL SUSCEPTIBILITY OF N. meningitidis:

ANTIMICROBIAL SUSCEPTIBILITY OF N. meningitidis isolated 
from carriers :-

We have studied the drug susceptibility of strains 
isolated from meningococcal carriers. Thirteen out of 
190 strains were found to be resistant to sulphadiazine (53). It is very interesting to note that during the out-
breaks which occurred in P.T.O, in 1980, all strains were 
found to be susceptible to both sulphadiazine and 
penicillin. (Vyas et al, 1980). During 1980, 7/116 (6%) 
strains isolated from permanent staff were found resistant 
to S.D. (Dixit et al, 1981) (Table 4).
Table 6

Emergence of resistant strains of mononococci to S.D. from 1900 to 1984

<table>
<thead>
<tr>
<th>Years</th>
<th>Non officers</th>
<th>Officers</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>0</td>
<td>(7)</td>
<td>-</td>
</tr>
<tr>
<td>1930-81</td>
<td>4</td>
<td>(3.5)</td>
<td>3 (2.5)</td>
</tr>
<tr>
<td>1982</td>
<td>2 (15.3)</td>
<td>-</td>
<td>not present studies</td>
</tr>
<tr>
<td>1983</td>
<td>3 (15.3)</td>
<td>-</td>
<td>&quot;</td>
</tr>
<tr>
<td>1984</td>
<td>3 (15.8)</td>
<td>5 (22.7)</td>
<td>&quot;</td>
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</tbody>
</table>

The incidence of resistant strains in non officer staff increased from 3.5% (1900-1981) to 15.3% (1982), 15.8% (1983) and 15.0% (1984). The incidence of resistant strains in officers of F.T.S. was 2.5% in 1980 (Dixit et al, 1981) and 22.7% in 1984.

On the other hand, all the strains (73 or 50% of total isolates) to isolated from new recruits of F.T.S. staff and new recruits of S.R.P. Gr. I and children from slums area were found to be sensitive to sulphamidine.
Among other differences one difference in these
two groups is that the permanent staff is exposed to sulpha drugs -
in an irregular way - that for 4.5 years.

This fact underlines the importance of admini-
stration of complete course of chemoprophylactic drug.

The isolation of different strains of meningococci
from a fairly homogeneous clinical and epidemiological
group raises the possibility that there may be variability
in the expression of surface antigens and for sulphan-
amide resistance in meningococci or that interchange of
genetic material between strains is occurring. There may
be a determinant for virulence closely associated with
either gene coding for sulphanamide resistance or
that coding for the type 15 antigen. (Cartwright 1966).

Acquisition or loss of resistant strains:

Two carriers harboured resistant strains earlier
but sensitive strains in the subsequent year. One carrier
showed reverse change in the strains she harboured. The
number of resistant strains is less. No conclusion can
be drawn about the acquisition or loss of resistant strain by carriers.

**Trends of resistant strains in other countries:**

Miller et al. (1963) reported first case of sulphadiazine strain of group I meningococci from the U.S. Naval Training centre in San Diego during the spring of 1963. But within the next few years, 90% of group C, 44% of group A, and 6% of group B strain; from carriers and from epidemics were found resistant to sulphadiazine, (Fraser et al, 1973 Salmi et al, 1976; Sunborn 1969; Leeder et al, 1987; Pelzella, 1964). In a study the carrier rate in recruits fell after 6 days' course of rifampicin, but rapidly rose again and many of the subsequent isolates were rifampicin-resistant, (Baun, 1971).

The meningococcal Disease Surveillance Group reported in 1976 the following subgroups among 324 meningococcal isolates: Group I-45%, group C-32%.

Group Y-18% Group A-2%

Although only 6% of the group B isolates were sulphonamide resistant, resistance was shown by in 7% of the group C strains.
Similar results were reported by the centres for Disease control in 1981, and sulphonamide resistance among meningococci of all major serogroup has emerged as a serious problem worldwide. (Scheld et al., 1984).

In our study the resistance of meningococci to sulphadiazine increases during 1980 to 1984. As mentioned above it was 0% in 1980 (during epidemic period), in 1981-82 6.0% (during post epidemic period), and during 1982-84, it was 15.0%

It is well known that host factor in the meningitis is more important than the virulence of the organism. Thus, though the number of strains resistant to SD was less, it rings a warning bell that these strains might replace the sensitive strains harboured by other carriers.

Now majority of the strains of meningococci isolated in many countries are sulphadiazine resistant. Hence sulphonamides are no longer employed in the routine treatment or prophylaxis of meningococcal meningitis in most of the countries. Penicillin/ampicillin remains the drug of choice, with substitution of chloramphenicol in the penicillin-allergic patients. (Scheld et al., 1984)
Seroepidemiological study:

A total of 658 subjects of different groups were studied by indirect haemagglutination test. It includes the permanent staff and new recruits of both P.T.S. and S.R.P. Gr. I, children and medical students of different socio-economic groups.

Permanent staff of P.T.S. shows significantly higher antibody titres as compared to new recruits of P.T.S. It was 16.3% against serogroup A and 13.6% against serogroup C. No marked difference was observed between permanent staff & new recruits of S.R.P. Gr. I and also against children and students.

A major barrier to understanding the epidemiology

and pathogenesis of meningococcal infections has been the inability to define the degree of susceptibility of

Standard immunologic techniques to detect presence of

meningococci in patients with meningitis and in asym-

patomatic carriers were tried (Dovis, 1965; Houton et al, 1967; Matsunani et al, 1968; Kolmar et al, 1970; Heint et al, 1922; Murray, 1929; Hale; 1935; Silver thorne et al, 1939; Cruckshank 1941; Thomas et al, 1943)
The extraction serogrouping and indirect haemagglutination tests made sensitive and highly specific measurements of antibody response to meningococcal infection possible.

The haemagglutination test proved to be both group specific and sensitive; it detected a serologic response in the majority of both clinical cases and asymptomatic carriers. Although the indirect haemagglutination test is a good indicator of recent infection, it does not appear to be capable of identifying particularly susceptible individuals. (Sickboff, 1973). The indirect haemagglutination test is not technically difficult, can be applied to large numbers of sera, and is generally reproducible to within a two-fold serial dilution. Available evidence (Gotschlich et al., 1969) indicates haemagglutinating activity is found primarily, but not exclusively, in the Ig M fraction. This test is found to be highly serogroup specific, sensitive and simple.

Seroologic studies undertaken at year Tenato & at Galadimawa Primary School indicated that infection with group A meningococci was more widespread in 1977 than
was suggested by carrier studies. The mean titer of antibody to group A meningococci increased significantly (39/82). During 1976, increase in the titer of antibody to group A meningococci found in all young children increases in titer ranging from 2 fold - 6 fold were observed in 5/6 subjects who were to carriers of group A meningococci at same time during the 2 year observation period (Blackbrough et al, 1982).

Because of its simplicity, sensitivity and specificity, the hemagglutination test has been the workhouse of serological study. In many situations study of nasopharyngeal cultures are also required in order to properly interpret the serological results, since carrier infections are frequently asymptomatic yet immunogenic.

Haemoglobin estimation was carried out & compared between the trainees of F.T.S. and trainees of S.R.P. Gr.I. during 1984. It was found that 47% were found to be anaemic trainees in F.T.S., as compared to 22% found in the S.R.P. Gr. I.