# INFECTIVE HEPATITIS IN NORTH AFRICA

BY

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SEVERAL authors have discussed the occurrence of infective hepatitis amongst troops in the Middle East and the Mediterranean Basin, but all have been concerned with the war years when troop movement was constant and when medical records or statistics could not, in the very nature of things, be as complete or as detailed as may be possible in more settled circumstances. With a view to ascertaining whether the disease behaved in the same way under peace conditions as it did during the war, a survey was made of infective hepatitis as it occurred among troops stationed in North Africa from 1947 to 1950, during which period conditions were ideal for the collection of accurate data on the incidence of the disease and allowed of the detailed interrogation of every single case admitted to hospital over a period of more than two years.

## PREVIOUS REPORTED WORK

Van Rooyen and Gordon (1942) reporting on the disease in Egypt concluded that a virus was the pathogenic agent, that the reservoir was man and that the method of spread was by droplet infection. Dixon (1944) gave the incidence in Malta in 1939 as 14 per 1,000 in British Troops and 0·24 per 1,000 in Maltese Troops. Kirk (1945) describing an epidemic among New Zealand troops in the Alamein position during 1942 concluded that the disease was prevalent among German and Italian troops who polluted the ground and the disease was then spread by dust and flies amongst other troops who later occupied that ground. A similar suggestion was made by Mackay-Dick (1947) who thought that the disease could be spread from infected corpses on the battlefield and could be water-borne. Harrison (1947) has described a series of 100 cases in an American Army Battalion in Italy which were proved to be caused by drinking water from an infected well within the unit location —infection of the well being due to fæcal pollution. Richmond and Gear (1945) stated that the incidence throughout the Middle East Theatre was 16·0 per 1,000 in 1942 and 14·7 per 1,000 in 1943. Gauld (1946) has described the disease as it affected American troops in the Mediterranean Theatre of Operations, his comprehensive series of eight articles covered a very large number of cases and gave statistical data of rates of incidence, but also noted the epidemic pattern in large and small units. He concluded that transmission was from person to person rather than from a common source such as food or water and that the seasonal incidence, autumn and early winter, favoured

a respiratory mode of spread, it was also noted that the disease was not common among the civil populations of French North Africa and Italy. The Statistical Report on the Health of the Army, 1943–1945, gives a great deal of information on the incidence of the disease among British, Dominion and Colonial troops in the Middle East and Central Mediterranean Theatres. Note is made of the higher incidence in officers than other ranks and of the extreme susceptibility of New Zealand and Canadian troops relative to British troops, whereas Indian and African troops are much less susceptible. The same is true of enteric group fever but the exact reverse is found in the case of tuberculosis. Findlay (1948) has dealt with the disease as seen in West Africa during the war years, he too notes the lesser susceptibility of Africans and has stated that the seasonal incidence is said to follow more closely that of dysentery (a wet season fly-borne disease) than that of either pneumonia or cerebrospinal meningitis (dry season, droplet diseases).

The incidence in the civilian population has been studied in Palestine where Olitzki, Bachi and Kallner (1948) reported that the average incidence could be estimated at about 10 per 1,000 per annum, that the disease is endemic there and is usually acquired in childhood, but immigrants from non-endemic regions become infected soon after arrival. The seasonal incidence resembled that of the respiratory diseases, i.e. maximal in December and January, but a secondary rise among children in July and August suggested that flies and food contamination may play a part in transmission. The incidence amongst the civil population in Tripolitania has always been negligible according to the Director of Medical Services of the British Administration there—infective hepatitis is not notifiable but it is rarely seen by the general practitioners and is never met with in hospital practice. An epidemic of the disease occurring amongst the staff and guests of a hotel in Sweden lasting fourteen months has been described by Olin (1947) who concluded that the disease was water-borne, the hotel water supply becoming polluted from the hotel sewage discharging into the same slow-flowing lake.

As regards experimental work, MacCullum and Bradley (1944) and Findlay and Willcox (1945) have shown that the virus is present in the blood, fæces and urine early in the disease and incubation period, transmission to human volunteers has been effected by oral ingestion of filtrates of these but not with saline nasopharyngeal washings.

## The Population at Risk

The community under consideration, soldiers living in barracks in Tripolitania, was in many ways an ideal group for any epidemiological investigation. In the first place their exact number was ascertainable at monthly intervals, thereby permitting accurate morbidity rates to be computed. As a rule each unit had a barracks to itself. The majority, about three-quarters, were stationed in and around Tripoli and the remainder in four small towns along the coast. Each unit group was, in most instances, isolated from regular

contact with the others, but there were of course sporadic contacts at football or cricket matches, leave camps, hostels and the like. All lived in close proximity to, and in casual contact with, the indigenous population of Arabs, Italians and Jews.

This military population was of the usual age structure. They were mainly young soldiers, regulars and National Servicemen, in their late teens or early twenties, but with older N.C.O.s and officers. There was a fairly rapid turnover of the younger soldiers due to the release and new intake of National Servicemen but on the whole the general structure remained unchanged. There was one exception to this, in that during the first nine or ten months of the survey a fair proportion of German prisoners of war were present in the Tripoli area, however these were organized into units with British officers and lived under exactly the same conditions as British troops, the only possible difference was that their presence altered the ratio of officers to other ranks, as the P.o.W. units had relatively few officers.

Apart from the structure there was a gradual decrease in numbers during the first year, followed by a sudden and even greater increase with the arrival of troops evacuated from Palestine about the middle of 1948, which, after a period of stability, was in turn followed by another gradual decrease until the end of the survey.

## Method of Investigation

Infective hepatitis was a notifiable condition in the district. All cases were hospitalized in one major hospital, and for part of the time in one small station hospital. Hospital records, from the Admission and Discharge Book, were available from July 1947, whilst from early in 1948 it was possible to interview every patient and to record the salient points of his illness on a *pro forma* or questionnaire. The details recorded for each patient were: (*a*) name and number; (*b*) unit and sub-unit (company, squadron or battery); (*c*) nature of symptoms; (*d*) date of first onset of symptoms; (*e*) dates of admission to hospital and of discharge; (*f*) movements during incubation period of up to six weeks prior to admission to hospital; (*g*) details of any injections or blood transfusions during three months prior to admission to hospital; (*h*) dates of any previous attacks of hepatitis; (*i*) any other information which seemed of interest in certain cases.

Such questionnaires were completed for about 250 cases during the two-year period 1948–50. The data accumulated from both hospital records and questionnaires were tabulated and analysed, whilst the detailed study of certain individual questionnaires yielded additional interesting facts in several cases.

## Annual and Seasonal Incidence

The epidemiological pattern of the disease was remarkably constant throughout the whole of the period under review. The incidence was negligible during the second quarter of the year and for at least some period during

this quarter, usually April and May, no cases were seen. A few scattered cases appeared about the middle of the year and continued sporadically until late August or early September after which time the epidemic wave increased rapidly to a maximum incidence, of about 4 or 5 per 1,000 per month, during October and November. There was a steady decline during December and January and by February the incidence was negligible again. The monthly incidence throughout the survey is recorded in Table I and is represented diagrammatically by fig. 1, the incidence is expressed as a ratio per 1,000 of strength and, with the full data available, there is no doubt that it portrays accurately the occurrence of the disease in relation to the population at risk at that time.

TABLE I.—INCIDENCE OF INFECTIVE HEPATITIS EXPRESSED AS A RATE PER 1,000 STRENGTH

| | *Jan.* | *Feb.* | *Mar.* | *Apr.* | *May* | *June* | *July* | *Aug.* | *Sept.* | *Oct.* | *Nov.* | *Dec.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1947 | — | — | — | — | — | — | 0·25 | 0·52 | 1·94 | 5·52 | 4·13 | 4·86 |
| 1948 | 1·42 | 0·51 | 0·18 | Nil | Nil | 0·15 | 0·36 | 0·68 | 1·40 | 3·84 | 3·23 | 1·62 |
| 1949 | 1·09 | 0·33 | 0·22 | Nil | 0·23 | Nil | 0·35 | 1·33 | 1·94 | 2·02 | 4·01 | 3·37 |
| 1950 | 1·39 | 0·42 | 0·31 | — | — | — | — | — | — | — | — | — |

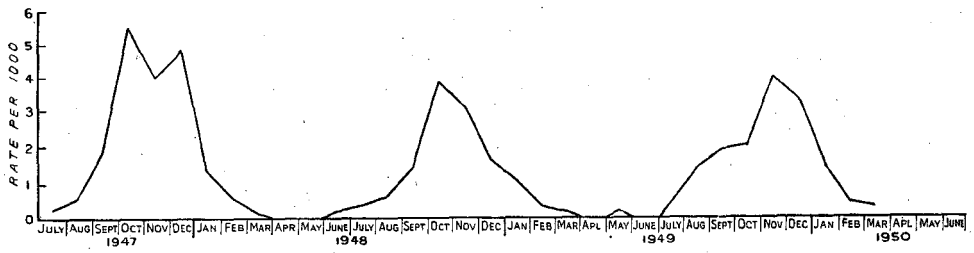


FIG. 1.—Infective hepatitis—monthly incidence 1947–50.

The annual incidence, also expressed as a rate per 1,000, was calculated, using the annual total of cases and the average annual strength. Data for the two complete calendar years of 1948 and 1949 were available. These annual rates of incidence were not satisfactory and gave a quite misleading picture—the rate for 1948 was appreciably greater than for 1949 when in fact the two years were almost exactly similar. The reason for such a discrepancy is, of course, the occurrence of a relatively large variation in the population during the non-epidemic period when the population was not at risk—this happened during the first part of 1948 as already noted. The use of such an annual rate therefore is not considered to be satisfactory for comparatively small military populations which may vary in size during the calendar year. However, such a rate may be used as a rough guide provided all variations in strength are known. It can be stated that for British troops in Tripolitania during 1948 and 1949, the annual incidence of infective hepatitis was about 15 per 1,000 and during 1947 was probably about 20 per 1,000.

In view of the conflicting evidence as to whether the seasonal incidence of the disease corresponds to that of the respiratory diseases (droplet infection)

or to the excremental (water and food-borne) diseases, an attempt was made to relate the monthly incidence as recorded in fig. 1 to such diseases. In the first instance the relationship to the respiratory diseases was considered, and for this purpose data were collected on the incidence of the common cold, tonsillitis, acute bronchitis and influenza over a period of almost two years. Details of all such conditions, whether hospital admissions or cases seen at M.I. Rooms, were recorded and their total monthly incidence, expressed as a rate per 1,000 strength, is shown in Table II. It is considered that these figures give a reasonably accurate measure of the incidence of the respiratory diseases in Tripolitania. For purposes of comparison these respiratory diseases

TABLE II.—INCIDENCE OF RESPIRATORY INFECTIONS

| | *Jan.* | *Feb.* | *Mar.* | *Apr.* | *May* | *June* | *July* | *Aug.* | *Sept.* | *Oct.* | *Nov.* | *Dec.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1948 | — | — | — | — | — | — | 27·6 | 32·1 | 31·9 | 34·8 | 50·5 | 45·7 |
| 1949 | 42·9 | 36·8 | 28·5 | 22·6 | 17·1 | 21·1 | 20·6 | 19·4 | 12·1 | 18·5 | 24·4 | 17·6 |
| 1950 | 30·6 | 14·0 | — | — | — | — | — | — | — | — | — | — |

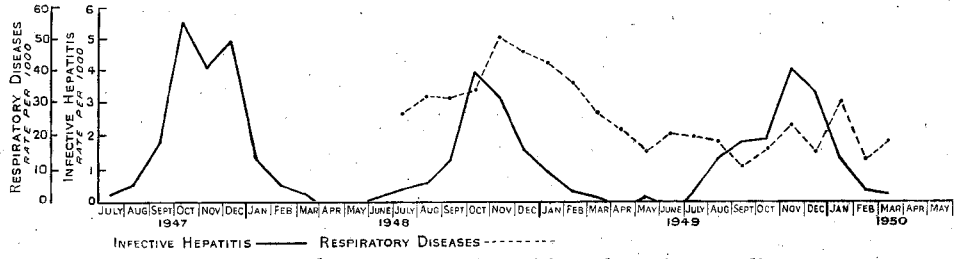


FIG. 2.—Comparison of infective hepatitis and respiratory diseases.

were superimposed on the diagram of the incidence of infective hepatitis as given in fig. 1, the result is shown in fig. 2 and it will be seen that there is not a close degree of correlation. The respiratory diseases would appear to vary considerably from year to year both as regards total incidence and seasonal periodicity, in striking contrast to infective hepatitis which was very constant and regular in both respects. Again, the seasonal peaks for the respiratory diseases were later than for infective hepatitis by about one or two months—a difference which must be increased still further if one takes into account the fact that the incubation period of infective hepatitis is at least a month longer. All these factors were carefully considered and it was concluded that there was not sufficient similarity between the two types of disease to warrant an analogy between their mode of transmission.

The next step was to compare the disease with an excremental disease known to be mainly water or food-borne. For this purpose the dysentery/diarrhœa group of diseases was rejected as being too definitely fly-borne, and the incidence of enteric group fever as it affected the civilian population was chosen. It was realized that in doing this one was considering a very different ethnic group from British troops, but it was argued that enteric fever in the local population

did take into account local conditions and would give a picture of the spread of a food and water-borne disease in an unprotected but partially immune community—which was precisely the state of the British soldier as regards infective hepatitis. In view of the fact that the local population varied very little in strength during the period under review the numbers of cases of enteric fever were recorded and not rates per 1,000. The result of such a comparison is shown at fig. 3 and it will be seen that there appears to be a definite similarity between the two as regards the seasonal rise and fall of the epidemic wave.

TABLE III.—INCIDENCE OF ENTERIC GROUP FEVER IN LOCAL CIVILIAN POPULATION OF TRIPOLI

| | *Jan.* | *Feb.* | *Mar.* | *Apr.* | *May* | *June* | *July* | *Aug.* | *Sept.* | *Oct.* | *Nov.* | *Dec.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1947 | — | — | — | — | — | — | 1 | 44 | 30 | 15 | 11 | 11 |
| 1948 | 15 | 1 | 10 | 4 | 7 | 7 | 16 | 22 | 17 | 33 | 14 | 8 |
| 1949 | 3 | 3 | 2 | 1 | 1 | 10 | 12 | 32 | 19 | 21 | 6 | 5 |
| 1950 | 1 | 3 | 2 | — | — | — | — | — | — | — | — | — |

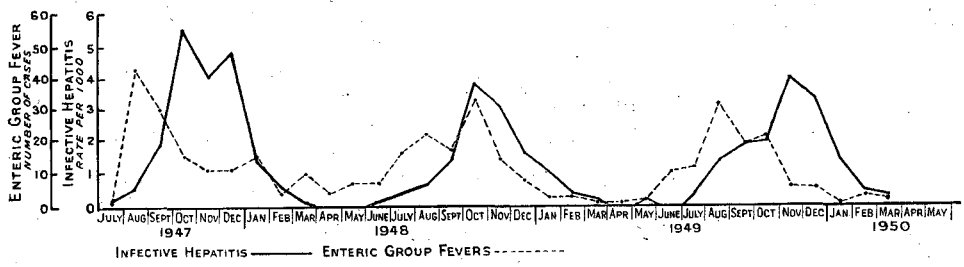


FIG. 3.—Comparison of infective hepatitis and enteric group fever.

The enteric fever, it is true, commences a month or more earlier on the whole but here again the longer incubation period of infective hepatitis probably plays a significant part. It would seem that such a comparison between these two conditions lends support to the conclusion that they have a similar mode of transmission. There is, however, one important fact which must be considered before such a conclusion can be justified. Whilst studying the similarities between these two disease patterns it became apparent that both were affected in the same way, and to a considerable degree, by climatic conditions, in particular by rainfall. Cases of infective hepatitis, for example, started to appear about three to five weeks after the winter rains had ceased, they increased to a peak during the period of drought and then declined rapidly from about a month after the winter rains re-commenced. There are some apparent anomalies to be explained and further work is needed; so it is considered that this aspect should be made the subject of another paper. An explanation is also required for the way in which the disease can vary so markedly between two such places as the desert country of North Africa and the tropical humid parts of West Africa where the excremental diseases

and infective hepatitis are more prevalent during the wet season (Findlay, 1948).

### Relative Incidence in Officers and Other Ranks

It has been a constant finding of all previous reports that in the British Army the incidence is greater in officers than in other ranks and this was again confirmed during the present survey. Officers accounted for 9·6 per cent of the total cases whilst their average proportion of the population at risk was about 5 per cent (4·8 per cent in 1947 rising to 5·4 per cent in 1949). On the other hand senior N.C.O.s, i.e. serjeants and warrant officers, accounted for 7·3 per cent of the total cases but their average proportion of the population at risk was about 8 per cent, these senior N.C.O.s therefore accounted for slightly less cases than the overall average level. The fact that the incidence in senior N.C.O.s was less than average is understandable in view of the known differential age incidence, but this of course would exaggerate still further the higher incidence in officers.

A detailed study of individual questionnaires was made, which showed that as a rule both officer and N.C.O. cases were limited to a small number of units during each epidemic period but the few units affected produced almost all the cases during that period, the remaining units escaping, for example:

(*a*) During 1947/48 out of 15 officer cases 11 were shared between 4 units only, whilst of 7 cases in senior N.C.O.s 4 occurred in one unit.

(*b*) In 1948/49 there were only 6 sporadic cases among officers and 6 among N.C.O.s—each case in a different unit. It is likely that the great disturbance of population after the evacuation from Palestine might have had some effect in this period.

(*c*) During 1949/50 out of 12 officer cases 8 were shared between 3 units, whilst of 12 cases in N.C.O.s 7 were shared between two units. These units had been out in a desert camp during the relevant incubation period where conditions were poor and the serjeants' mess in particular was found to be filthy. Incidentally, of the officers who contracted the disease 6 had been to this camp during the incubation period.

It would appear therefore that amongst officers and senior N.C.O.s the disease caused several cases in each of a limited number of units and none at all in most of the remaining units. There was a definite suggestion that the reason for this was the fact that officers and N.C.O.s lived or, even if married, spent a considerable proportion of their time, within the small compact groups of their respective messes, and once infection was introduced into such a group then several secondary cases would be caused. On the other hand such infection was not easily introduced, as is shown by the many units that escaped, nor could it be easily spread once introduced, as several units had single cases only. It was concluded that the mode of spread was related to the feeding habits of the group and was probably through the medium of infected crockery or cutlery, e.g. cups, glasses, spoons and

forks, which articles are usually shared by all members of the mess. It is suggested that when the first case occurs amongst officers or N.C.O.s no further spread takes place in about 60–70 per cent of instances but in the remaining 30 or 40 per cent some article of crockery or cutlery gets infected, probably from contaminated fingers, and then several secondary cases occur in each group. Such a method of transmission of the disease must be operative equally as regards officers and N.C.O.s, and indeed this seems to be the case.

One is therefore forced to the conclusion that in addition there is another factor in operation by which, with equal potentialities for spreading the disease in messes, officers are on the whole more susceptible than are senior N.C.O.s and by implication all other ranks.

## Spread of the Disease in Individual Units

Each unit was a self-contained community easily identifiable from records or questionnaires and more or less isolated from other units, certainly as regards daily living conditions. An analysis of the incidence by units was therefore carried out. It soon became apparent that in larger units cases occurred in "clumps" or "batches" and were not spread evenly over the epidemic period, such batches of cases always followed a small number of irregularly distributed cases which occurred during the early part of the season. In smaller units, cases, usually the only cases occurring in the unit throughout the whole three-year period, would occur all in one batch within a week or so, or even within a few days. The following examples have been extracted from the general series as being illustrative.

(*a*) *Unit A* (*A Guards Battalion*).—During 1948 this unit started off with 2 cases in early August, these cases were probably infected in Palestine before arrival in the territory. No further cases occurred for some five weeks and then 8 cases appeared at irregular intervals until the middle of November, when the following series occurred:

| *Serial Number* | *Name* | *Date of admission to hospital* | *Sub-unit* |
|---|---|---|---|
| 193 | Gdsm. T | 11 Nov. 1948 | King's Coy. |
| 195 | ,, H | 19 ,, ,, | 2 Coy. |
| 196 | ,, F | 19 ,, ,, | Support Coy. |
| 197 | L/Cpl. N | 20 ,, ,, | ,, ,, |
| 198 | ,, G | 20 ,, ,, | 3 Coy. |
| 200 | Gdsm. T | 21 ,, ,, | Support Coy. |
| 201 | ,, F | 22 ,, ,, | ,, ,, |
| 202 | ,, F | 22 ,, ,, | ,, ,, |
| 203 | ,, B | 22 ,, ,, | ,, ,, |
| 204 | ,, B | 23 ,, ,, | ,, ,, |
| 206 | ,, B | 25 ,, ,, | H.Q. Coy. |
| 207 | ,, M | 26 ,, ,, | ,, ,, |
| 208 | L/Cpl. H | 26 ,, ,, | ,, ,, |
| 211 | Gdsm. L | 28 ,, ,, | Support Coy. |
| 212 | ,, S | 29 ,, ,, | ,, ,, |
| 213 | ,, A | 3 Dec. ,, | 3 Coy. |

Only 5 further cases occurred, at irregular intervals, until the end of the epidemic period. It was ascertained that during the month of October the unit had been doing company training and companies had been out as sub-units in small camps during this period.

A similar but not so striking a series occurred in this battalion during 1949/50, however, it is not recorded owing to the possibility of fallacies arising from a mass yellow fever inoculation of the whole unit—this is noted below.

(*b*) *Unit B* (*a Regiment of Royal Artillery*).—This regiment had only 2 cases during 1948/49. During 1949/50 there were 22 cases all within the period July to October when they suddenly ceased, just when the epidemic wave was at its height elsewhere. The cases were mainly grouped into three batches, in early August, late September and mid-October. The officer community was attacked early and produced several cases all of whom later infected their wives or children. It was first suggested by the medical officer of this unit that those who worked in offices were mainly affected and on further investigation it was found that some 60 per cent of those attacked worked in offices or stores.

(*c*) *Unit C* (*a Regiment of Royal Artillery*).—During 1947 this unit had 25 cases from mid-September to late December, the officers were affected early and produced several secondary cases. From December 1947 until late 1949 when they left the territory this unit had only one further case although they remained in the same barracks throughout.

(*d*) *Unit D* (*a Highland Regiment*).—This unit only arrived from U.K. in April 1949, the following record of its cases is particularly illustrative:

| *Serial Number* | *Name* | *Date of admission to hospital* | *Sub-unit* |
|---|---|---|---|
| 245 | Pte. B | 11 July 1949 | D Coy. |
| 263 | „ M | 17 Sept. „ | H.Q. Coy. |
| 292 | Lieut. F | 5 Nov. „ | Support Coy. |
| 306 | Major M | 16 „ „ | B Coy. |
| 308 | Pte. McC | 18 „ „ | H.Q. Coy. |
| 318 | Boy McK | 2 Dec. „ | „ „ |
| 329 | Pte. S | 12 „ „ | „ „ |
| 330 | „ S | 12 „ „ | „ „ |
| 332 | „ C | 15 „ „ | „ „ |
| 333 | „ S | 15 „ „ | „ „ |
| 334 | Cpl. K | 19 „ „ | „ „ |
| 335 | Pte. W | 20 „ „ | „ „ |
| 338 | „ R | 21 „ „ | „ „ |

only one further case occurred during the epidemic period. This unit was one of the units to inhabit the desert camp referred to previously and they were in this primitive camp for about four weeks during October/November.

(*e*) *District Headquarters*.—The numbers working at this headquarters made it a medium-sized unit with a disproportionately large number of officers and senior N.C.O.s. Throughout the three-year period this unit was at risk only, 11 cases were seen of which 7 occurred during an interval of fifteen days in September 1948:

| *Serial Number* | *Name* | *Date of admission to hospital* | *Employment* |
|---|---|---|---|
| 141 | Dvr. D | 4 Sept. 1948 | M.T. Driver |
| 146 | Sjt. P | 9 „ „ | Education Instructor |
| 166 | Gdsm. P | 15 „ „ | Regimental Police |
| 167 | Cpl. P | 15 „ „ | Armoury |
| 168 | Gdsm. B | 16 „ „ | Batman |
| 169 | Pte. J | 16 „ „ | M.T. Driver |
| 174 | L/Cpl. O | 19 „ „ | Laundry |
| Two other cases occurred over a year later: | | | |
| 336 | Gdsm. E | 20 Dec. 1949 | Armoury |
| 339 | Pte. J | 29 „ „ | M.T. Clerk |

It must be regarded as remarkable that such a unit had no officer cases although the proportion of officers on its strength was vastly in excess of any other unit. It was observed that all of the affected men worked on routine unit duties and none worked in the headquarter offices, in addition all these men lived in barracks whereas in this unit a high proportion of all ranks were married and lived out in quarters.

Although all these instances have been chosen as being particularly illustrative there were many other similar cases in other units. It will be seen that during the span of each epidemic wave, the majority of cases in the larger units occurred usually over a limited period, and were undoubtedly secondary, or sometimes tertiary, cases infected from a common source. There probably was a limited amount of case-to-case infection but, with the long incubation period of this disease, the numbers of cases so infected must of necessity have been small, and would only become obvious at the beginning and end of each epidemic wave.

Another striking fact was the way in which those men working at or about the unit headquarters were most heavily attacked—men of H.Q. Coy. and Support Coy. account for about 80 per cent of all the cases recorded for Units A and D whilst in Unit B it was noted that 60 per cent of those affected worked in offices or around Regimental H.Q. At the District Headquarters those mainly affected were men working at domestic details in the Camp Commandant's department—the clerks and officers of the actual Headquarters were not affected at all, yet these should have been the most liable to droplet spread from the nature of their work in small and often crowded offices, whilst their number included a very high percentage (about 20 per cent) of officers in whom the attack rate is usually about double that of other ranks.

Another point observed when considering the incidence by units was that the incidence varied greatly in similar units and also would vary from year to year in the same unit. Thus Unit A had the highest rate throughout, Units B and C and District Headquarters had, at different times, a high incidence lasting for a comparatively short period, and then throughout the whole of the rest of the survey only odd cases occurred. There were other units too, both large and small, in which only odd cases were seen, occurring usually in twos and threes at intervals of four to six weeks but sometimes occurring quite

haphazardly, in which instance they were almost certainly infected from an outside source.

### Infection in Hospital

As has already been noted, all cases were treated in hospital and the vast majority in one hospital. In addition to cases admitted with the disease, there were a number of proved hospital infections—patients who had come into hospital for some other condition and, after being in hospital for a month or longer, developed an infective hepatitis. In all, some 6 cases were proved beyond all reasonable doubt to have been so infected whilst 3 other cases were probably infected in hospital although other possibilities for infection elsewhere did exist.

It was noted that no cases occurred amongst the medical or nursing staffs (nursing sisters and R.A.M.C. orderlies) but amongst the non-nursing section of the hospital staff the incidence was about average, and here too it was noticeable that those who worked in offices or stores seemed to be more commonly affected than the rest.

It must surely be significant that although infective hepatitis patients could infect other patients in hospital the nursing staffs were never infected, and this fact above all others must weigh heavily against the hypothesis that pure droplet infection is the method by which the disease is spread.

### Miscellaneous Observations

The analysis of the questionnaires led to the accumulation of a great deal of data on various aspects of the disease which it is thought worth while to record briefly.

(*a*) Some 59 or 25 per cent of the sample questioned had received injections of one sort or another during the three months prior to the onset of their illness, such injections were usually for T.A.B. inoculation but a few had had penicillin or blood transfusions. In September 1949 one unit (Unit A) was inoculated *en masse* with yellow fever vaccine, some 15 subsequently developed infective hepatitis nearly all from one sub-unit, H.Q. Coy. The incident was carefully investigated with a view to proving a syringe transmitted jaundice but it was eventually decided that the injections had played no part in transmission in this instance.

(*b*) Two men admitted with infective hepatitis in February 1949 both developed poliomyelitis. The first (Pte. H) developed it on February 16, seventeen days after admission and died three days later. The other man who had been in the next bed to Pte. H for a few days was discharged, journeyed to Benghasi and there developed poliomyelitis on February 23, seven days after Pte. H. This was an unusual time of year to contract poliomyelitis in Tripoli and these were the only cases to occur at such a time during the whole of the period under review. It is possible that the infective hepatitis rendered one or both of these men more susceptible to the virus of poliomyelitis or that it

assisted in the activation of the latent virus. It might also be noted, in passing, that, although too few cases of poliomyelitis were seen to quote accurate figures, there was a definite impression that the method of spread of the two diseases was similar. The seasonal incidence was a little earlier in the case of poliomyelitis (July–September); but there was the same pattern, with cases occurring in twos or threes in the same unit, and in one instance of association with work in the office of H.Q. Coy.

(*c*) The time between the onset of the first symptoms and admission to hospital was on the average 4·3 days (S.D. 2·5 days).

(*d*) The duration of stay in hospital averaged 27·6 days (S.D. 11·4 days).

(*e*) The proportion who had had previous attacks was just 2 per cent, of whom about half had their attack within two months and were therefore probably relapses rather than second attacks.

## Discussion

There would appear to be two aspects of the disease on which this survey might yield information—the rate of incidence and the mode of transmission.

It was evident that the annual incidence although expressed as a rate per 1,000 strength was of little value, and could even be misleading, when applied to a comparatively small population whose number was liable to variation during a non-epidemic period. Possibly such a rate of incidence might be of value for a large and relatively stable population, such as a Command or a Theatre of Operations; but even in these instances the exact composition and numbers of the different ethnic groups would need to be known, and dealt with separately, if fallacies and misleading inferences are to be avoided. The only satisfactory way to compare the occurrence of the disease in different years is to record the seasonal incidence, expressed as a rate per 1,000, on a graph or chart. Such a chart should preferably show the monthly incidence, but a quarterly rate would be adequate in most instances.

By such a method it has been shown that amongst British troops in Tripolitania the disease is epidemic, with a regular epidemic wave during each autumn and early winter and a peak incidence, during October or November, of about 4 or 5 per 1,000.

The mode of transmission was studied in two ways. In the first place the seasonal incidence and epidemiological pattern of the disease was related to the respiratory diseases and to enteric group fever in an attempt to see whether it was possible to deduce, by analogy, a similar method of spread. In considering these attempts the significant factor must be the much longer incubation period of infective hepatitis; for, whilst all the data and the visual patterns of the charts deal with the disease from the time of admission to hospital, any consideration of the mode of transmission must necessarily be concerned with the time of infection, and this will be the date of admission referred back by the average duration of the incubation period. The time of infection must obviously be impossible of ascertainment in this type of approach but one can

say that, taking into account the differing incubation periods, the pattern of infective hepatitis approaches closely to that of the enteric group fevers whereas it differs considerably from that of the respiratory diseases, although in this connexion the influence of rainfall and humidity may be the operative factor in the causation of a similar pattern in these two diseases, and this aspect needs further clarification.

Consideration of the spread of the disease in individual units showed that, apart from the beginning and end of each epidemic period, the majority of cases in each unit occurred in one or two batches and were almost certainly secondary or tertiary cases infected from a common source. The average time between the onset of the first symptoms and admission to hospital was noted as being 4·3 days and it was up to seven or eight days in some cases, during this period the sufferer would be infective and would have ample opportunity to spread the virus. It was concluded that the disease was spread by oral ingestion of the virus, the vehicle for transmission could be food or water; but it is possible that, in the majority of cases, infection was spread through the medium of imperfectly washed crockery or cutlery in canteens, clubs, messes or even in offices (where cups or mugs are kept for the mid-morning or afternoon cups of tea and are invariably inadequately washed). It has been suggested that spread amongst office workers may have been caused by the handling of papers or documents with contaminated fingers, the virus remaining on the papers and later being conveyed to the mouth of a susceptible recipient by his own fingers. It will follow, too, that the medium or vehicle by which the virus is spread will to a certain degree determine the pattern of spread in any unit or group.

The survey has shown that the disease attacks certain groups or classes to a disproportionate degree, namely officers, all ranks of H.Q. and Support Coys. and possibly (although this is not so definite) those who work in offices or stores. The reasons for this are not clear. It is possible that, as all of these categories work in or around the headquarters of the unit, they have more opportunities for frequenting canteens or messes for extra cups of tea; whilst they are in addition a more constant grouping and may be in closer association than others of the unit. It has been suggested, too, that the men of these particular companies are, above all others, those who get the least exercise—they nearly all have sedentary jobs or drive mechanical transport, and it may well be that such lack of exercise is a predisposing factor. In this connexion it is worth recalling that in the Middle East in 1944 the relative incidence of infective hepatitis was highest amongst the Royal Army Pay Corps (Statistical Report on the Health of the Army 1943–45), the personnel of which work exclusively in offices and can get little exercise.

Whether the disease is spread through the agency of papers and documents or whether lack of exercise is a predisposing factor, there is little doubt that the greater susceptibility of officers is partly due to a lesser degree of exposure to the disease in infancy and early life with the result that they reach adult life

with a lesser degree of immunity. Only thus can it be explained why there is a very much different attack rate in officers and senior N.C.O.s with almost identical possibilities for introduction and spread of the infection within their respective messes. Indeed, by an extension of the same reasoning we can deduce the cause of the constant epidemic pattern of the disease, by postulating that the incidence of the disease is directly related to the sanitary standards of the community. Where these are low the disease is hyperendemic, occurs as a mild childish ailment and is not seen in adult life—it might even be that in childhood the disease does not produce jaundice; with the higher sanitary standards of Western Europe and North America the incidence is less and many escape the disease, but if large numbers of such an ethnic group are introduced into a hyperendemic region which has the appropriate climatic conditions, then the typical epidemic pattern will occur. Furthermore, whilst no evidence can be offered, there was a definite impression that diseases which have a similar behaviour and seem in some way to be comparable are poliomyelitis, atypical virus pneumonia and possibly glandular fever, especially in children. It is, however, stressed that such a similarity might only be true under local conditions of climate, especially rainfall, and in other circumstances these conditions would be spread in other ways, e.g. by droplet infection.

As regards preventive measures, the first essential must be the raising of the general sanitary level of the group under consideration, with particular emphasis on the highest possible standards of food hygiene and attention to all aspects of food preparation or storage. The personal hygiene of all food handlers is of the greatest importance, particularly the routine of hand-washing after every visit to the W.C. or urinal. Sterilization of water supplies must always be carried out, although doubt has been expressed as to whether chlorination, in ordinary dosages, is sufficient to kill the virus. In addition to all this, however, it is probable that the most important single measure will be the really efficient washing of all crockery and cutlery used in canteens, clubs or messes and the provision of adequate facilities for the soldier to wash his own utensils after a meal. Recent tests have shown (Frisby, 1950; and Higgins and Hobbs, 1950) that the fully efficient washing of crockery and cutlery should be carried out as follows:

(1) Wash in really hot water (50° C.), to which a detergent has been added. This water must be changed at frequent intervals so that it is always hot and reasonably clean—the success of the process depends upon having little or no protein matter carried over from this stage.

(2) Rinse in very hot water for one to two minutes, if necessary with the aid of racks, at a temperature of 85° C. or 185° F. Water sterilizing powder, 1 scoop per gallon could be added to this water, although it is not essential—the temperature is the important item.

(3) Dry on a rack by draining and not by wiping with a cloth, which soon gets dirty and then can cause gross contamination of the article being wiped.

Such a routine, which may be called the "Wash, Hot Rinse and Drain" process

could be carried out at all canteens, clubs or messes, if some form of apparatus was provided to ensure the supply of hot water for rinsing. Its application to the soldier in barracks is less easy, even the present ineffective process of "wash, rinse and sterilize" is not done properly. The alternatives are either (*a*) to modify the "wash, rinse and sterilize" process by heating the water in either the rinsing or sterilizing compartment to 85° C. and maintaining it at this level, or (*b*) to discontinue the use of individual utensils for the soldier, in barracks at least, and to use all articles of tableware on a communal basis, to be washed centrally by the use of washing machines or with the use of various aids such as heated sinks, long-handled rinsing racks and drying racks.

## Summary and Conclusions

A study has been made of infective hepatitis as it occurred among British soldiers in Tripolitania during the years 1947–50. Records of every case which occurred during this period were available, whilst during two of the three years it was possible to question every patient individually and so obtain much personal detail. The data thus accumulated were capable of being related to the population at risk with great accuracy owing to the availability of detailed strength figures. Study and analysis of this data brought out the following points:

(1) The annual incidence is an unreliable or even misleading figure when used for comparatively small military populations. Comparisons of different years can only be made from the perusal of monthly or quarterly rates, preferably represented on a chart.

(2) It was concluded that the spread of the disease in Tripolitania was excremental in origin and was transmitted by oral ingestion of the virus via water, food and especially articles of crockery or cutlery. It was also possible that spread could take place via papers, documents, office files or books.

(3) The incidence was greatest among officers, the personnel of H.Q. and Support Coys. and those who worked in offices or stores. Some possible reasons for this are discussed.

(4) It was concluded that apart from the mode of transmission, the most important factor in determining the occurrence of the disease was the susceptibility of the individual, which would seem to be influenced by the sanitary standards of the individual's environment during his early years. It is probable that this may be the chief factor which determines the greater incidence among officers.

(5) Some impressions were noted of the possibility of a similarity to, and relationship with, poliomyelitis, atypical virus pneumonia and glandular fever.

Finally suggestions were made for some preventive measures which could be adopted—mainly in relation to better kitchen hygiene and improved methods of washing crockery and cutlery using hot water to which has been added a detergent followed by rinsing in very hot water and allowing to drain dry.

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