A Survey of Meningitis in a Military Organization and Plotting its GIS Distribution

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Abstract
Aims: Meningitis is an infectious disease. In case it spreads to the military personnel living in dormitories in large numbers, it can cause high mortality. The present study was an attempt to examine the number of Meningitis cases, their types, and effective factors in its spread among Iranian Ground Forces (IGF). The distribution pattern of Meningitis in different parts of Iran was also examined.

Methods: In this cross-sectional research, records of patients with meningitis from mid-2006 to 2011 (5.5 years) were checked. All cases reported to IGF Health Office were included in the study. Variables such as age, military status (formal or conscripted), meningitis type, month and year of disease occurrence, recovery status, educational status of patient's military unit, and place of disease occurrence were checked. In addition, the distribution map of the disease was prepared using ArcGIS 9.3.

Results: Totally, 59 cases were reported to IGF Health Office. The mean age of patients was 20.09. 86.4% of the reported cases were in conscripts. Meningococcal meningitis was the most frequent type, and pneumococcal and viral types stood next. 63% of cases had occurred in training units. The highest and lowest incidences of disease were observed in 2006 and 2010 respectively. The number of Meningitis cases was highest in February. The death rate was 10.2%. The highest number of cases was reported in Tehran, Kerman, and Khouzestan provinces respectively.

Conclusion: Since all the patients were conscripts or formal trainees, permanent residence in military dormitories was one of the most important risk factors of meningitis morbidity. Meningitis incidence trend has been descending over the past few years, and hygiene programs have reduced the number of reported cases. GIS map of the case distribution was not concordant that much to GIS map of cumulative incidence mostly due to the differences in the number of military personnel in different provinces. However, disease mortality was similar to other references.

Keywords: Meningitis, Ground Forces, Incidence
Introduction
Among infectious diseases, bacterial meningitis is an important disease which has received a lot of attention from health system authorities [1-3]. Meningitis is a central nervous system (CNS) disease with a high death rate (up to 20%). Though rare (3.5 in one hundred thousand cases), it exists in societies and can cause long-term effects [4-7]. Although meningitis is more common in poor and developing countries with a high death rate, it does exist in developed countries despite vaccinations and imposes appropriate antibacterial treatments and medical care to these countries [9-11]. Every year, approximately 170,000 deaths occur as a result of bacterial meningitis [12] mostly in kids and younger age groups [13].

Three factors can cause bacterial meningitis: Streptococcus pneumonia, Hemophilus influenza type B, and Neisseria Meningitidis [14,15]. Neisseria Meningitidis, which is transmitted via nasopharyngeal secretions, is the cause of Meningococcal Meningitis which has numerous serogroups (A, B, C, E-29, H, I, K, L, W135, X, Y) [11]. This bacterium is the cause to 80 to 95 percent of bacterial meningitis epidemics [16]. Streptococcus pneumonia is the second most common cause (after Hemophilus influenza type B) of bacterial meningitis [17]. Hemophilus influenza is a pleomorphic organism whose serotype B encompasses 90% of the cases. In half the cases it demonstrates itself in the form of meningitis and in the other half in the form of Cellulitis, Arteritis, and Sepsis [14]. Viral meningitis can be caused by a wide range of viruses including Picornaviruses, Rubeolavirus, Arboviruses, Coxsackievirus, Herpes viruses, etc. [18].

At the moment, all conscripts enrolling for military service in Iran are vaccinated against serotypes A and C [8]. However, some sporadic cases of meningitis are reported in military units. Considering the dangerous nature of this disease and its high death toll if not treated, an active and efficient health care system for military forces is required.

The present study was an attempt to investigate the epidemic spread of meningitis in Iranian Ground Forces from mid-2006 to 2011 and prepare the distribution map of the disease using GIS. Being aware of the number of cases and the effective factors in its occurrence and spread as well as its distribution map in the military forces can be very effective in planning for preventing from the spread of meningitis and reducing the death toll resulting from that.

Methods
In this cross-sectional study, all the cases of meningitis reported to the IGF Health Care Centers from mid-2006 to 2011 were examined. The population of the study included all conscripts and formal trainees present in the Iranian Ground Forces. The sample included 59 cases whose infection with meningitis were confirmed and reported to the army health care centers. The diagnosis procedure for checking all the suspicious cases was the same and included both laboratorial and clinical examinations. The clinical diagnosis was based on symptoms like sudden fever above 38.5 °C, stiff neck, a low consciousness level, headache, vomiting, and sudden neurotic symptoms. Laboratory diagnosis included the CSF test. The definite diagnosis was based on CSF or positive blood culturing and the separation of the pathogens or Latex agglutination test and finding the related antigen in CSF.

CSF samples were prepared in aseptic conditions and after being investigated in terms of appearance, a wet mount and a dry mount smear were prepared for each sample. The wet smears were directly examined using lens no. 100, and the dry smears were examined after Blue O, Toluidine and gram staining. In case, the bacteria or polymorphs were not observed on the slide, the sample was centrifuged...
for five minutes at 3,000 rounds per minute, so that a smear could be prepared from the debris which was examined as explained above.

For the purpose of bacteriological culturing, 50 microliter of liquid CSF or its debris was injected to each culturing environment including Mueller Hinton Agar, Trypticase Soy Agar, and Thayer Martin Agar and was kept in 3% CO₂, for 24-48 hours in 37 °C. After that based on standard bacteriological methods, the samples were stained and examined for their growth. The identification protocols were then followed accordingly. This protocol used colony characteristics, gram staining, catalase tests, oxidase coagulase, Mannitol Salt Agar, bacitracin, opetition, bile dissolution, glucose, lactose, maltose, and sucrose fermentation as well as TSI, SIM, OF, Andol, citrate tests.

Then, the information regarding variables such as age, military status, type of meningitis, date of occurrence, recovery status, type of military unit (training or non-training), and place of occurrence were extracted from the files. The data were entered into SPSS 16 and were analyzed using descriptive statistics. The distribution map of the cases with meningitis was prepared using ArcGIS 9.3 based on the population of each region and the number of reported cases.

Results
In the period between mid-2006 and 2011, 56 cases of meningitis were reported in all military units of IGF. From among the reported cases, 50 were among conscripts and 8 cases happened in the formal trainees. The mean age of the patients was 20.09 (SD = 1.21) with an age range of 16 to 23. In the analysis of the cumulative occurrence of the disease, the highest number of cases was reported in 2006 with 16 cases and the lowest number was in 2010 with 1 case. The highest number of cases was reported in February and the lowest number of cases was reported in November.

![Figure 1. The Number of Reported Cases between 2006 and 2011](image1)

![Figure 2. Distribution of Reported Cases Based on Months of a Year](image2)

Regarding the type of meningitis, 30 cases (50.8%) were of Meningococcal, with 8 cases (13.6%) being Pneumococcal, and 2 cases (3.4%) being Viral. The type of meningitis could not be determined for 19 cases (32.2%). From among the 59 cases reported, 6 (10.2%) died and the rest recovered. 63% of the cases happened in training units while only 37% of the reported cases were in non-training units. The highest number of cases was reported in Tehran (14 cases), Kerman (13 cases), and Khouzestan (8 cases) provinces. Regarding the cumulative occurrence of the disease, Gilan Province (1.9 per a thousand), Kerman Province (1.71 per a thousand), and Southern Khorasan Province (0.77 per a thousand) ranked from first to third.
Discussion

Based on the findings of the present study, only 8 cases (13.6%) were reported in non-conscripts. Even these cases were trainees who were studying at training centers. As such, permanent residence in military dormitories is one of the most important risk factors in being infected with meningitis. Moreover, the majority of cases were reported in training units (63%). It is even likely that some of the cases reported from non-training units in fact occurred in training units, but since they were reported by higher ranking units, they were classified as cases in non-training units. The fact that regions with more training units stood higher in the distribution of the disease supports this hypothesis.

Due to hygienic measures taken, the incidence trend of meningitis has declined from 16 cases in 2006 to 1 case in 2010 and 2 cases in 2011. Despite the fact that conscripts are vaccinated against meningitis serotype A and C, still some suspicious cases of Meningococcal Meningitis are reported in military units. Three factors could be involved: there might be other serotypes involved, the vaccination cannot guarantee a 100% immunity against serotype A and C, and it is likely that some of the soldiers get the vaccination confirmation paper without actually being vaccinated.

Regarding seasonal incidence of the disease, the literature mentions the end of winter and the beginning of spring [18], which to a great extent matches the results of the present study. The only exception was Farvardin (April) which showed a significant decline. It can be due to the fact that this month coincides with New Year holiday in the Persian calendar in which most of the soldiers leave their units for holiday.

The majority of the cases (50.8%) were of Meningococcal type. Most probably, the majority of the undiagnosed cases (32.2%) were of this type, too. One of the reasons why it was not possible to diagnose the disease from the cultured CSF was the fact that when a suspicious case of meningitis referred to health clinics in military units, she had to receive antibiotics based on the available protocols before being referred to hospitals. This could make diagnosis of the pathogens difficult.

Another study done on the Bacterial etiology of 100 patients with meningitis visiting four military hospitals in Tehran showed that only 8 percent of patients were conscripted soldiers. Based on the
results of the cultured samples, the bacteria were confirmed in CSF only in 28 percent of the cases. The most common type of separated bacteria were Streptococcus pneumonia (35.7%), Neisseria Meningitidis (17.8%), negative Staphylococcus coagulase and Escherichia coli (14.2%) [20].

Conclusion
The GIS map prepared in this study based on the number of cases, does not match the one based on cumulative incidence because all provinces are not homogenous in the number of population. For example, although the number of cases of meningitis was only 1 in Gilan from 2006 to 2011, due to its low population, it ranked first in the cumulative incidence ranking. On the contrary, Tehran with 14 cases ranked much lower in the distribution map based on cumulative incidence. The death rate was 10.2%, which corresponds other resources on the subject. One of the most effective factors in reducing death rate was fast diagnosis in conjunction with in time treatment. Delayed treatment decreased the probability of recovery. As such, increasing the health care personnel’s awareness of the specific treatments exclusive to this disease can help decrease death toll.

References