Surveillance and control of meningococcal meningitis epidemics in refugee populations*

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Epidemics of communicable diseases pose a direct threat to refugee and internally displaced populations, and could lead to high mortality rates and a disruption of basic health care services. Several large refugee populations live in regions of high meningococcal disease endemicity and their camps are at risk for outbreaks of meningococcal meningitis. Surveillance in these camps allows early detection and control of impending outbreaks. Confirmation of meningococcal disease can be performed under field conditions using simple techniques, such as latex agglutination. Isolates should be obtained for serogroup confirmation and antibiotic sensitivity studies at reference laboratories. Serogroup information is used to determine the risk of widespread epidemic disease and the utility of available vaccines.

During epidemics, treatment regimens should be standardized, preferably with an effective single-dose antibiotic. Mass vaccination campaigns should be initiated, the populations at high risk being targeted for vaccination as quickly as possible. When the risk of epidemic disease is deemed to be high, preemptive vaccination may be warranted. Daily surveillance using a simple case definition is essential during an epidemic to determine the effectiveness of control measures and to delineate high-risk groups for vaccination or chemoprophylaxis. Many of these recommendations can be applied also to other populations in developing countries.

Introduction

Displaced populations in developing countries may be unusually susceptible to communicable diseases because of crowding, poor sanitation, inadequate health care, and a high prevalence of malnutrition. Crude mortality rates (CMRs) in refugee populations during the initial phase of an emergency can be many times higher than those in host country populations. CMRs as high as 42 per 1000 per month have been reported during the acute phase of refugee emergencies (1).

Meningococcal meningitis is a major concern in refugee camps, since crowding, poor hygiene, and, in some instances, limited access to medical services can contribute to large outbreaks of disease. In 1980, an outbreak of group A meningococcal disease at the Sakaeo refugee camp in Thailand involved 32 refugees with an attack rate of 0.13% over a four-month period and a case-fatality rate of 28%. A similar outbreak occurred at the Khao-I-Dang camp, with 46 cases and an attack rate of 0.08% over a three-month period (2). Although they did not differentiate meningococcal meningitis from other causes, Feldstein & Weiss found meningitis to be the fourth leading admission diagnosis at a paediatric ward in a refugee camp for Cambodians during a three-month period in Thailand (3). More recently, meningitis cases and deaths have been reported among Ethiopian refugees in eastern Sudan in 1985 (1) and among displaced southern Sudanese in relief camps in 1988.¹ There were, however, very few cases reported among Sudanese and Somali refugees in Ethiopia during the epidemic in that country in 1989. Since meningococcal meningitis is a relatively common, preventable, and potentially fatal disease in displaced populations, it is important to examine surveillance, prevention, and treatment strategies for refugees.

Epidemiology and surveillance

Epidemiology of meningococcal meningitis

Group A meningococcal meningitis is the most likely cause of epidemic meningitis in refugees. Neisseria meningitidis, a Gram-negative diplococcus, produces polysaccharide capsular antigens which allow bacterial serogrouping and the manufacture of serogroup-specific vaccines (4). There are numerous meningococcal serogroups (A, B, C, D, E29, X, Y, ² International Health Program Office, Centers for Disease Control. Requests for reprints should be addressed to Dr M.J. Toole.

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W135, and Z) which differ in epidemic potential. Group A can cause widespread severe epidemics; groups B and C may cause epidemic disease but attack rates are substantially lower. Industrialized countries have been generally free of group A outbreaks since the 1940s; since that time, the most common serogroups reported have been B and C (5). Within each serogroup, serotyping (based on outer membrane protein antigens) and isoenzyme typing can be used to identify individual strains and to define epidemiological patterns of the disease (6, 7).

In sub-Saharan Africa, a 600-km wide “meningitis belt” exists from the Gambia in the west to Ethiopia in the east (8). Large refugee populations within this belt include Sudanese and Somali refugees in Ethiopia (700,000), Ethiopians and Chadians in Sudan (685,000), and internally displaced southern Sudanese (2 million) (9). Endemic disease rates in this region are typically 10 to 50 times the endemic incidence rates of 1 to 3 per 100,000 found in most industrialized countries. Epidemics of group A meningococcal meningitis occur every 8 to 14 years in the meningitis belt, with attack rates approaching 1%; higher rates may be seen in confined populations (boarding schools, military garrisons, prisons, and possibly refugee camps). Meningococcal meningitis incidence is highly seasonal, with the onset of the meningitis season occurring during the dry months of December to February (10). The meningitis season generally ends with the onset of the rainy season in June and July. Theoretically, the potential for epidemic disease might increase in drought years because of displaced persons converging on central relief areas for food and medicines. Aside from the sub-Saharan meningitis belt, group A epidemics have also recently occurred in the Middle East (Saudi Arabia), South Asia (Pakistan, India, Nepal), and East Asia (Viet Nam and the People’s Republic of China), which are geographic areas with large refugee populations (9, 11, 12, 14).

Serogroup-specific vaccines are available for groups A, C, Y and W135 as either monovalent or polyvalent preparations. Vaccine efficacy against group A meningococcus is greater than 90% in adults and children over the age of 4 years. Protection in this group may decline slowly, but efficacy of approximately 66% has been shown 3 years after vaccination (15). In contrast, the duration of vaccine protection is short in children under 4 years old. While antibody titres are high immediately after vaccination in these children, protection is essentially absent three years after immunization (15).

Communicable disease surveillance in refugee populations

Since protective meningococcal antibody levels are not sustained in young children, childhood immunization campaigns are not recommended unless there is evidence of an impending epidemic. Sporadic meningococcal disease is usually a less immediate danger than other major causes of mortality (measles, malnutrition, diarrhoea) in refugee groups; however, institution of a simple surveillance system is essential for the early detection and prompt management of epidemics in refugee camps. The cornerstones of a successful surveillance system are simplicity, timeliness, accuracy, and regular feedback to those who collect the data. Surveillance must be sustainable with existing resources since it will quickly fall into disuse if it places an undue burden on camp personnel. This is especially true under emergency conditions when health workers tend to be more concerned with immediate priorities than with potential disasters that might be detected by surveillance.

Ideally, meningococcal disease surveillance should be based on laboratory confirmed cases. However, this is rarely possible under emergency relief conditions, and surveillance for all types of bacterial meningitis is used to approximate the true incidence of meningococcal disease. The simplest method for monitoring communicable diseases, including meningitis, is a weekly tabulation of health centre consultations or hospital admissions by diagnosis. This requires implementing a strict case definition for each disease being monitored to determine which admissions are counted as cases for purposes of surveillance. In the absence of laboratory facilities, the case definition for meningitis should require the patient to have compatible clinical signs and symptoms (fever, nuchal rigidity, and headache) and, in addition, purulent (macroscopically turbid) cerebrospinal fluid (CSF). Presence of petechial rash or purpura is helpful in supporting the diagnosis. This case definition will not differentiate meningococcal meningitis from other causes of meningitis, but will help detect upward trends in disease incidence. Other patients with some symptoms and signs suspicious of meningococcal disease who do not meet these strict case-definition requirements should be counted in a separate category as “suspected” but not “probable” cases.

Visual examination of CSF cannot be overemphasized for both clinical and public health reasons. During most acute disaster relief operations, bacteriological diagnostic facilities are limited or non-

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Surveillance of meningococcal meningitis epidemics in refugee populations

existential. Even in the absence of sophisticated medical supplies, useful clinical information can be obtained from a sample of CSF obtained using a sterile 21-gauge needle under sanitary conditions. Purulent CSF is strong evidence for meningitis, although other illnesses, such as poliomyelitis, may occasionally cause pleocytosis.

Surveillance based on inpatient admissions is simple and useful if implemented correctly. A single staff member with a strong interest in preventive medicine should be in charge of disease surveillance for the entire camp. Local, literate health workers can be trained quickly to collect information on admissions from the hospital or treatment area and to compile weekly records for use by staff personnel. These data can be graphed either by hand or by using portable computer statistical programs (e.g., EPIINFO, Centers for Disease Control) in order to determine disease trends. The importance of reporting communicable disease cases should be emphasized to health personnel since useful communicable disease surveillance requires prompt and accurate recording of cases in persons admitted to the hospital or treated as outpatients. A consultation log book containing the name, age, sex, date of consultation, current residence, duration of stay in the camp, and diagnosis is essential for maintaining surveillance for meningitis and other communicable diseases. If possible, confirmed and suspected cases should be recorded separately. Weekly appraisal of outpatient registers and hospital admission logs is the most reliable method of tracking meningitis cases.

Continuous evaluation of surveillance data by camp public health personnel is necessary, and entries must be regularly tabulated and analysed. To be useful, surveillance statistics should be standardized to the population (i.e., calculated as the rate of disease per 100 000 refugees per week or month). Since the refugee population may fluctuate dramatically over a short time period, tabulating only the number of cases of disease may mask a significant increase in disease activity. Meningitis admission rates should be calculated by age categories (e.g., 0–4 years, 5–14 years, and 15 or more years) and compiled at regular intervals. Frequent feedback of the results of disease surveillance to hospital personnel will increase case-reporting compliance as well as allow the institution of preventive measures. The importance of regular analysis of surveillance data cannot be overemphasized. Unfortunately, there are instances where detailed surveillance has been conducted for years with the data being neither analysed nor used in the planning of public health interventions.

**Detection of epidemic meningococcal disease**

The purpose of meningitis surveillance is to detect the emergence of an epidemic in order to institute control measures at the earliest possible time. Unfortunately, meningococcal disease incidence varies widely according to season, geography, and age distribution. Annual incidence rates in areas where meningococcal meningitis is hyperendemic are greater than 10 per 100,000 population, and in sub-Saharan Africa these rates may be as high as 50 per 100,000. During epidemic years, however, annual incidence rates over 500 per 100,000 are common, especially in cities (16). Because of the wide variation in rates between geographic areas, it is not possible to establish precise guidelines to differentiate hyperendemic from epidemic meningococcal disease in a refugee population. None the less, rough estimates of meningococcal disease incidence can be useful in determining the likelihood of an epidemic.

Guidelines using weekly disease rates to predict annual disease rates have been proposed based on a study conducted in sub-Saharan Africa. In this study, clinical reports of meningitis were collected from health centres in a large, central region of Burkina Faso over a five-year period. The study region was divided into 30 × 30-km areas, and the pattern of endemic and epidemic disease was studied within these areas, using an arbitrarily defined "epidemic" rate of 100 cases per 100,000 per year. It was found that rates of 15 cases per 100,000 per week or higher, averaged over two consecutive weeks, were sensitive, specific, and had a high positive predictive value for detecting which of the areas would experience epidemic annual rates of disease. The results of the study have been used to develop threshold guidelines for instituting vaccination programmes in sub-Saharan Africa. According to these guidelines, when average disease rates exceed 15 cases per 100,000 per week for two consecutive weeks, preparations should be made for widespread vaccination of the area under surveillance. Random fluctuations will occur in small populations; therefore, these rates should be used with caution in populations of less than 100,000 people. Differences in the predictive value of these threshold rates may be seen when they are applied to other regions, and efforts should be made to confirm these guidelines in a variety of settings.

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Since the size of refugee populations may fluctuate rapidly during acute disaster relief situations, it may also be difficult to determine precise disease rates. If population-based information is unavailable, or if the refugee population is relatively small, several approaches can be taken to estimate the risk of epidemic disease in specific settings. A useful rule to follow is that the doubling of meningitis cases from one week to the next over a three-week period should arouse suspicions of an impending outbreak. This guideline is not accurate when meningitis cases are few, and it has not been rigorously investigated to determine its sensitivity or specificity in predicting an outbreak. Therefore, this method should only be used as a rough guide to alert personnel to the possibility of a meningococcal meningitis problem. If the average weekly number of cases over the preceding four weeks is considered as the baseline, then weekly doubling of cases over two consecutive weeks should trigger an investigation (i.e., determination of the age groups affected, location of affected camp sites, and confirmation of meningococcal disease).

Sentinel surveillance for meningitis in young adult patients may also provide useful epidemiological information. Although meningococcal meningitis rates are often highest in infants aged 6–12 months, older age groups are also affected. In comparison, other bacterial meningitides, such as Haemophilus influenzae, are unusual in patients 5–30 years old. During a group A epidemic in Finland, the mean age of patients with meningococcal disease increased prior to and during the epidemic (17). If a significant increase in meningitis admissions occurs in persons aged over 5 years, it is likely that the outbreak is due to meningococcal disease. Monitoring of meningitis trends in this age group may be useful, especially when laboratory confirmation of meningococcal meningitis is unavailable.

The seasonality of meningococcal disease should also be used to determine the risk of epidemic meningitis. If relief operations are conducted during the local meningitis season, then particular attention should be paid to surveillance. In the meningitis belt of sub-Saharan Africa, meningococcal disease is uncommon except in the hyperendemic/epidemic season from December till June. Information on the local meningitis season is often available from public health officials and physicians working in the host country. Seasonal variation, however, should be used only as a rough guideline to predict the occurrence of epidemic disease, since exceptions can occur. For example, a major group A meningococcal meningitis epidemic in Mecca, Saudi Arabia occurred from July till August 1987. This epidemic appeared to be precipitated by mass population movements and the importation of a particularly virulent serogroup A clone (7).

Diagnosis and management

Establishment of diagnosis

Since establishing the presence of serogroup A or C is central to the planning of control measures, arrangements for latex agglutination tests of CSF to determine meningococcal etiology and serogroup should be planned, preferably in advance. Detection of meningococcal antigen using latex agglutination can be performed quickly under field conditions by personnel trained in its use. It is reliable, relatively inexpensive, and 70–90% as sensitive as CSF culture.* This test will often differentiate between meningococcal and non-meningococcal pathogens commonly encountered in developing countries (e.g., tetanus, angiostrongylies, cerebral malaria, bacterial sepsis) which can clinically mimic early meningococcal meningitis. Surveillance for serogroups A and C by throat cultures is not useful for predicting epidemic disease and is not recommended. If latex agglutination kits cannot be supplied to the camps, CSF samples can be transported to a regional or reference laboratory for testing since the antigen is relatively stable. If possible, sterile vials should be used for transport of CSF. Refrigeration of the sample is preferable, but not essential.

If surveillance data indicate an impending epidemic, periodic CSF or petechial cultures may provide useful information on serogroup and antimicrobial susceptibility; however, the culturing of specimens may be difficult to arrange. Usually, advance arrangements can be made with local or regional laboratories to perform these tests on meningococcal cultures, but care should be taken to ensure the viability of the organism during transport. Meningococci are fragile and very susceptible to heat, cold, and direct sunlight. The organism rapidly undergoes autolysis in cerebrospinal fluid, and requires plating onto suitable media soon after the specimen is obtained. To ensure survivability, CSF or petechial washings should be placed in suitable transport media, such as transport-isolate, and kept at 37°C during transport (18). If transport media are not available, the CSF specimens should be shipped in a test tube at body temperature as soon as possible.

Once an epidemic is suspected, surveillance

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* Latex agglutination kits are available from several manufacturers, including Merieux, Burroughs Wellcome, Pharmacia, and Becton-Dickinson. Further information is available from the authors.
surveillance of meningococcal meningitis epidemics in refugee populations

Efforts should be increased to detect new cases and efforts taken to define the etiology of new meningitis admissions. National public health and relief agency officials should be notified, and weekly comparisons and analysis of meningitis surveillance data should be performed if such data had been collected less frequently. If local or regional outbreaks of meningococcal meningitis have been reported by national health authorities, camp officials should be alert for spread of the disease into the refugee population.

Prevention and control of epidemic meningococcal meningitis

Although the attack rates during major epidemics of meningitis may be relatively low (approximately 0.1 to 1 case per 100 population) compared with other major medical problems facing refugee populations, the rapid influx of patients, the high case-fatality rate, and the fear generated by epidemic disease can severely disrupt health care delivery systems.

If epidemic disease occurs in a refugee population, a prompt and well-coordinated response by relief personnel is required. The immediate tasks to be performed are rapid assessment of the problem, identification of groups at highest risk, and marshalling of resources to limit the spread of the epidemic (Fig. 1). Rapid assessment of the suspected meningococcal epidemic is the first task to be undertaken. Surveillance data should be analysed to determine if an actual increase in meningitis rates is occurring. In addition, the data should be examined to characterize the outbreak in terms of the age, sex, and social characteristics of the patients (e.g., new arrivals vs. old arrivals or particular ethnic groups), as well as the location, extent, and time course of the outbreak. Thus, groups in the population who are at higher risk may be identified and trends in disease incidence determined. Also, priority should be given to the early collection of specimens to confirm the causative agent and to determine serogroup and antibiotic resistance patterns.

Using the information from the initial rapid assessment, plans can be formulated to combat the epidemic through an appropriate vaccination and treatment strategy. Often, control efforts need to be implemented prior to completion of the rapid assessment. In this case, assessment of the situation should continue while a response is being organized, and flexibility should be maintained to change control policies as new information becomes available.

To develop an effective strategy for epidemic control in refugee camps, a meningitis committee should be formed to coordinate public health efforts and to delegate responsibilities among camp personnel. However, a clear line of authority is needed so that control measures can be decided upon and implemented quickly. The purposes of such a committee are (1) to gather information from different parts of the refugee population (camp sections, ethnic groups, religious groups), (2) to plot the course of the epidemic, (3) to coordinate intervention efforts, and (4) to educate the community on appropriate control measures such as vaccination and to allay unreasonable fears. The committee should also be responsible for providing the host government and relief agencies with meningitis statistics, and for ensuring the proper distribution of vaccines, medicines, and other materials. Coordinated efforts to provide the necessary drugs, personnel, and equipment must be made early since the peak of the epidemic generally occurs within the first 12 weeks of the outbreak. In general, vaccination campaigns must be implemented within the first 4 to 8 weeks to have a substantial impact on the course of the epidemic.

Surveillance during an epidemic

Surveillance efforts should be geared to monitoring the epidemic and the effectiveness of intervention strategies. Daily meningitis case counts should be maintained if available, but weekly compilation of cases will give a better indication of the epidemic trend by avoiding day-to-day fluctuations in admis-

Fig. 1. Flow of action during a meningococcal outbreak.

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Weeks 2–3</th>
<th>Weeks 3 onwards</th>
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</thead>
<tbody>
<tr>
<td><strong>Rapid assessment:</strong></td>
<td><strong>Response planning:</strong></td>
<td><strong>Containment:</strong></td>
</tr>
<tr>
<td>• Case definition</td>
<td>• Set up committee</td>
<td>• Vaccination campaign</td>
</tr>
<tr>
<td>• Laboratory confirmation of etiology (rapid latex test, culture)</td>
<td>• Strengthen surveillance</td>
<td>• Treatment (standard protocols, case-finding and follow-up visits)</td>
</tr>
<tr>
<td>• Define outbreak (person, place, time)</td>
<td>• Plan vaccination strategy</td>
<td>• Continue surveillance</td>
</tr>
<tr>
<td>• Mobilize supplies</td>
<td></td>
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</tbody>
</table>
sion rates. Construction of an epidemic curve (number of cases vs. number of days or weeks) is essential to provide a visual representation. Meningococcal disease rates should also be plotted by age category to monitor the age groups at highest risk.

During major epidemics in large urban centres, it is not uncommon to have over 100 daily meningitis admissions to central hospitals; the same situation is possible in certain large refugee camps with populations greater than 10 000. Under such circumstances, laboratory confirmation of meningitis for all cases is neither possible nor necessary. However, once an epidemic has been confirmed, presumptive clinical diagnoses of meningococcal meningitis can be made in individuals by visual inspection of CSF from lumbar punctures. Patients with characteristic symptoms and cloudy CSF should be considered to have meningococcal meningitis until proved otherwise. Even during major epidemics of meningococcal disease, some patients will have meningeal disease resulting from other common pathogens, such as H. influenzae and Streptococcus pneumoniae. If group A N. meningitidis is initially found to be responsible for the epidemic, health personnel should continue periodic latex agglutination testing, if this is feasible, to confirm the presence of group A meningococcal disease during the epidemic.

Treatment of epidemic meningococcal disease

Effective therapy for bacterial meningitis is based on knowledge of the specific pathogen. Meningitis in developing countries during non-epidemic seasons is caused by a list of pathogens that are similar to those found in industrialized countries. Therefore, empiric therapy for sporadic meningitis is strongly influenced by the age of the patient and is determined on an individual basis. During meningococcal epidemics, however, the vast majority of meningitis cases are due to meningococcus, and operational guidelines for the treatment of these patients should be established. A standardized treatment protocol and preprinted questionnaire should be developed and administered by physicians and nursing personnel. The questionnaire should include historical and clinical data as well as demographic information for surveillance purposes.

Specialized meningitis wards may be improvised to care for meningococcal patients, and shelters should be planned for the anticipated influx of new patients; however, isolation of meningitis patients for quarantine purposes is not necessary. During a recent epidemic in the non-refugee population of Ethiopia, the establishment of temporary treatment shelters near heavily affected areas undoubtedly reduced mortality and morbidity by providing greater access to treatment facilities for patients living at a distance from permanent treatment shelters. Even in refugee camps where most patients live close to health facilities, initial outpatient treatment is not recommended; makeshift observation areas should be organized where patients can be monitored for the first 48 hours after treatment is initiated. If laboratory facilities are available, treatment should not be delayed until the results of laboratory tests are known, since fulminant meningococcal meningitis can develop in about 10% of patients within hours after onset of the illness.

Although high-dose, intravenous crystalline penicillin is the drug of choice for meningococcal meningitis in industrialized countries, penicillin is often not appropriate for use in isolated areas during meningococcal epidemics. During most epidemic situations, drug shortages, logistical constraints, high admission rates, and compliance problems will require modifying the standard treatment protocol to a single-dose treatment regimen. Under these conditions, the most convenient and effective treatment schedule for adults (with dosage adjustments made for children under age 15) consists of a single intramuscular dose (6 ml) of long-acting chloramphenicol in oil suspension (Tifomycin) administered on admission (Table 1). Meningococci are extremely sensitive to chloramphenicol and symptoms of meningococcal meningitis should rapidly improve in properly treated patients within 24 to 48 hours. A controlled trial has shown similar clinical outcomes for patients treated with penicillin and single-dose chloramphenicol (19). In small children, febrile seizures are common, and acetaminophen (paracetamol) oral suspension or rectal suppositories should be administered to patients on admission. Adequate stocks of anticonvulsants should be on hand for seizure control.

Table 1: Dosage of long-acting chloramphenicol in oil during meningococcal epidemics, by age group

<table>
<thead>
<tr>
<th>Age group</th>
<th>Dose (grams)</th>
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<tbody>
<tr>
<td>≥15 years</td>
<td>3.0 (6 ml)</td>
</tr>
<tr>
<td>11-14 years</td>
<td>2.5 (5 ml)</td>
</tr>
<tr>
<td>7-10 years</td>
<td>2.0 (4 ml)</td>
</tr>
<tr>
<td>3-6 years</td>
<td>1.5 (3 ml)</td>
</tr>
<tr>
<td>1-2 years</td>
<td>1.0 (2 ml)</td>
</tr>
<tr>
<td>&lt;1 year*</td>
<td>50-100 mg/kg</td>
</tr>
</tbody>
</table>

* Avoid chloramphenicol in newborns if alternative therapy is available.
patients can be discharged from care after 48 hours. Single-dose oily chloramphenicol is not an effective agent for the treatment of *H. influenzae* or *S. pneumoniae*. If symptoms do not resolve within 24 hours, a repeat dose of chloramphenicol may be given, and other causes of the clinical illness should be sought. Under most epidemic circumstances, the routine administration of intravenous penicillin G is not recommended since it requires continuous monitoring and multiple daily doses. During a major epidemic, repeat dosing of hospitalized patients often becomes unmanageable, and maintaining adequate stocks of penicillin and intravenous fluids may be impossible. Therefore, penicillin use should be restricted mainly to urban centres where personnel and logistic limitations are not a barrier to treatment.

In addition to treatment facilities, an active case-finding system should be set up in a refugee camp. This may be carried out by trained community health workers who refer suspected patients in the camp sections to a central clinic or hospital.

**Role of chemoprophylaxis**

Close contacts of meningococcal meningitis patients are at marked increased risk of disease. In the USA, for example, household members of meningococcal meningitis patients are at 1000 times greater risk of disease than the general population (20). The risk of disease in close contacts of cases is highest in the week following onset of disease; therefore, early detection and intervention are essential for disease prevention. Vaccination of contacts is easier and cheaper than chemoprophylaxis; however, it does not eliminate carriage and will not prevent transmission to other susceptible persons (21). Organizing a programme for vaccination of contacts may be difficult, and mass vaccination is a more practical control strategy; however, if it is logistically feasible, the vaccination status of household contacts should be checked and vaccine given to unimmunized individuals. Although the vaccine requires 5–10 days to produce a maximal antibody response, studies conducted during an epidemic in the Gambia indicate that immediate vaccination of close contacts is largely effective in reducing secondary meningococcal cases (22).

Chemoprophylaxis of contacts of meningitis patients is not warranted during an epidemic and should be discouraged. Since attack rates can reach 1%, a sizeable proportion of the population can qualify as being in close contact with a meningococcal meningitis patient at some time during the epidemic. Mass prophylaxis is probably ineffective because of reinfection of asymptomatic persons (23). Also, rifampicin is relatively expensive in developing countries, prophylaxis diverts resources from higher priority health programmes, and the efficacy of rifampicin in these settings is somewhat uncertain, especially if administration of the drug is unmonitored.

Although chemoprophylaxis is generally not recommended, the following guidelines are presented for those circumstances when it is implemented. The recommended dose of rifampicin is 600 mg twice a day for 2 days in adults, 10 mg/kg twice a day for 2 days in children over one month of age, and 5 mg/kg twice a day for 2 days in neonates. It should be administered to all persons in the affected household at the same time to prevent reinfection. Patients recovering from meningococcal meningitis also should be given chemoprophylaxis since treatment with penicillin or chloramphenicol does not eliminate meningococcal carriage. Meningococci are not transmitted by casual contact or dried fomites, and since health personnel generally are not at increased risk of disease, they do not require prophylaxis unless close respiratory contact, such as mouth-to-mouth resuscitation, has occurred. Rifampicin should not be used in pregnant women. Patients should be warned that the drug will temporarily make the urine and saliva orange. Alternative regimens include ceftriaxone (250 mg in a single intramuscular injection) or ciprofloxacin (750 mg in a single oral dose); however, these two drugs are expensive and inappropriate in most settings (11, 24). Sulfonamides should not be used since widespread resistance to these compounds has occurred, and any given strain can be highly variable in the expression of resistance (25). There is concern that widespread use of rifampicin encourages drug resistance and may cause iatrogenic morbidity through adverse drug reactions.

**Vaccination during meningococcal epidemics**

Vaccination against meningococcus plays a pivotal role in the control of meningococcal meningitis epidemics. Vaccination is effective in rapidly controlling outbreaks caused by group A and C meningococci. Once an epidemic is confirmed, consideration should be given to mass vaccination of the entire at-risk population. If latex agglutination and meningococcal serogrouping results indicate that a current outbreak is due to group A or group C meningococcus, mass vaccination campaigns should be initiated.

A major consideration in the design of vaccination campaigns is vaccine availability. If vaccine stocks are inadequate for general mass vaccination campaigns, decisions must be made to focus initially on groups at highest risk of the disease. Since meningitis outbreaks tend to cluster within geographical foci, such as a particular section of a refugee camp, it may be most efficient to vaccinate those in the
involved section(s) first. When surveillance data are available, vaccination campaigns can also initially be targeted on population groups with high rates of disease. If surveillance information does not exist, vaccination strategies should be guided by knowledge gained from previous meningococcal epidemics. Meningococcal outbreaks might be expected to occur earlier and to be more intense in larger or more densely populated refugee centres, requiring vaccination in these camps first. Within camps, certain groups, such as young children attending crowded feeding centres, might be at higher risk. Mass vaccination of children and young adults aged 1–25 years generally will cover the majority of refugees at risk. Although current polysaccharide vaccines do not promote long-lasting immunity in children under 4 years of age, short-term protection can be expected in children as young as 1 year of age. At present, the vaccination of children under 1 year of age is not recommended because of the poor efficacy of the vaccine in this age group.

Rapid mass vaccination can be performed using mobile vaccination centres with teams trained to administer the vaccine and maintain statistics on vaccine distribution. Providing vaccination cards (or using cards already distributed for childhood vaccine programmes) will prevent unnecessary confusion during the campaign, and will be useful in monitoring vaccine distribution and coverage. Cold chain facilities of the national Expanded Programme on Immunization (EPI) should be used to store vaccines, which can be delivered to refugee camps in 7–10-day cold boxes. Separate cold chain stores in individual camps are rarely indicated. Freeze-dried meningococcal vaccine is available in 10-dose and 50-dose vials and should be stored between 2°C and 8°C; it should not be frozen. Dried vaccine is reconstituted by mixing with cold diluent; the dissolved vaccine should be refrigerated and used within 5 days. The dose of vaccine is 0.5 ml subcutaneously. A sterile, non-disposable syringe and needle should be used for each injection. In mass campaigns, jet injectors may be employed; to date, the transmission of a viral disease by jet injector has been reported only once, and this involved a model of injector that is not in general use outside the USA (13).

Since infected individuals can still transmit meningococci after immunization, vaccination of high-risk groups may not stop the epidemic, and efforts should be made to monitor disease rates in unvaccinated groups. Other interventions might theoretically be useful in preventing disease, such as limiting the contact between housing groups, limiting mass gatherings, and increasing the space between beds for camp inhabitants. Unfortunately, these measures may be impossible to implement and have not been proved to be clearly beneficial. Routine vaccination of refugees during non-epidemic periods is probably not effective since the duration of protection in children is short. However, if there are strong reasons to believe that a refugee population is at high risk for an epidemic (e.g., if there was an epidemic in the previous year’s meningitis season), preventive vaccination prior to the meningitis seasons may be warranted. During the 1989 epidemic of group A meningococcal meningitis in Ethiopia, all Sudanese and Somali refugees were vaccinated during the endemic season. Refugee authorities correctly assumed that the refugee population was at high risk for disease since an outbreak had occurred in Ethiopia in 1987 and since reports indicated that the importation of a new strain of group A meningococcus into the meningitis belt might give rise to a new epidemic wave. Although Ethiopia experienced a severe epidemic, with over 40,000 cases reported, very few cases were reported from refugee camps located in that country.

**Prevention of sporadic meningococcal disease**

In the absence of an epidemic, sporadic meningococcal disease may occur as isolated cases or small numbers of related cases of disease. A major concern for a public health official in a refugee camp is the differentiation between sporadic disease cases and cases arising early in an epidemic. Threshold weekly incidence rates described earlier will be useful in differentiating between sporadic and epidemic cases, and public health measures should be applied to sporadic disease contacts to prevent additional cases. In most cases, it is not possible to have laboratory confirmation of every isolated patient; however, if an etiological diagnosis is possible, several measures can be taken to prevent further spread of the disease. Vaccination of household contacts, if vaccine is available, is effective in reducing secondary transmission, as discussed earlier. If sporadic cases due to a susceptible serogroup (A,C,Y,W135) continue to occur in a defined population (such as one section of a refugee camp), expanding the vaccination facilities to cover the entire population at risk may be required. The use of chemoprophylaxis for sporadic meningococcal meningitis in developing countries is to be discouraged for the reasons already given, even though rifampicin prophylaxis is routinely used in industrialized countries.

**Prospects for the future**

Meningococcal meningitis epidemics may be predictable using simple surveillance methods. In addition, the development of newer technologies, such as clonal typing, may allow early detection of particularly virulent meningococcal strains that can be
Controlled if vaccination programmes are implemented early in the epidemic process (7). Although epidemics are often predictable, they continue to cause major problems in developing countries because of the difficulties in mounting a timely response to an impending epidemic. It is technically feasible to develop a conjugate vaccine against group A meningococcus similar to the current conjugate vaccine against *H. influenzae* type B. This might be more effective in providing long-term protection to infants and young children. If a reliable conjugate vaccine can be developed and produced cheaply, it could be incorporated into the EPI of countries at risk for epidemic meningitis. Routine administration of a conjugate group A vaccine to young children in affected areas as part of the EPI could potentially eliminate the threat of epidemics in large parts of the developing world.

**Conclusions**

Refugees are at high risk for epidemic meningitis, and refugee populations should be closely monitored for the emergence of epidemic disease. Surveillance for meningococcal meningitis and other communicable diseases is a necessary part of refugee management, and a simple, reliable surveillance system can be established in the refugee setting using a clinical case definition and data from hospital admissions. Detection of meningitis outbreaks using surveillance information will allow early control and rapid mobilization of resources. The need for widespread vaccination can be determined from meningitis surveillance information, and a formal organization of resources is required if epidemic disease is detected. Instituting standardized therapy for suspected patients will allow the most efficient use of resources and the best quality of care possible for refugees under the circumstances of the epidemic.

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**Résumé**

Surveillance des épidémies de méningite à méningocoques dans les populations de réfugiés et moyens de lutte

Les épidémies de maladies transmissibles constituent une menace directe pour les rassemblements de réfugiés ou de personnes déplacées et peuvent se traduire par une mortalité élevée et une désorganisation des services de santé essentiels. D’importantes populations de réfugiés vivent dans des régions où les maladies à méningocoques présentent une forte endémicité, et les camps qui les abritent risquent notamment de connaître des flambées de méningite à méningocoques. La surveillance de ces camps permet de détecter et de maîtriser les épidémies dès leur apparition. L’existence d’une infection à méningocoques peut être confirmée sur le terrain à l’aide de techniques simples, comme l’agglutination sur latex. Des isoléments bactériens doivent être pratiqués et envoyés à un laboratoire de référence qui précisera le sérogroupe du germe responsable et étudiera sa sensibilité aux antibiotiques. La connaissance du sérogroupe permet d’évaluer le risque d’épidémie généralisée et l’utilité des vaccins disponibles.

En cas d’épidémie, le traitement doit être standardisé et comporter de préférence un antibiotique efficace à dose unique. Des campagnes de vaccination de masse doivent être entreprises après avoir identifié aussi rapidement que possible les populations à haut risque qui doivent en bénéficier. Si le risque d’épidémie est jugé élevé, il peut être justifié de procéder à une vaccination preventive. Lorsque l’épidémie s’est déclarée, il est essentiel de pratiquer une surveillance quotidienne fondée sur une définition simple des cas de maladie, afin d’évaluer l’efficacité des mesures de lutte et de délimiter les groupes à haut risque qui doivent faire l’objet d’une vaccination ou d’une chimio prophylaxie. La plupart de ces recommandations peuvent aussi s’appliquer à d’autres populations dans les pays en développement.

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