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PATTERNS OF SMALLPOX INTRODUCTION INTO NON-ENDEMIC AREAS

by

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INTRODUCTION

The study of smallpox outbreaks in non-endemic areas is productive for two reasons: the outbreaks are usually investigated in detail; they afford opportunity to examine basic aspects of smallpox transmission. This paper deals with the subject of introduced smallpox in two parts, a definition of general principles, and examination of case histories.

BACKGROUND

Smallpox in non-endemic areas depends on importation of the disease. Until recently, such importations have occurred principally into the United States and Europe. However, with the increasing freedom from smallpox, many previously endemic countries are exposed to smallpox importation as a new and important threat.

Once imported, spread of smallpox depends on factors affecting the availability of susceptibles. If susceptibles exist, and have effective contact with the smallpox patient, spread may be expected. While smallpox patients remain in the general population capable of infecting susceptible individuals, transmission will continue. If unchecked, in a society with sufficient susceptibles, imported smallpox will eventually become "reestablished" endemic smallpox.

The epidemiological environment in non-endemic areas is generally different from that in endemic areas.

1. Health services are usually more highly developed; hospitals, medical care, and preventive medical services are generally more available (The very freedom from smallpox implies such development).

2. The sociology of sick people may differ greatly between endemic and non-endemic areas. In the industrially developed areas, people falling ill are inclined to remain at home, to seek medical care, and to be admitted to hospitals. This gives rise to a "selective pattern of contact" which is quite different from the communal contact pattern which may characterize spread in endemic areas.

3. Until recently, patterns of living have been quite different in non-endemic areas than in endemic areas. In Western Europe and the United States for instance, people live in separate dwelling units, in small, non-extended families; life is oriented to the family rather than the village. Under such circumstances, the number of effective contacts with people outside the family is much less than is the case in village-oriented societies, especially market-oriented societies. The result of these factors is that the smallpox patient in non-endemic areas is likely to have relatively few contacts outside his (a) family and (b) individuals who are responsible for his health.

It is also generally true at the present time that the immunity levels are higher in non-endemic areas as a result of the past vaccination efforts which freed them of smallpox; the availability of susceptibles is less than in most endemic areas. There are wide variations in this, however, and some presently non-endemic countries have relatively low levels of existing immunity. In most non-endemic areas, medical and public health authorities are unfamiliar with smallpox, and are disinclined to diagnose the disease clinically until the diagnosis is inescapable. Thus, there is a tendency to "miss" atypical cases, particularly of very mild disease.

The severity of the illness in the imported patient is profoundly important. In severe cases the patient is prostrated, has limited mobility, demands intense medical care, and is usually hospitalized. In mild cases, the patient retains its mobility, may not seek medical care, and has a greater potential for spreading the disease in the population at large.

These factors determine two predominant patterns of transmission of smallpox in non-endemic areas: (a) spread in hospitals, and (b) spread in families. The severity of the illness in the index case is frequently the most important factor in determining which pattern will predominate.

EPIDEMIOLOGY OF SMALLPOX TRANSMISSION IN NON-ENDEMIC AREAS

The transmission of smallpox proceeds in accordance with its basic epidemiological characteristics. Transmission of the disease will occur in generations from person to person, but the pattern will be dictated by the availability of susceptibles and the limitations of contact between the patient and his environment. The age and sex distribution of cases occurring in outbreaks in non-endemic areas will precisely reflect

the particular universe of contacts of the imported patient. Rather than the classical age distribution of patterns seen in endemic areas, the age distribution of cases in outbreaks due to importation may be skewed bizarrely to the elderly, the young, to specific age and sex sub-groups, or may inscribe a usual population distribution; the pattern depends entirely on the contact environment.

Most importantly, a concept of the "high risk group" emerges from analysis of transmission patterns of non-endemic areas. High risk groups are those individuals who, for one reason or another, are more likely than the general population to come in contact with imported smallpox. Chief among the "high risk groups" is the hospital and health worker whose chances of coming in contact with the smallpox patient are substantially greater than those of any other single segment of the population.

CHARACTERISTICS OF SMALLPOX IMPORTATION

All smallpox in non-endemic areas begins with importation of the disease from endemic areas. In 1965, Mack analyzed over 75 introductions into Western Europe and the United States during the period 1946-64 (see handout). Of these, 29 originated in India. During the period 1946 and 1950, 25 of 37 imported cases occurred in returning military personnel. During the period 1951 to 1964, a wide variety of professions were represented among those importing smallpox; the largest number, 7, were involved in technical aid or employment abroad.

A total of 47 of individuals importing smallpox were nationals of the country to which smallpox was introduced. Before 1950, the principal mode of introduction was by sea; since 1951, air transport has constituted the bulk of cases. The vast majority of importations occurred during the period December to May.

First generation indigenous cases have generally occurred at the ultimate destinations of the imported patient which were evenly divided between the port of arrival, and areas elsewhere. Data were available for 516 of the 685 indigenous cases in 30 outbreaks of variola major. More than half, 280, acquired disease by hospital exposure. No indigenous spread from imported cases occurred aboard common carriers. In short, the typical patient introducing smallpox into the non-endemic area is a business or technical traveler returning to his own country, by air, during

the period December to May, who then spreads the disease principally to hospital contacts, in his city of destination.

ILLUSTRATIVE CASE HISTORIES OF EPIDEMICS IN NON-ENDEMIC AREAS

A. United Kingdom, 1961-1962

Five importations of smallpox from Pakistan gave rise to two large epidemics with 62 indigenous cases and 25 deaths.

In Bradford, a four-year old Pakistani girl was admitted to a hospital shortly before Christmas with fever and was thoguht to have malaria. She improved on therapy, and then developed a hemorrhagic rash, and died on December 30. A post mortem examination was performed; the diagnosis was "septicemia." Two weeks later a woman and a man fell ill (almost simultaneously), were admitted to two other Bradford hospitals, and died with hemorrhagic disease. Both were thought to have died of idiopathic thrombocytopenic purpura. Post-mortem pathology specimens looked suspiciously similar. An investigation revealed that the woman was a cook at the Bradford Children's Hospital; the man had been a visitor there. Both could have had contact with the young Pakistani girl before her death. Investigation of children who had been patients on the ward revealed six that had eruptive disease. In addition, the ward nurse developed smallpox, as did the pathologist (fatally) who performed the post-mortem examination. A child patient who had been on the ward, had been transferred elsewhere, resulting in three additional cases via hospital spread.

In Wales, a young Pakistani man arrived in Cardiff, was recognized as having smallpox, hospitalized, and isolated. A young pregnant woman lived near the hospital; she traveled to visit her mother, and on February 6 in her mother's home, had onset of labor. She delivered a still-born child, was attended by her mother and a friend, subsequently hospitalized, and died despite heroic resuscitation efforts. A post-mortem examination was performed and a diagnosis of hypofibrinogenemia was made. Smallpox appeared in a child who followed the woman to the surgical operating room, and family and friends who kissed or otherwise handled her corpse at the two-day wake. A third generation of cases occurred among hospital contacts of the young boy in the second generation, and among family contacts of the dead woman. What appeared to be

the last case in the outbreak, in fact triggered a new 20-case outbreak on the ward of an old ladies domiciliary resulting in 12 deaths.

The UK experience dramatizes five aspects of non-endemic smallpox transmission: (1) the role of the hospital in smallpox transmission, (2) the role of the undiagnosed atypical case in initiating epidemics, (3) that smallpox can carry exceptionally high mortality even under conditions of optimal medical care, (4) that intimate contact is the usual mode of spread, (5) that even in non-endemic areas, smallpox is a disease of unvaccinated individuals (43 of 62 cases occurred in the totally unvaccinated persons; no case occurred in persons vaccinated within seven years).

B. Ivory Coast, 1967

A 25 year old male farmer from the village of Dimba had been in the Ivory Coast two years. He had come from Upper Volta and claimed vaccination in 1964 in Upper Volta. He was not in his village in 1965 when Ivory Coast smallpox vaccination teams visited. On January 20, he was exposed in a vehicle to a case of eruptive smallpox. On January 24, he returned to his home, and 8 to 10 days later suffered the onset of smallpox. He was admitted to a hospital in Agni Belicrou on February 4. On February 12 another Upper Voltan was admitted to the same hospital with another disease. There he contracted smallpox from the index case patient and died on March 3. Two relatives visited him and returned to the village. Both became ill and went to Goua for hospitalization. In Goua, an additional 14 cases occurred as a result.

This African example again illustrates the role of the hospital in smallpox transmission in non-endemic areas.

C. United Kingdom, 1966 (Variola Minor)

In the years since 1947, there is one outbreak which is substantially different from that presented above. This outbreak produced 73 indigenous cases of smallpox with no deaths. Illness in the initial patients was sufficiently mild that no patient was hospitalized until the fifth generation of the epidemic.

Of the cases detected, the first occurred in a photographer who spread the disease to his girlfriend and another friend working together in a drugstore. Subsequently several chains of transmission developed involving a youth club, a schoolboy picnic,

face-to-face contacts in a public house, and intrafamilial spread. Prior to discovery of the outbreak, and diagnosis of smallpox, one patient was hospitalized, giving rise to one hospital-acquired case. The basic unit of spread in this outbreak was the family with 61 of 73 patients acquiring their illness as a result from spread from another household member.

This outbreak dramatizes the role of the type of clinical illness in the initial cases. When the illness is mild and hospitalization does not occur, smallpox in non-endemic areas spreads as it does in endemic areas, that is principally in families and between social and communal groups.

SUMMARY

The spread of introduced smallpox is dependent upon several factors. The severity of the illness in the introducer plays a significant role and predetermines whether the pattern of spread will be principally via hospital contact, or family contact. Spread occurs to susceptible individuals who have close contact with the smallpox-infected patient; spread to chance contacts, when it occurs, is infrequent. The hospital plays a major and ominous role in the transmission of non-endemic smallpox, and spread of the disease, as in endemic smallpox, is principally among the unvaccinated. The experience in non-endemic areas indicates that special attention must be given to certain groups to assure high levels of immunity among them, and principal among these are hospital and health workers. There is a need for a high level of suspicion in any patient with an eruptive febrile illness to assure accurate and early diagnosis. While high levels of general immunity in a population form an effective barrier to family spread of smallpox, the greatest defense against introduced disease is a strong surveillance-containment capability.

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