Zeitschrift für Präventivmedizin *18*, 11–17 (1973) Revue de Médecine préventive

Control of Smallpox Epidemics by Surveillance[1]

E. Shafa

Smallpox Eradication, World Health Organization, Geneva, Switzland

Summary

Surveillance is the key for control of smallpox epidemics. Epidemiological characteristics of smallpox make surveillance of this disease very simple, resulting in fast interruption of transmission. To cope with a possible outbreak of smallpox in a non-endemic country, the risk of importation should be calculated. The efficacy of the reporting system has to be examined. The ability of medical facilities for prompt diagnosis, clinically and by laboratory means, should be ascertained. An epidemiological team should be established and trained in such a manner that they could follow each case and find the source of infection for every case, trace the chain of transmission and detect all other unreported cases. The team should be in a position to carry out proper containment measures immediately. Proper, separate facilities for isolation of confirmed cases, suspect cases and contacts should be arranged. Vaccine of good quality in terms of potency and stability should be available in sufficient quantity. Potency of vaccine used in the field and coverage of vulnerable groups vaccinated should be assessed regularly. Contraindications to vaccination, if any, should be established in advance to avoid conflict of opinion in an emergency situation. Important epidemiological data for each case should be collected in a simple form for further analysis. The epidemiological unit involved in surveillance activities should preferably be attached at a national level to ensure coordinated policy throughout the country.

Rapid interruption of transmission is the main objective in the control of a smallpox epidemic. This can be done effectively by promoting the surveillance system which, by definition, includes finding the source, the detection of additional unknown cases and containment of the outbreak.

By the application of surveillance techniques smallpox outbreaks have been effectively controlled in spite of low levels of population immunity.

The control of epidemics, especially by means of surveillance, is more effective in developed countries, as a single case of smallpox is considered a national emergency and the public are highly literate. The medical facilities are plentiful, reporting is generally more prompt, and as a whole the capacity of health services to detect and contain outbreaks is quite high.

The epidemiological characteristics of smallpox make the surveillance of this disease rather simple, and permit the surveillance activities to be highly effective and practicable. These are:

1. Smallpox is transmitted only from man to man and there is not, so far, any recognised animal reservoir.
2. Recognition of a case is comparatively simple as the infected person develops a distinctive rash, most dense on readily visible parts of the body.
3. In most cases visible scars notably on the face remain after the case is cured, thus the extent of the disease, the place and time can be determined.
4. Following infection, permanent immunity is acquired.
5. Subclinical infections are rare and are of little epidemiological importance since they do not appear to be able to transmit the disease to others.
6. The period of communicability is comparatively short, i.e. from appearance of the first lesions until the scabs have fallen off, a period of 3–4 weeks.
7. Transmission is mostly the result of close contact between infected and susceptible individuals and most commonly occurs in homes, hospitals, or schools. Transmission in a bus, train or plane is a rare happening.
8. Epidemics develop comparatively slowly. Normally 2–3 weeks elapse between each generation of cases. Usually an infected individual transmits the disease to no more than 2–5 other susceptible persons.
9. Smallpox does not occur as widely dispersed sporadic cases all over a country, but as concentrated pockets of infection sustained by a chain of transmission.

[1] Presented at the "Berner Kolloquium über Pockenimpfung", October 24, 1972, Berne, Switzerland.

10. Successful vaccination confers substantial protection for many years. Although the duration of protection by a single vaccination is unknown, field observations show that 85–95 per cent of all cases have no scar of vaccination.
11. Previously vaccinated smallpox cases are far less effective in transmitting the disease than those who are unvaccinated. This may be the result of fewer lesions on the skin and mucous membranes of previously vaccinated cases as compared to unvaccinated cases.
12. In endemic countries smallpox tends to occur mainly in children under 15 years of age and among those of lower socio-economic groups. This is probably because of a higher number of susceptibles in these groups. However, in developed countries where hospital transmission occurs, this age distribution may differ.
These epidemiological characteristics make the control of a smallpox epidemic much easier than for other communicable diseases.
When dealing with a smallpox emergency, consideration should be given to these epidemiological features. The following points, which constitute the surveillance of smallpox, should be noted also:

1. Importation

In non-endemic countries the major threat of a smallpox outbreak is through importation. This normally occurs when a case, in the incubation period or in a very mild form, enters the country unnoticed. This case may not be readily recognised and it is usually when the second generation of cases appear and they seek medical treatment that the diagnosis is suspected.
The possibility of widespread contacts in view of modern means of transportation is a definite threat in the event of an importation.

2. Reporting

Every effort should be made to obtain prompt reports of cases from established reporting sources, i.e. private physicians, hospitals, health centres, clinics, etc.
The more complete and accurate the report of cases, the better is the knowledge of the extent and location of the disease, and the better. The danger is the control always that a number of cases may not be reported because of misdiagnosis.
It may be necessary to examine existing reporting channels in order to see how reports may best reach local and national health authorities with maximum speed.
In case of an epidemic, all health establishments should firstly be well informed, and secondly visited to strengthen this understanding of the need for prompt, regular reporting. Other potential sources of information should also be sought.
A regular daily account of cases, distributed to all health establishments, as well as immediate news releases through existing news media, serve further to call attention to the need for prompt reporting.

3. Clinical diagnosis

Clinical diagnosis of the first case in developed countries where the disease has been absent for a long period of time may pose some problems. The general practitioner, not having seen a single case of smallpox throughout his medical education as well as his career, may find it difficult to label a suspect case as smallpox. Mainly these are mistaken for chickenpox, skin allergy to drugs, etc. Clinical diagnosis of the first case in the first days is therefore the most important problem in dealing with smallpox outbreaks. Physicians should periodically be refreshed in clinical diagnosis of smallpox. Slide series and diagnostic posters, now available through WHO, can be provided to medical schools

and hospitals to refresh their knowledge and keep them alert. However, when a few cases occur and an outbreak is recognised, the clinical diagnosis becomes easier because of heigthened awareness.
When only one case has been reported, and the diagnosis is in doubt, alle contacts should be examined as well as the individual from whom the infection was contracted. While the diagnosis of the initially reported case may be confusing, other possible cases among contacts, and particularly in the individual from whom infection was acquired, may clarify the diagnosis.

4. Laboratory diagnosis

In countries or in areas where cases occur for the first time after a long absence, specimens for laboratory diagnosis should always be collected. The laboratory diagnosis should include electron microscopic examination, culture in the chorio allantoic membrane of chick embryos and the precipitation-in-gel test. Problems in relation to the collection, handling and shipment of specimens should be borne in mind.
If, on laboratory study, variola virus is detected, the outbreak is of course, considered to be smallpox. If no virus is isolated, the question of diagnosis remains uncertain. Specimens which have been collected may have been improperly handled, or some error may have been made in the laboratory. Failure to isolate the virus on laboratory examination does not exclude the diagnosis of smallpox. All factors need to be carefully weighed before reaching a final conclusion.

5. Source of infection

A smallpox case most certainly has been in close contact with another case approximately 7—17 days before rash appears. The source of infection must be found. Failure to do so means missing other chains of transmission and a number of other cases. More than likely, this case will be found amongst other members of the household; visitors to the household during the period of 7—17 days before the rash appeared; residents of places the case visited during this time; a school, if the case is a school child; a hospital, if the case was hospitalized during this time for other reasons; chickenpox, and other unspecified skin disorders in the community, particularly those who have died.
If the source of infection is in another town or locality, this town should be visited and other cases sought. If the source of infection is outside the territory under the investigator's responsibility, the national authorities of that area should be informed promptly so that the investigation of the source may not be interrupted. If the source is outside the country, WHO should be informed immediately.

6. Chain of transmission

After finding the source of the first case, in turn, the source of infection for each previous generation of cases has to be determined. Tracing of the infection source in this manner may lead to significant outbreaks in other towns and localities, and even in other countries which otherwise would not have come to notice until much later.
A chain of transmission can be traced back over months. For non-endemic areas it is sufficient to trace back the chain of transmission to find where the original case was imported from, normally a known infected area.

7. Detection of other cases

In an area where a case is confirmed, everything possible should be done to reveal other cases if they exist. To detect these additional cases, a few places are of particular importance, e. g. the patient's house, the neighbouring area, the schools, the hospitals, the factories, etc.

Each case so detected is interviewed to determine the probable source of infection and thus find further cases.
In some vulnerable areas a house-to-house survey may be necessary to ensure that all cases have been detected.

8. Isolation of cases

Cases must be isolated immediately. This should be done in a hospital. Frequently, transmission to many additional persons patients and hospital staff has been observed. This is mainly because the first admitted case is misdiagnosed and proper isolation is not practised. Furthermore, hospital staff have been poorly vaccinated. In some instances, remote non-medical facilities have been used effectively as isolation hospitals.
If the suspect case is isolated in a hospital, all patients and staff should be vaccinated or revaccinated immediately.
The patient should be isolated in a special area/ward and not be allowed to mix with others. Visitors should be severely restricted. Special care should be taken to avoid transport of the patient from one place to another in order to decrease the possibility of virus dissemination to new areas. If the case is isolated at home, all the family should be vaccinated or revaccinated and instructed to admit no visitors. The patient must remain in isolation until every last scab has separated.
The confirmed cases should never be isolated in the same place as suspected, or undetermined cases.

9. Vaccination of household contacts

Transmission is most frequent in the home, either to family members or to other visitors. At the time that a confirmed or suspect case is noticed, all household contacts should be vaccinated. Visitors to the household during the period that the patient has had a rash should also be found and vaccinated.

10. Vaccination of other residents in the area

To prevent further spread of the disease, a barrier of protection should be built around the case by vaccinating all residents in the immediate vicinity of the case. If a little town or village is affected, the entire town should be vaccinated immediately. In a rural area, all localities within a radius of a few kilometres should be vaccinated. In large urban areas all residents of adjacent blocks should be vaccinated first.
The whole point is to give priority to the immediate surroundings, vaccinating in a ring about the case.

11. Vaccination of vulnerable groups and places

When an outbreak occurs, higher risk groups should get specific attention. While in endemic areas these are mainly children under 15 years of age in lower socio-economic groups, in developed countries they are mainly medical staff working in hospitals and perhaps those working at international ports and airports.
If cases have occurred amongst school children, all attending the school, including teachers, should be vaccinated.
If patients have been isolated in the hospital, all hospital staff and patients should be vaccinated. It has been a common experience that hospitals especially serve as a major focus for transmission of the disease.

12. Return visit to infected area

To ensure that containment activities have been effective and to detect any further cases which may have occurred, regular revisits to infected areas should be carried out. It is quite possible that a few more cases may occur, mainly amongst contacts of the known case. These may have been unsuccessfully vaccinated during the incubation period. These visits should be at least once a week for a period of about 2 months after

the last case has been detected. All subsequent cases should be recorded and isolated, contacts vaccinated, and all other containment measures implemented.

13. Handling suspect cases

In the course of an epidemic the general alertness of the public leads to all kinds of reports of rashes due to reasons other than smallpox. Although this is troublesome, it is a good sign of public awareness. Each case should be epidemiologically investigated and a diagnosis established.

Many people with any kind of rash who think they may have smallpox may be calling or visiting private practitioners. Therefore, physicians should be particularly instructed to have their staff vaccinated and if they notice a suspect case they should make sure that the patient stays at home and is not sent to another hospital or consultant. The physicians should know exactly who they should inform, and where they should call for assistance.

What should be made clear is that when in doubt, a suspect case should always be considered to be smallpox and dealt with as such.

For undetermined cases and those pending a final diagnosis, special isolation arrangements should be made so that they may not be mixed with definite smallpox cases.

14. Contacts

Handling contacts in smallpox emergencies is very important. It should be assured that all contacts are traced, interviewed, vaccinated and placed under surveillance. For tracing contacts, all resources such as hotel registers, hospital and police records and any other sources of information, should be consulted.

The vaccination status of contacts should be determined, vaccination scars examined and their households vaccinated. Contacts of an infected case should be put under surveillance for 18 days after the day of the last association with the case, or until a major reaction develops after smallpox vaccination. The contacts should be visted once a day to see if any symptoms of smallpox develop. If no symptoms appear and the daily temperature reading has not been over 38 °C, then they may be released.

Contacts who develop prodromal signs of smallpox or have fever over 38 °C for two consecutive readings should be isolated in a separate facility and not mixed with cases confirmed by the laboratory, or suspect cases pending diagnosis.

15. Vaccine and vaccination policy

Freeze-dried smallpox vaccine of high quality in terms of potency and stability should be available in sufficient quantity in case of a smallpox emergency. Vaccination technique giving the best take rate should be employed and vaccinators should be trained in advance. The bifurcated needle and multiple puncture technique are being used today in all endemic countries.

In the event of an outbreak, practically all the contacts of a smallpox case should be vaccinated or revaccinated. A policy should be established in order to avoid any conflict of opinion in regard to complications of vaccination.

Clearly, in an outbreak situation, the risk of a contact developing smallpox is greater than the risk of developing a serious complication related to vaccination. When there are logically determined contraindications, vaccinia immune globulin (VIG) can be given at the time of vaccination. The vaccination reaction should be read after 7 days. If a major reaction does not occur then revaccination should be performed.

16. Assessment of activities

Vaccination activities should be assessed in

terms of potency of vaccine as used in the field and the technique of vaccination. It is equally important to assess coverage of vulnerable groups being vaccinated. Without this assessment there can be no assurance that the measures taken are the correct ones. Shortcomings of the operation are revealed only when a systematic assessment is carried out and results are continuously analysed.

17. Recording of epidemiological data

Special forms to record data on each case, each outbreak and contacts are necessary. These forms serve to determine what has been found and what has been done. Further, the forms are useful for a final analysis of data for many other purposes.

The forms should be simple, but must contain data vital to surveillance operations. For each case, the form should include name, age, sex, address of the case, date of onset of disease, date reported, date isolated, clinical condition of case on day of investigation, outcome of case (cured or died), previous vaccination history (presence or absence of vaccinaton scar), source of infection, results of laboratory examination, methods by which the case was found, name and address and vaccination status of all contacts, and extent of containment measures taken.

18. Administration

The surveillance team undertaking the surveillance activities should be well trained to carry out its tasks efficiently. It is advisable for this team to work from a national level, ensuring necessary administrative mobility throughout the country.

While it is desirable to encourage local health officials to do everything possible in the investigation and containment of outbreaks, experience has shown that when full responsibility is left to them, the results are generally unsatisfactory. Local officials are often busy and preoccupied with other duties, some are not particularly competent in the clinical diagnosis, and few have a very clear concept of how investigation and containment activities should be carried out. Whatever is done at a local level, the special national team should also carefully investigate the outbreak to ensure that all steps have been taken correctly.

This surveillance team must be prepared to move quickly and special administrative and budgetary arrangements should be made in advance.

For each day that is lost, the probability of successful containment of an outbreak is diminished.

Zusammenfassung

Überwachung ist der Schlüssel zur Kontrolle von Pokkenepidemien. Die epidemiologischen Merkmale der Pocken erleichtern die Überwachung sehr, so daß die Übertragung rasch unterbrochen werden kann. Um einem möglichen Pockenausbruch in einem nichtendemischen Land begegnen zu können, sollte mit dem Risiko der Einschleppung eines Falles gerechnet werden. Die Wirksamkeit des Meldesystems muß überprüft werden. Die Zuverlässigkeit medizinischer Einrichtungen zur prompten Diagnose durch klinische und Laboratoriumsmethoden muß sichergestellt werden. Ein epidemiologisches Team muß zusammengestellt und so ausgebildet werden, daß es jedem Falle folgen, die Infektionsquelle jedes Falles finden, die Übertragungskette ausfindig machen und alle anderen nichtgemeldeten Fälle entdecken kann. Das Team sollte in der Lage sein, unmittelbar angemessene Kontrollmaßnahmen anzuordnen. Geeignete getrennte Einrichtungen für die Isolierung bestätigter Fälle, verdächtiger Fälle und von Kontaktpersonen sollten bereitgestellt werden. Impfstoff von guter Qualität in bezug auf Wirksamkeit und Stabilität sollte in genügender Menge zur Verfügung stehen. Die Wirksamkeit des im Felde benützten Impfstoffes und der Durchimpfungsgrad vulnerabler Gruppen sollten regelmäßig neu überprüft werden. Allfällige Kontraindikationen der Impfung sollten zum voraus festgelegt werden, um Meinungsverschiedenheiten in Notfallsituationen zu vermeiden. Wichtige epidemiologische Angaben sollten für jeden Fall auf einem einfachen Formular für

weitere Analysen gesammelt werden. Zur Sicherstellung einer einheitlichen, koordinierten nationalen Politik in diesem Gebiet ist es von Vorteil, wenn die sich mit der Pockenüberwachung befassende epidemiologische Abteilung auf nationaler Ebene errichtet wird.

Résumé

La surveillance est la clé de la lutte contre les épidémies de variole. Les caractéristiques épidémiologiques de cette maladie en simplifient beaucoup plus la surveillance, ce qui permet d'obtenir rapidement l'interruption de la transmission. Pour se prémunir contre d'éventuelles poussées épidémiques dans les pays de non-endémie, il faut compter avec le risque d'importation de cas. Il faut éprouver pour cela l'efficacité du système de notification, et s'assurer que les services médicaux sont en mesure d'établir promptement le diagnostic de la maladie, aussi bien cliniquement qu'en laboratoire. On devra mettre en place une équipe épidémiologique à qui l'on donnera la formation qui lui permettra de suivre chaque cas, de retrouver pour chaque cas l'origine de l'infection, de remonter la chaîne de la transmission et de dépister tous les autres cas non notifiés. L'équipe doit être en mesure de mettre en place dans les délais les plus brefs les mesures d'endiguement qui s'imposent. On devra prévoir des installations pour l'isolement des cas confirmés, des cas suspects et des sujets contacts. Il faudra disposer de quantités suffisantes de vaccin de bonne qualité du point de vue de l'activité et de la stabilité. L'activité du vaccin utilisé sur le terrain et la couverture des groupes vulnérables vaccinés devront être vérifiées régulièrement. Le cas échéant, les contre-indications à la vaccination devront être établies à l'avance afin d'éviter les désaccords dans les cas d'urgence. Pour chaque cas, on recueillera sous une forme simple les données épidémiologiques importantes, pour les besoins de l'analyse ultérieure. Le service épidémiologique chargé des activités de surveillance fonctionnera de préférence à l'échelon national afin que la politique adoptée puisse être coordonnée sur l'ensemble du territoire.

Address of the author:

E. Shafa, M.D., M.P.H., Medical Officer, Smallpox Eradication, World Health Organization, 1211 Geneva (Switzerland)