CANADIAN PUBLIC HEALTH JOURNAL

VOL. XXIV March, 1933 No. 3

The Vancouver Outbreak of Haemorrhagic Smallpox

I.—Epidemiological Study of the Outbreak

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FAMILIARITY breeds contempt. In Vancouver's recorded smallpox history, out of a total incidence of 2,018 cases, spread over twenty-six of the twenty-seven years, 2,009 were of the benign type. The indifference so engendered, aided and abetted by anti-vaccinationists' propaganda, resulted in a fairly widespread susceptibility of the populace to this disease. An indication of the neglect of vaccination is shown by an estimate made by the School Medical Officer that approximately one-half of the 40,000 public school pupils were unprotected by vaccination. Discovery, therefore, of three mild cases between the 8th and 15th of January, 1932, caused little uneasiness, apart from the fact that many contacts had been made, owing to the nature of the occupations of these first cases. These first cases were thought to be chickenpox. On the 17th, however, the reporting of a case of the severe confluent type, which had been associated with two of the former cases, caused anxiety which developed in a few days into consternation, on the discovery of several more mild cases and two of the haemorrhagic type. These two haemorrhagic cases were diagnosed by physicians as measles. It was realized, therefore, that there had been, by this time, thousands of possible contacts.

The spread of the disease was facilitated by:

(*a*) The large percentage of the community unprotected against smallpox by vaccination.

(*b*) The mistakes in diagnosis both by the persons affected and a few physicians, owing to unusual factors.

(*c*) The nature of the occupations of some of the cases, at large after taking ill.

(*d*) Three, four or five possible sources of origin about the same time.

(*e*) The intense communicability of the malignant type.

ORIGIN—There were five groups of cases* in all, contracted certainly from three sources, possibly from five.

Group 1

The origin of the first eight cases in time, though not in order of discovery, was from Everett, State of Washington. The first case, a woman, and those she infected were at large for six weeks before being located. Seven of the eight cases were mild.

Group 2

The source of this case was not revealed. It developed too early to have been Group 1, and too late to have caused Group 3, though it and the latter may have had a common unknown origin. It was a mild case in an unvaccinated person.

Group 3

Though there is no evidence of contact of this group with the first group, it was possible as to time, and both groups lived in about the same section of Vancouver and Burnaby. It comprised certainly 31, probably 33 cases. There were 12 deaths, all but one occurring in unvaccinated persons.

Group 4

These cases developed from a man who became ill about three days after his arrival in the city from eastern Canada. These all occurred, in time, after the first three groups were under control. There were 12 cases with four deaths.

Group 5

The case in this group arose from a woman living many miles from Vancouver, whose only possible exposure was in a visit to the state of Washington where there were cases of smallpox, but none of the haemorrhagic variety. She had never been vaccinated, and died. Her husband was vaccinated 50 years previously; he nearly died. Three children were recently vaccinated; none of them took the disease.

The groups are summarized in the following table:—

TABLE I

CASES AND DEATHS IN GROUPS

Group	Cases	Deaths
1	8	0
2	1	0
3	33	12
4	12	4
5	2	1
Totals	56	17
Case—fatality rate		30.4

*Case histories are given in the tables on pages 116-119.

TABLE Ia
CASES AND DEATHS IN GROUP 3

Group 3 cases	Cases	Deaths
Early cases and contacts.....	8	0
First fatal haemorrhagic case and contacts....	9	7
First fatal confluent case and contacts.....	16	5

All cases in Group 3 (mild and malignant) appeared to have a common source of origin, which source, however, was not proved. Before January 25th, there were eight cases; all recovered except two. Of the 21 cases resulting from exposure to these two, all were malignant except those who had been previously vaccinated; 10 died.

OCCUPATION OF PATIENTS—Some of those contracting smallpox exposed others for periods varying from one day to 2½ weeks in the case of a motorman on the railway. To mention the nature of their employment tells the seriousness of the tale:—

One woman at large for 10 days after an attack of what she called "flu".
One man operating a delivery truck for a general store.
One man operating a delivery truck for a chain store.
Two men operating milk delivery vehicles.
Two working in a box factory with 70 other employees.
One motorman on an electric railway passenger car.
One laundry worker.
One employee in a beauty parlor.
One employee on C.P.R. dock.
One manager of branch bank.
One school child in a class in which, fortunately, all were vaccinated except two.
One regimental officer interviewing serially several hundred men, and attending a regimental dance on a second evening. This case was the origin of the fourth group.

ERRORS IN DIAGNOSIS—Owing to unfamiliarity of many physicians with smallpox, especially with the haemorrhagic form, health officers are likely to have difficulties. Examples of our troubles are given here.

Influenza—Two cases were so diagnosed; one of these was the first case, who went about for 10 days after her arrival from Everett, Washington, on Christmas day. Her case was not revealed until the 6th of February by working back from two families infected by her. She repeatedly denied, here and to the health officer in Everett, having had a rash at all, until confronted in the presence of her mother. Chickenpox was the diagnosis made in eight cases. Two of these errors were made by physicians, one of whom contracted smallpox as a consequence.

Measles—Three cases. Two of these were diagnosed as haemorrhagic measles by physicians, and one as ordinary measles by a Christian Science practitioner. Measles had been epidemic. The prodromal lobster variety of rash may resemble measles very closely. Concerning the first of these cases an undertaker telephoned the medical health officer stating that a certificate of death from haemorrhagic measles had been given by a reputable physician. This was reported to our epidemiologist, who on inquiry was satisfied to allow the burial to proceed.

This was before we had had any haemorrhagic smallpox. Later, the attending physician corrected the diagnosis with the approval of our epidemiologist, at the instance of an interested insurance company, because deceased, as a conscientious objector to vaccination, had signed a waiver in case of death from smallpox. This man's whole family, except three children who had been vaccinated, died of haemorrhagic smallpox.

Myelitis and haemorrhage of the brain probably as a result of vaccination was a diagnosis of one physician in the case of a woman whom he had vaccinated some four days before she became ill. The first word the medical health officer had of this case was from a newspaper reporter who had been informed by the physician himself. He persisted in this diagnosis in spite of the opinions expressed by a nurse, a nursing-sister and the attending physician at the hospital, also a pathologist who refused to do an autopsy, as his diagnosis was smallpox. We got a permit from the coroner to hold an autopsy. No myelitis, encephalitis, nor haemorrhage of the brain was found, and the diagnosis of smallpox was corroborated. Besides, a practical nurse who attended this case contracted smallpox; in citing the contacts of the case the physician had not given her name, nor had he warned her to be vaccinated. We just happened to hear about her and vaccinated her before she became ill, but too late to avert the disease.

Cholecystitis—A woman entered the hospital under this diagnosis. On entry her husband signed a paper refusing vaccination to his wife. After a time in hospital exceeding the incubation period of smallpox, she suddenly became ill. A diagnosis of an acute exacerbation of cholecystitis led to a gall bladder operation. The illness was haemorrhagic smallpox, of which she died.

Chicken-pox—In several cases the differential diagnosis of chicken-pox or smallpox was in doubt for a few days. To settle a difference of opinion in one case as to chicken-pox, an unsuccessful vaccination was a factor in confirming the diagnosis of smallpox. One case of smallpox, apparently on information or advice given professionally that the disease had been chicken-pox, was deliberately vaccinated in order, in the event of a "take", to sue the city for damages consequent on a false diagnosis and quarantine restriction. The vaccination was unsuccessful.

These points of information are given to show the difficulties that may arise in the face of serious contagious disease, with deaths, in a community.

VACCINATION HISTORY OF PATIENTS

It is worthy of note that of a total of 56 cases, 40 had never been vaccinated before infection and 16 had been vaccinated more than 15 years before. There was not one case of smallpox in a person who had been vaccinated within 15 years.

TABLE II
VACCINATION HISTORY

Type of Disease	Vaccinated				
	Never	Over 15 years previously	Under 15 years before	After infected	Totals
Discrete					
Mild before malignant type appeared	10	2	..	..	12 } 26
Mild after malignant type appeared.	1	8	..	5	14 }
Moderate severity	..	1	..	..	1
Severe	3	.	..	2	5
Confluent	2	4	..	3	9
Haemorrhagic	12	1 (36 yrs.)	..	2	15
Total cases	28	16	..	12	56
Total deaths	16	1	..	..	17

Of the 17 who died, 16 had never been vaccinated; the 17th had been vaccinated 36 years previously. Of the cases never vaccinated, 53 per cent died. Of those cases vaccinated over 15 years before, 1 out of 16 died, or 6 per cent.

DOES VACCINATION PROTECT AGAINST SMALLPOX?

Everyone actively connected with this epidemic does not think, but knows, that vaccination is an absolute necessity as a protection. This experience in Vancouver, summarized in Table II, leaves no doubt whatever of the efficacy of vaccination. Some striking demonstrations of its value are shown in the following examples:—

1. Family S.—Conscientious objectors to vaccination—father, his brother, wife, three children and the fiancé of one of the girls, never vaccinated—all contracted smallpox and died—seven persons. Three other children, vaccinated in school some years before, did not even take the disease, though all lived in the same house.

2. Family D.—Three children unvaccinated contracted smallpox—father and mother, vaccinated, did not.

3. Unvaccinated child in school class; all in the class vaccinated but two; no further cases.

4. Family in the country—the mother, never vaccinated, contracted smallpox and died, after exposing her husband and three children. Her husband, said to have been vaccinated 50 years before, contracted the disease and nearly died. The three children were vaccinated, and did not take smallpox.

5. Man, at mining camp, exposed in Vancouver, vaccinated as a child, contracted smallpox and recovered. His wife contracted it from him. She had never been vaccinated and died. Another woman contact who had been vaccinated as a child contracted the disease in a mild form.

6. Father, mother and 2 children equally exposed—father and one child, never vaccinated, contracted smallpox; mother and other child, vaccinated, escaped.

7. The whole hospital staff was re-vaccinated. Not one contracted smallpox.

CONTROL MEASURES

Reporting—Pressure was brought to bear on all to report any rashes or illness of any doubtful nature to the health department.

Quarantine.—Rigid isolation of all cases at home or in hospital was practised, as was strict quarantine of contacts, except, in the latter, when proof was produced of recent vaccination.

Vaccination.—All contacts who were found or traced out were vaccinated. A wide vaccination campaign was carried out. Vaccine was supplied to all physicians, who vaccinated about 50,000 persons. The health department advertised, supplied all vaccine free, operated school clinics where 10,901 were vaccinated in four days, and conducted public clinics daily, where 6,600 were vaccinated. The department vaccinated, also, about 2,000 contacts and all city employees. In all, between 90,000 and 100,000 persons in the province were vaccinated.

Publicity—Half-page advertisements, urging vaccination, were inserted on two occasions in the three daily papers, which were also kept informed of the situation daily. The advertising was done jointly by the Greater Vancouver Health League and the city health department.

Port Authorities and other bodies, domestic and foreign and consuls, were kept informed of the situation. The U.S. Consular Service was daily advised that the outbreak was under control. There was consequently no interference with the port, or with the border traffic.

Anti-vaccinationist propaganda.—This consisted of:

(*a*) Printed dodgers distributed on the street containing anti-vaccination statements extending to the most weird and fantastic.

(*b*) Press articles and paid anti-vaccinationist advertisements. Some of these requested those who had had any trouble with their vaccination to report to their office. No material was forthcoming.

(*c*) Public meetings of protest against vaccination.

(*d*) Public debate at which two public health officers took part. The city medical health officer refused the invitation, holding that it was not a debatable question. In lieu of this, he issued an invitation for vaccination objectors, who were not vaccinated, to visit the smallpox wards with him, and inside of two weeks they would know whether or not vaccination protected against smallpox. There were *no takers* of this offer.

MILD AND MALIGNANT FORMS OF SMALLPOX

Since the question as to whether the mild form ever develops into the malignant has given rise to much dispute, only facts will be noted here in order to put medical officers of health on their guard, so that they will not look complacently upon the mild form, feeling that the malignant type is very far away and that it will probably give ample warning of its approach.

Such an attitude is based on the hypothesis that the virus of malignant smallpox causes always malignant smallpox, except in a vaccinated person, who, if he is not wholly protected, is partially so, and the disease in him will be milder; if, however, he passes it on to an unvaccinated person, the type will run true to form and be malignant; on the other hand, according to this hypothesis, the virus of mild smallpox passed from one to another remains of the mild type, whether in vaccinated or unvaccinated persons.

The natural reaction to this is to look with more or less condescension on the mild form. This may and does tend towards laxity on the part of public health officials, and to neglect of vaccination on the part of the public.

In Vancouver, of the 5 groups, Nos. 1 and 2 contained only mild cases. Groups 4 and 5 conform to the hypothesis so far as our cases are concerned, namely, all were malignant save and except in those previously vaccinated. The cases of group 3 were all of the same social set, who had freely intermingled, and would appear to have had a common source. If the original case was an overlooked mild case in a vaccinated person who had been exposed to a malignant type abroad, what should have happened and what did happen may be shown thus:—

Serial No.	Date of onset	State as to vaccination	Type of case to be expected	Actual result	Actual: Expected
4	Jan. 8	Never	Malignant	Mild	At variance
5	" 8	Years ago	Mild	Mild	As expected
6	" 12	Never	Malignant	Confluent Died	As expected
8	" 12	Never	Malignant	Haemorrhagic Died	As expected
10	" 16	Years ago	Mild	Confluent Recovered	At variance

Of the five, three held true, two did not.

To us, this is evidence that the hypothesis is not supported by the sequence of events in the third group. To support this hypothesis one would have to suppose that someone, previously vaccinated but not completely protected, was, say, in Shanghai during a smallpox outbreak in November, that he was exposed there, contracted the infection and immediately shipped for Vancouver, that the incubation period was prolonged to outlast the voyage and terminal inspection, that the disease

developed after arrival in Vancouver, that the attack was mild, that he escaped observation, that he infected others in the southeast suburban part of Vancouver, that they developed the disease in both mild and malignant forms in both vaccinated and unvaccinated persons (at variance with the hypothesis); and that someone in Mexico repeated the same performance, happening only to infect vaccinated persons in Washington (as a matter of report, chiefly unvaccinated persons developed the disease there, and all cases were mild); and, similarly, the infection travelled from Mexico to eastern Canada, that there a mild case in a formerly vaccinated person infected a vaccinated person heading for Vancouver, that again the same thing happened to the woman living outside Vancouver, going to Washington; so that from at least three points, perhaps five, these sources of infection all happened to head for Vancouver. This taxes one's credulity, and if the hypothesis that like invariably breeds like, in reference to mild and malignant smallpox, be accepted, the experience of other places at other times must be similarly dismissed, and recent observations of laboratory workers developing occasionally mild viruses into malignant must be set aside. From the trying experience in Vancouver, it seems but fair for us to conclude that malignant smallpox can arise from the mild type. It is admittedly difficult to get the complete information under all circumstances, but certainly the facts as we have them in Vancouver support that hypothesis more readily than they support the former hypothesis.

Under these considerations it will be well for the medical officer of health, even if he believes that malignant can only develop from malignant, to treat a case, an outbreak or an epidemic of the mild form of smallpox as seriously as if it were of the malignant type.

II.—Lessons Learned from the Outbreak

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(1) Malignant smallpox is a horrible, filthy disease, foul-smelling, painful and excessively infectious, with two-thirds of the cases resulting fatally and gross disfigurement of those who survive. There were fifteen haemorrhagic cases and every case resulted fatally—mortality, 100 per cent; of the confluent cases, 11 per cent died. Of the confluent and haemorrhagic cases together, 66.7 per cent died.

(2) The communicability of the haemorrhagic type is so very great that it is difficult to prevent its spread. By absolutely rigid technique, however, haemorrhagic smallpox can be safely cared for in the same hospital building with other patients without its spread. Isolation of all those in attendance, together, of course, with the vaccination of all patients and members of the staff, is essential. The following notice was sent to the medical superintendent of the hospital:

"From this time until further notice, no unvaccinated person will be admitted to the hospital for treatment, except in dire necessity."

(3) *Indifference to smallpox.*—"There is little chance of my getting smallpox, and, if I do, it does not amount to much, anyway." This expresses the attitude of many citizens. Vancouver's twenty-six years' recorded experience of mild smallpox was no guarantee that the malignant type might not at any time appear. There is sufficient evidence from this experience and from laboratory experiments in other maladies to justify being on guard against the appearance of the malignant type in the presence of mild cases.

(4) Except in those vaccinated, malignant smallpox always produces the malignant type. This held true in this outbreak.

(5) The hypothesis, "once mild in the unvaccinated, always mild in transmission", appears to require further consideration in the light of our experience, though any conditions causing such changes are unknown. One outbreak of smallpox in a community may have more than one source. We had three definitely, possibly five—one from eastern Canada and two or more from the United States.

(6) *Indifference to vaccination.*—"Vaccination is a nuisance for which there is no need." "It will be time enough, should severe smallpox appear." According to some authorities, "vaccination is dangerous", and, according to others, "it will not prevent the disease". This latter attitude was strengthened by the occurrence of post-vaccinal nervous disease in Belgium, Great Britain and elsewhere. Anti-vaccinationists are very active in Vancouver. They are responsible for quite a section of the community being unvaccinated. Further, some health officials had recommended everyone to be vaccinated, but felt that objectors could be neglected on the ground that if smallpox came, it would be of the mild type and would not kill. As a result, a large percentage of the community was insufficiently protected against the disease. Widespread vaccination of the community, approaching 100 per cent, is the only safeguard from smallpox of whatever type. It is essential thereafter to vaccinate all children under one year of age, revaccinating before leaving school. In the presence of an epidemic, as a minimum provision, vaccination of all contacts and all who have not been vaccinated within fifteen years is essential. Those whose occupation brings special exposure—namely, physicians, nurses, undertakers, hairdressers, laundry workers, hospital employees, etc.—should be vaccinated from time to time.

In the presence of deaths, the old universal dread of smallpox revives, making vaccination much easier of accomplishment. Public meetings, with lantern slides and photographs of actual cases, were very effective in securing the public's assistance in the control of the outbreak. Large corporations and employers of labour rendered very

great assistance in the vaccination campaign. Vaccination clinics held in all the schools were open to everyone. Public clinics were held in the afternoons and evenings and mass clinics in large public and industrial establishments. The Press is of the greatest value in a campaign for vaccination.

(7) Smallpox vaccine, giving no untoward results after being used in from ninety to one hundred thousand people, needs no other testimony as to its purity and strength. Except for an early emergency, it was supplied by the Connaught Laboratories.

(8) Vaccination is the only effective means for the control of smallpox. There was not one case of smallpox in a person who had been vaccinated within fifteen years. Of the 17 who died, 16 had never been vaccinated, while the 17th had been vaccinated thirty-six years previous. Of the cases never vaccinated, 53 per cent died. Of the cases vaccinated over fifteen years before, one out of 16 died.

(9) The reporting of all diseases with rash and all illnesses of a doubtful nature is essential. The Department must be astute and diligent in finding and following with vaccination or quarantine all contacts of cases.

(10) Difficulties in diagnosis are real. The first haemorrhagic smallpox death was recorded as heamorrhagic measles. The next and indirect report was a death suspected to be from smallpox but proved, on investigation, to be from measles. The third case of smallpox had an initial diagnosis of measles, which was epidemic at the time.

(11) *Treatment*

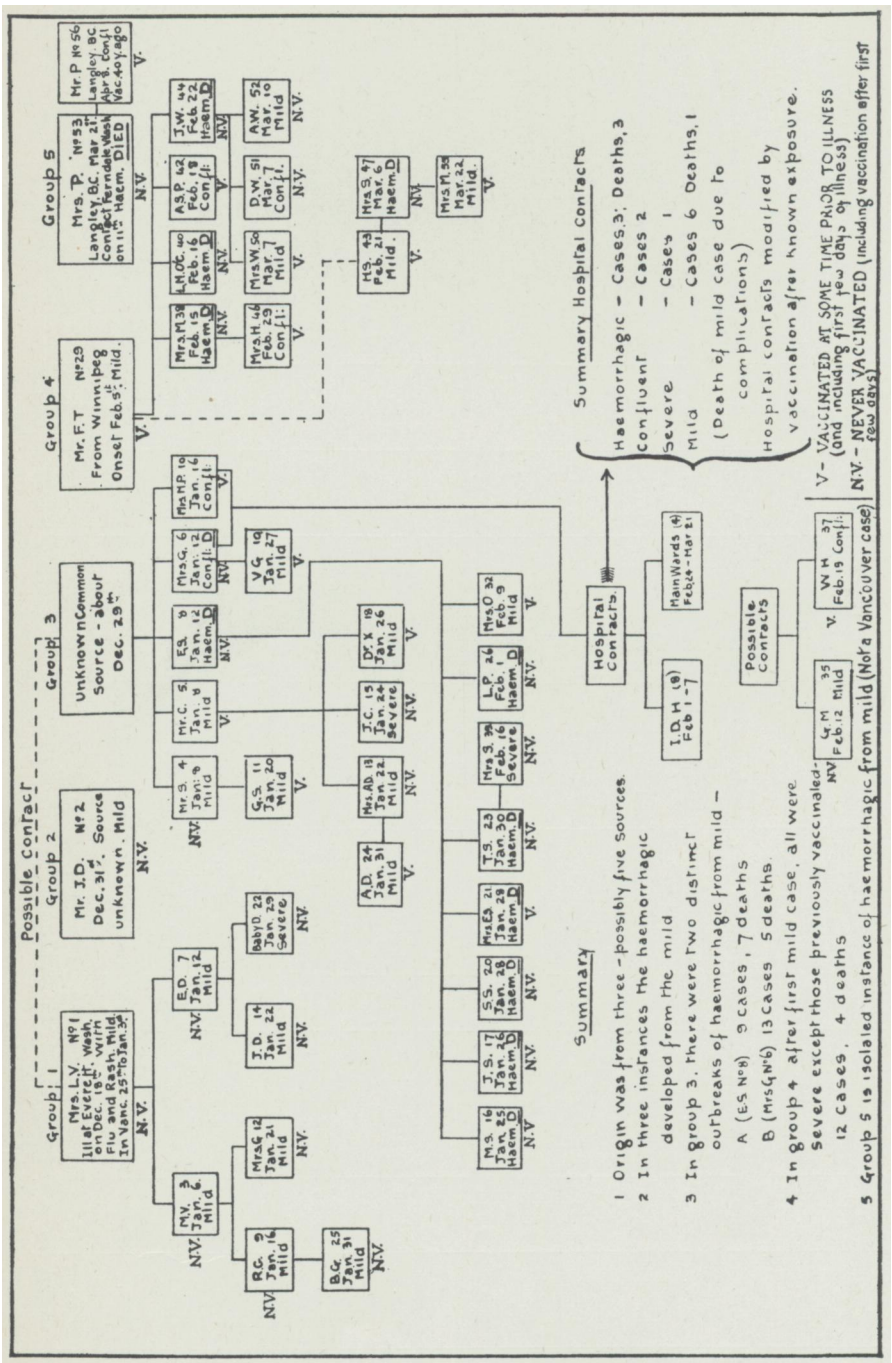
(*a*) Vaccination of all contacts. Some vaccinated after exposure to the malignant type contracted a milder form of the disease.

(*b*) Human convalescent blood was used in two cases. It appeared to have a pronounced beneficial effect in one case that in all probability would have died. Its late use in a second case did not prevent a fatal result. We feel that the treatment is worth further trial.

(*c*) An apparently hopeless confluent case recovered. Treatment by dipping into a tepid bichloride bath, after the appearance of pustules, was certainly considered a factor in his recovery, by reducing the toxaemia and producing a feeling of comfort.

(12) *Financial.*—The cost of the outbreak, in addition to hospital outlay and additional help for the public clinics, was confined to providing the vaccine for all, the doctors making their own charge privately for treatment.

In the experience of some other cities afflicted with an epidemic of haemorrhagic smallpox, the greatest cost has been the enormous losses incident to more or less complete closure from outside points. For Vancouver this meant the closure of the port and a ban on travel across the United States border. This was averted by keeping the foreign consuls and port authorities constantly informed, showing that the situation was in hand.



EPIDEMIOLOGICAL CHART, VANCOUVER EPIDEMIC

SMALLPOX—VANCOUVER—1832

CASES IN ORDER OF ONSET

No.	Initials	Sex and Age	Occupation	Onset	Source	Diagnosis	Vaccination	Type	Outcome	Remarks
1	L.V.	F. 31	Housewife	Dec. 16	Everett, Wash., U.S.A.	Influenza. No Dr.	Never	D.(M.)	R.	Ill in Everett; Vancouver Dec. 25 with rash, at brother's many contacts; returned Jan. 3 to Everett. Rep. Feb. 6.
2	J.D.	M. 21	Clerk	Dec. 31	Untraced	Smallpox by Dr.	Never	D. (M.)	R.	Only time out of Vancouver, Dec. 21 to Burnaby Hall. Rash Jan. 4, rep. Jan. 8.
3	M.V.	F. 6	School	Jan. 6	Daughter No. 1 Contact Dec. 25	Varicella	Never	D. (M.)	R.	With uncle (No. 9); rash Jan. 11. Rep. Feb. 6.
4	S.	M. 32	Delivery Dept. Store	Jan. 8	Uncertain; with man from U.S.A.	Varicella by Dr.	Never	D. (M.)	R.	Friend of No. 5; had same possible contact Dec. 28. Rep. Jan. 15.
5	C.	M. 35	Delivery Milk Co.	Jan. 8	Ditto	Ditto	In youth in War	D. (M.)	R.	Friend of No. 4; had same possible contact.
6	G.	F. 37	Laundry worker	Jan. 12	Friend No. 4 and No. 5	Smallpox by	Never Objector	C.	D.	In laundry till 13th; close friend of No. 9 and family; 1st malignant type. Rep. Jan. 17.
*7	E.D.	F. 10	School	Jan. 12	Aunt No. 1	Varicella No Dr.	Never	D. (M.)	R.	Visited grandmother (No. 12) while aunt (No. 1) was there; returned Burnaby Jan. 3. Father and mother vaccinated, did not get smallpox; brother and sister did. Rash 12th
8	E.S.	M. 39	Printer Box Co.	Jan. 12	Close friend Nos. 5 and 6	Haem. measles by Dr.	Never	H.	D.	Dr. gave death certificate of measles Jan. 19, later changed diagnosis to smallpox. First Sutherland death—7 of family died. Rep. Jan. 26.
9	B.G.	M. 16	Delivery Chain Store	Jan. 16	Brother No. 1 Uncle No. 3	Varicella No. Dr.	Never	D. (M.)	R.	On delivery job while infective. Rash on 8th. Rep. Feb. 6.
10	M.P.	F. 49	Beauty parlor parlor	Jan. 16	Friend No. 5 Common source	Smallpox by Dr.	48 years ago & 41 years ago	C.	R.	Conf. on face. Rep. Jan. 20.
11	G.S.	F. 7	School	Jan. 20	Father No. 4	Ditto	Never till after infection	D. (M.)	R.	
12	G.	F. 48	Housewife	Jan. 21	Niece No. 3	Varicella No Dr.	Never	D. (M.)	R.	Rash Jan. 24. Rep. Feb. 6.
13	A.D.	F. 26	Housewife	Jan. 22	Contact No. 5	Smallpox by Dr.	Never	D. (M.)	R.	Rep. Jan. 26.
.14	J.D.	M. 8	School	Jan. 22	Sister No. 7	Varicella No Dr.	Never	D. (M.)	R.	

Type..... D.—discrete (mild, medium, severe)
C.—confluent
H.—haemorrhagic.

R.—recovered
D.—Died.

No.	Initials	Sex and Age	Occupation	Onset	Source	Diagnosis	Vaccination	Type	Outcome	Remarks
15	J.C.	M. 6	School	Jan. 24	Father No. 5	Smallpox by	Never till 7 dys. after contact	(D. (S.)	R.	Rep. Jan. 28.
16	M.S.	F. 7	School	Jan. 25	Father No. 8	Haemorrhagic measles by Dr. Consult. Smallpox	Never; Mother objector	H.	D.	2nd Sutherland death—whole family died except three vaccinated children who did not contract smallpox. Rep. Jan. 28.
17	I.S.	F. 9	School	Jan. 26	Father No. 8	Smallpox	Never	H.	D.	Conf. with intra-pockal haemorrhages. 3rd Sutherland death. Rep. Jan. 28.
18	'X'	M. 45	Physician	Jan. 26	Attended No. 5 and No. 15	Flu, then smallpox	Childhood	D.(M.)	R.	Contact of No. 5 on Jan. 15; unsuccessful vaccination 1909. Rep. Jan. 29.
19	V.G.	F. 12	School	Jan. 27	Mother No. 6	Smallpox	Never till mother taken to hospital	D. (M.)	R.	Vaccinated 15 days before onset; mother never vaccinated, died. Rep. Feb. 1.
20	S.S.	F. 4	At home	Jan. 28	Father No. 8	Smallpox	Never	H.	D.	On Feb. 7 intra-pockal haem., conf. 4th Sutherland death. Rash Jan. 30.
21	E.S.	F. 37	Housewife	Jan. 28	Husband No. 8	Smallpox	36 yrs. ago	H.	D.	On Feb. 7 intra-pockal haem., conf. 5th Sutherland death. Objector to vacc.
*22	D.	F. 1	At home	Jan. 29	Sister No. 7	Smallpox by Dr. Feb. 4	Never	D. (S.)	R.	3rd of family; early cases now revealed to Health Dept. Rep. Feb. 4.
23	T.S.	M. 34	Foreman Box Co.	Jan. 30	Brother No. 8	Smallpox	Never; obj.	H.	D.	6th Sutherland death; while ill exposed 70 employees. Rep. Feb. 3.
24	A.D.	M. 29	Driver milk wagon	Jan. 31	Same as wife	Smallpox	Years ago and on wife's entry hosp.	D. (M.)	R.	Rep. Feb. 3.
25	B.G.	M. 29	Motorman	Jan. 31	Brother No. 9	Varicella No Dr.	Never	D. (M.)	R.	At work with rash. Rep. Feb. 6.
26	L.P.	M. 21	Unemployed	Feb. 1	Sutherlands	Smallpox	Never	H.	D.	Fiance Sutherland girl; death No. 7. Conf. with intrapock. haem. Rep. Feb. 4.
27	B.B.	F. 3	At home	Feb. 1	Inf. in hosp.	Smallpox	Never	C.	R.	Isolation Dept. Hospital No. 1; a few intra-pock haem., immune blood injections used.
28	J.R.	M. 51	Carpenter	Feb.	Inf. in hospital	Smallpox	Childhood and revaccinated	D. (M.)	R.	I.D.H. No. 2; discharged from hosp. Re-vaccinated Feb. 6; rep. Feb. 6.
29	F.T.	M. 42	Manager	Feb. 5	Winnipeg	Smallpox by Dr.—late	Childhood	D. (M.)	R.	Three or 4 days after arrival in Vancouver. Exposed 72nd regiment and many others. Rep. Feb. 10.
30	G.A.	M. 40	Electrician	Feb. 7	Inf. in hospital	Smallpox	Never; obj.	H.	D.	I.D.H. No. 3. Conf. with intra-pockal haem. Left hospital, under observation. Rep. Feb. 11.

No.	Initials	Sex and Age	Occupation	Onset	Source	Diagnosis	Vaccination	Type	Outcome	Remarks
31	K.D.	M. 7	School	Feb. 9	Inf. in hospital	Smallpox	Never; obj.	D. (S.)	R.	I.D.H. No. 4, under observation after hosp. Not vaccinated after possible infection on advice family Dr. Rep. Feb. 14.
*32	O.	F. 65	Nurse	Feb. 9	At Sutherland's till Jan. 29	Smallpox by Dr.	Childhood and after contact	D. (M.)	R.	Grandmother Sutherland children. Nursed them. Vacc. Jan. 29 and went home to Burnaby. Ill Feb. 9. Rep. Feb. 12.
33	A.M.	F. 9	School	Feb. 10	Inf. in hospital	Smallpox	Never till after infection	D. (S.)	R.	I.D.H. No. 5. Onset at home under obsertion.
34	I.F.	M. 6	School	Feb. 10	Ditto	Smallpox	Ditto	H.	D.	I.D.H. No. 6. Had measles and T.B. hip. Immune blood given.
35	G.M.	M. 12	School	Feb. 12	Uncertain	Smallpox	Never	D. (M.)	R.	Lived near hospital. In school on 12th; one of only 3 unvaccinated in class. Rep. Feb. 18.
36	R.C.	M. 7	School	Feb. 13	Infected in hospital	Smallpox	Never till after infection; success	D. (M.)	R.	I.D.H. No. 7 modified by vacc.
37	W. H	M. 20	Engineer	Feb. 15	Probably I.D.H.	Smallpox	20 years ago	C.	R.	Visitor to Isolation Hospital two weeks before onset. Said case of smallpox admitted while he was there. Rep. Feb. 19.
38	P.M.	F. 29	Housewife	Feb. 15	Probably No. 29	Vaccination causing myelitis by Dr. See note	Never. Refused then done 10 days after infected	H.	D.	At. St. Paul's Hospital, Feb. 19. Because of Dr.'s diagnosis, Health Dept. had coroner order autopsy—diagnosis smallpox, on nerve system involvement. Rep. Feb. 21.
39	T.S.	F. 25	Housewife	Feb. 16	Husband, No. 23, who died	Smallpox	Never till after contact, no take	D. (S.)	R.	In quar. since Feb. 3 (date of vaccination). Not rep. to Health Dept. till Feb. 20, four days after onset. Only Sutherland who recovered.
40	L.M.O.'C.	M. 29	Clark	Feb. 16	Probably indirect from No. 29	Smallpox	Never	H.	D.	On Feb. 29th. Many contacts on C.P.R. docks. Vaccinated. Played in orchestra at military ball (72nd contact .No. 29). Rep. Feb. 21.
41	Wong	M. 3	At home	Feb. 18	Inf. in hospital	Smallpox held in doubt	Never till infected	D. (M.)	D. other affection	I.D.H. No. 8. Diagnosis delayed. Had measles and broncho-pneumonia; smallpox a mild complication.
42	A.S.P.	M. 37	Mgr. Bank	Feb. 18	Probably No. 29 Indirect with No. 38	Smallpox	Childhood	C.	R. Very ill	Many bank contacts. Unsuccessful vaccination 1917 and 1920. Rep. Feb. 22.
†43	H.S.	M. 36	Miner	Feb. 21	In Vancouver Feb. 5-10	Smallpox by Dr.	During war	D. (M.)	R.	Probably indirect with No. 29.
44	J.C.W.	M. 10	School	Feb. 22	Friends No. 38 Indirect to No. 29	Measles by Christian Scientist	Never	H.	D.	On March 5. Rest of family exposed. See below. Mother C.S. objector to vaccination. Child had symptoms six days before rash. Rep. Feb. 29.

No.	Initials	Sex and Age	Occupation	Onset	Source	Diagnosis	Vaccination	Type	Outcome	Remarks
45	A.S.	F. 64	Housewife	Feb. 24	Inf. in hospital	Smallpox; held as varicella suspect	60 years ago	D. (Med.)	R.	Vaccination test for diagnosis from varicella, no take. Source possibly cross-infection from I.D.H. V.G.H. No. 1. Diagnosis deferred.
46	F.H.	F. 49	Practical nurse	Feb. 29	Nursed No. 38	Smallpox by Health Dept.	45 years ago and after infection	C.	R.	Was not warned by No. 38 Dr. or nurse to be vaccinated. Dept. not informed of contact. Vacc. and quar. until onset, then taken to hosp. unconscious from hysteria. Some small intra-pock haem. Rep. Mar. 1.
*47	H.S.	F. 34	Housewife	Mar. 6	Husband at Brittania	Smallpox by Dr.	Never till five days after exposure.	H.	D.	Vaccinated 9 days before outbreak. No take. Died March 17.
48	R.C.	M. 40	Logger	Mar. 6	Inf. in hospital	Smallpox	In army 1915 and after infected	D. (Med.)	R.	Probably indirect infection from No. 45. V.G.H. No. 2. Vaccination successful.
49	F.D.	M. 28	Unemployed	Mar. 7	Ditto	Smallpox	Never till after infected; obj.	C.	R.	Nearly died. Probably indirect infection from No. 45 at same time as No. 48. V.G.H. No. 3.
50	A.H.W	F. 39	Housewife	Mar. 7	Son No. 44	Smallpox	30 years ago and after contact	D. (M.)	R.	Vaccinated 11 days after infection though C.S. objector. Held in quar. after removal of son to hospital. Husband vaccinated and revaccinated. O.K. Rep. March 12.
51	D.W.	F. 14	School	Mar. 7	Brother No. 44	Smallpox	Never till after infected; successful	C.S.	R.	Vaccinated 11 days after infection; nearly died; some small haem. in some vesicles. Rep. March 12.
58	A.W.	F. 7	School	Mar. 10	Brother No. 44	Smallpox	Never till after infected; good take	D. (Med.)	R.	Vaccinated 8 days after infection. Mild. March 12.
†53	P.	F. 53	Housewife	Mar. 21	Wash., U.S.A.	Smallpox by Dr.	Never	H.	D.	Possible contact in Washington State on March 6. Unsuccessful vaccination as child; all contacts vaccinated except No. No. 56. Seemingly a further instance of mild developing into malignant.
54	S.	F. 30	Housewufe	Mar. 21	Inf. in hospital	Smallpox	Never	H.	D.	Vaccination refused by husband in writing on entry to hospital. Gall bladder operation day of onset of smallpox. V.G.H. No. 4. Had psoriasis.
55	M.	F. 52	Housewife	Mar. 22	Probably indirect from No. 43 and No. 47	Smallpox. No Dr. till April 2	52 years ago and 1 week before onset	D. (Med.)	R.	Went to Britannia to bring down body of No. 47 on March 18. Son was down about time of her infection. Son vaccinated, probably indirect infection.
†56	P.	M. 58	Farmer	Apr. 8	Wife No. 53	Smallpox by Dr.	40 years ago. Refused revaccination	C.	R.	Intra-pock. haem. When wife took smallpox, husband refused vaccination; 3 children were vaccinated. Husband took smallpox, others did not. Very seriously ill.

*Burnaby. .Britannia Mines. †Langley.

III.—Clinical Notes

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The disease was very virulent. Fifty-six cases occurred, with seventeen deaths—a case fatality rate of 30 per 100. All ages were represented—the youngest, one year, and the oldest, sixty-five years. Male and female patients were equal in numbers: twenty-eight of each. Forty were unvaccinated, while sixteen had been vaccinated at some time previous to exposure. Of those previously vaccinated, however, not one had been successfully vaccinated within seventeen years. Several were vaccinated after known exposure, but those vaccinated later than four days after such exposure were not fully protected and in a considerable number a typical vaccination and the development of the smallpox rash proceeded simultaneously, without apparent modification.

Incubation Period

It was possible, in the majority, to determine the incubation period, and without exception in all the severe cases, it was ten to eleven days.

The prodromal symptoms showed great uniformity and, in order of frequency, were: fever, headache, backache, nausea, chills, anorexia, insomnia. Fever at the onset ranged from 100°F. to 104°F., subsiding as the rash developed, except in the haemorrhagic cases. Headache was usually severe and backache was more uniformly present in this than in previous epidemics. The severity or otherwise of the prodromes was no criterion of the subsequent symptoms, except in haemorrhagic cases, in which, without exception, the prodromal symptoms were very severe. The prodomal period was usually 2 to 2½ days, the rash appearing on the third day.

Clinical Types

All types were represented, and may be classified as follows:—

1. Varioloid (modified by vaccination)	13 cases	
2. Discrete (mild and severe)	18 cases	
		1 death
3. Confluent	10 cases	
		1 death
4. Haemorrhagic (pustular and purpuric)	15 cases	
		15 deaths

The outstanding features of each of these types are presented in the short clinical histories as follows:

Varioloid (Modified Smallpox)

Case 18—male, age 45, vaccinated in childhood, diagnosed first as

"flu". Prodromes were stormy: fever, intense backache, headache severe necessitating morphia; urine showing albumin 4, and casts. Symptoms subsided on appearance of the rash, though insomnia persisted. The rash consisted of a few discrete spots of normal distribution but rapid evolution. Patient recovered fully in 10 days.

Case 55—female, age 52, vaccinated 30 years previously. Contracted smallpox from her son, who died of the haemorrhagic form. Prodromal symptoms were mild, and rash consisted of about two dozen papules distributed on face, upper chest and forearms. Recovery was prompt and complete.

The husband had been vaccinated in childhood, and was the only one in this family of five to escape the disease.

Discrete (Mild and Severe)

Case 13—female, age 26, never vaccinated. Prodromes were headache, gastric distress and fever—diagnosed as "flu". On the third day the rash appeared on the face, then on the neck and chest, forearms and palms. The papules were discrete and fairly numerous. Her course was quite uneventful, and recovery was complete, with no marking.

While convalescing this patient acted as donor for blood given to another patient reported in this series.

A young son, who had been successfully vaccinated one year previously, escaped; but her husband, who had not been vaccinated since boyhood, contracted the disease.

Confluent

Case 27—female, age 3, unvaccinated. Prodromal symptoms were very mild, and a doctor was called because of the appearance of a rash. When admitted to the hospital the child had a temperature of 105°F.; there were many small, hard papules on the face, forehead, arms, legs and upper back. Those on the face, in a few days, became confluent and the patient very ill. Twenty cc. of whole blood from a convalescing patient was injected subcutaneously four days after admission. This little girl had a very stormy time but recovered, though her convalescence was prolonged by a troublesome series of boils. It is our impression that the injection of blood from a convalescent in this case was an important factor in the recovery.

Case 49—male, age 28, unvaccinated; objector. Prodromes were fever, backache, nausea and abdominal cramps. Rash appeared on the third day. It was profuse and by the seventh day had become confluent on the face, hands and feet. There were occasional haemorrhages into the pocks. This patient was literally covered with pocks, was intensely toxic and delirious, requiring restraint. The odour was extremely offensive, the patient being bathed in pus from the constant rupture of pustules, and the condition was so terrible that a bichloride

bath was given by lowering him on a sheet into a tub after the fashion of the typhoid bath of some years ago. The cleansing and stimulating effect of this procedure was so marked that it was repeated at intervals, and the patient, after a protracted convalescence, made a good recovery.

Haemorrhagic

(*a*) Haemorrhagica pustulosa

Case 21—female, age 37. Said to have been vaccinated 35 years previously; no mark visible. The prodromes—headache, fever, sweating—were severe, and two days later a profuse papular rash made its appearance. The evolution was rapid, and the patient presented in the hospital a truly terrible picture. There was much involvement of the pharynx, oesophagus and trachea, feeding or even swallowing being most difficult, and after a few days impossible. Haemorrhages occurred into the pocks and between them. The rash was fully developed and, on the face, completely confluent. The patient was conscious until a few hours before death, which occurred on the tenth day.

(*b*) Haemorrhagica purpurica (Lobster)

Case 23—male, age 34. When admitted to hospital, temperature was 102°F. The face was swollen and covered by an erysipelatous rash extending down over the shoulders, arms and chest. Numerous petechial spots were noted on the forearms and in the axillae, and a macular rash covered the extremities and body. The mouth and lips were swollen and dirty, and there was much difficulty in swallowing. The rash never developed beyond the papular stage. The patient died on the third day after admission.

Case 54—female, age 30, unvaccinated. Was admitted to the hospital for gall stones and submitted to an operation. For two days following the operation she had a temperature, nausea and headache, which were regarded as post-operative. On the third day a diffuse erythematous rash appeared on the face and neck. The face was described as red, leathery and infiltrated. She was immediately removed to isolation because of the suggestive resemblance to previous haemorrhagic smallpox cases. Numerous papules appeared on the upper chest, back and arms, and later haemorrhagic areas developed over the whole body, involving particularly lesions of psoriasis from which the patient suffered. The patient died four days after appearance of the rash.