

# Outbreak of Hong Kong Influenza in Milwaukee, Winter of 1968-69

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**E**PIDEMIC INFLUENZA in a large urban population is of great public health concern. Practically all levels of human activity are affected, and the urban community may for a short period be seriously disabled. The heavy absenteeism and morbidity which are characteristic of epidemic influenza can drain vital community resources, both public and private. Major medical facilities rapidly become overloaded. The efficiency of fire, police, and health department services are seriously impaired. Educational activities are interrupted or halted completely. Our report is an account of a major epidemic of influenza which occurred in Milwaukee, Wis., during the winter of 1968-69.

The first cases of Hong Kong virus infections in the United States were reported in a civilian population in California during late October 1968. Influenza was reported at the same time in New Jersey, Colorado, Utah, and Illinois. By mid-December it was evident that the entire country was experiencing a major outbreak (1, 2), with 47 of 50 States reporting either spo-

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radic or widespread disease. For the nation as a whole, the epidemic peaked during the week ending January 11, 1969. There were no reported outbreaks of Hong Kong influenza after early February.

Metropolitan Milwaukee has a population of about 776,000, and the county's population is 1,121,940. The area has 28 major hospitals with 7,049 beds. Of 281 schools, 231 are elementary grade schools, 17 junior high schools, and 33 high schools. The area has a broad base of economic activity, but mainly manufactures heavy machinery of all types and electronic products.

By early November, it was apparent that a major epidemic of Hong Kong influenza was imminent. We therefore decided to distribute a questionnaire among 637 employees of the health department and their families to obtain information on attack rates among children and adults, the duration and characteristics of the epidemic curve, and the overall protective effect of current influenza immunization programs. We expected that this study would provide data which could be used to assess the overall impact of the epidemic on the community.

## Materials, Methods, and Procedures

*Description of the study group.* The study group consisted of 637 members of the health department and their families. The city was arbitrarily divided into five areas, and the percentage distribution of persons in the study among these areas was compared with that of

the 1960 population. There were no great differences except in the so-called "inner core" area. Only 5.9 percent of the study group were residents of this area, compared with 23.5 percent of the general population.

*Survey for influenza.* Each member of the health department was instructed on three occasions to submit information covering specific periods—October 1–December 16, 1968, December 17–30, 1968, and December 31, 1968–January 13, 1969. Questionnaires were sent to the supervisors of each bureau for distribution on December 16 and 30 and January 13. Each employee was requested to give his family address and the following information for each household member: name, age, sex, number of days ill with symptoms of influenza, number of days confined to the home with these symptoms, and any influenzalike symptoms present. The choices of symptoms were fever, cough, headache, general aches and pains, and chills. This information was punched on index cards for computer processing.

In the first period, 437 families (69 percent), comprising 1,352 persons, participated in the study; in the second period, 398 families (63 percent), comprising 1,262 persons; and in the last period, 452 families (71 percent), comprising 1,374 persons.

*Serologic and immunization studies.* On October 17 and 18, 1968, the immunization clinic of the City of Milwaukee Health Department offered a polyvalent influenza vaccine for those employees who were providing essential community services. The vaccine, obtained from the National Drug Company, Philadelphia, Pa., consisted of 100 units of type A influenza virus, 100 of A prime, 200 of type A2, and 200 of type B. On December 13, 1968, a limited supply of specific Hong Kong influenza vaccine, obtained from the Parke Davis Company, was offered to the same selected group.

During the week of February 16–22, 1969, (week 8 of the year), about 100 postepidemic blood samples were collected from the employees of the study group. The persons from whom the samples were collected were chosen without knowledge of their responses on the questionnaire. Blood specimens were obtained by venipuncture and tested for hemagglutination-inhibiting (HI) antibodies to the Hong Kong

strain of influenza virus by the microtiter method of Sever (3). The antigen used, designated as A2 Hong Kong 8-68, was obtained from the National Communicable Disease Center, Atlanta, Ga., in the fall of 1968. Upon receipt, the virus stock was passaged once through the chorioallantoic cavity of 10-day-old chick embryos. Individual fluids were tested for hemagglutination of human "O" cells, and fluids of high titer were pooled and used as the stock antigen in the hemagglutination-inhibition test.

Nonspecific serum inhibitors were removed by treatment with a pellet of dry ice added to a 1:10 serum dilution in distilled water (4). The precipitate was removed by centrifugation and the salt concentration restored by adding an appropriate amount of 8.5 percent NaCl. The HI titer was expressed as the reciprocal of the highest serum dilution that completely prevented agglutination of "O" cells by 4 hemagglutinating units of virus.

The HI titers were analyzed according to the employee's previous vaccination status and the severity of his clinical illness.

*Parameters of epidemic disease.* Data on the number of excess deaths and the number of deaths caused by influenza were obtained from the vital statistics division of the health department. A twice monthly record of absenteeism in the study group was obtained from the payroll division. Absenteeism is reported as the percentage of time, in hours, taken off from work because of illness by the 489 employees in this group.

Data on confirmed viral infections among hospitalized patients were obtained from the virus division of the bureau of laboratories. Confirmed infections were those in which paired serum specimens gave at least a fourfold rise in complement-fixation or HI antibody titers. Blood samples of hospitalized patients are routinely tested for serologic evidence of infection by influenza, parainfluenza, herpes-virus, adenovirus, and Eaton agent. This diagnostic service is widely used by the medical profession in the Milwaukee area, and the results are believed to afford a reliable basis for estimating respiratory viral disease in the community (5).

The data on admissions to Milwaukee County General Hospital were obtained from Health

Service Data of Wisconsin, Inc., an organization which provides summary data to member hospitals primarily for reviews of hospital use. This hospital was chosen for study because it is widely used by many segments of the metropolitan population, is the second largest hospital in the county (826 beds), and has excellent emergency care services.

### Results

*Epidemic curve.* The epidemic curve of Hong Kong influenza in Milwaukee during the winter of 1968-69 (see chart) was reconstructed from three sources of data: (a) the records of absenteeism among health department employees (table 1); (b) the data on laboratory-confirmed cases of influenza in hospitalized patients, by week of hospital admission (table 2); and (c) the following data on patients admitted to Milwaukee County General Hospital from September 1968 through January 1969 with a primary diagnosis of influenza, pneumonia, or both, by week of admission:

7-day period (ordinal week)	Number of patients
Sept. 1-7, 1968 (36th)-----	13
Sept. 8-14, 1968 (37th)-----	8
Sept. 15-21, 1968 (38th)-----	8
Sept. 22-28, 1968 (39th)-----	11
Sept. 29-Oct. 5, 1968 (40th)-----	14
Oct. 6-12, 1968 (41st)-----	23
Oct. 13-19, 1968 (42d)-----	17
Oct. 20-26, 1968 (43d)-----	19
Oct. 27-Nov. 2, 1968 (44th)-----	14
Nov. 3-9, 1968 (45th)-----	17
Nov. 10-16, 1968 (46th)-----	13
Nov. 17-23, 1968 (47th)-----	12
Nov. 24-30, 1968 (48th)-----	15
Dec. 1-7, 1968 (49th)-----	19
Dec. 8-14, 1968 (50th)-----	30
Dec. 15-21, 1968 (51st)-----	35
Dec. 22-28, 1968 (52d)-----	19
Dec. 29-Jan. 4, 1969 (1st)-----	15
Jan. 5-11, 1969 (2d)-----	11
Jan. 12-18, 1969 (3d)-----	12
Jan. 19-25, 1969 (4th)-----	12
Jan. 26-31, 1969 (5th)-----	10

The peak period for all three sets of data fell within the 14-day interval December 11-25 (between weeks 50 and 52 of 1968). The epidemic lasted 8 weeks, beginning about November 10 (week 46 of 1968) and ending about January 11 (week 2 of 1969). Symptoms of influenza, however, were sporadically reported during a pre-epidemic period of 5 to 6 weeks. This pre-epidemic period went back at least to

**Table 1. Absenteeism among 489 employees of Milwaukee, Wis., health department, September 29, 1968-February 15, 1969**

2-week period (ordinal weeks)	Em- ployees absent	Total working hours	Hours absent	Percent of working hours absent
Sept. 29-Oct. 12, 1968 (40th-41st)	88	39, 120	1, 040	2. 7
Oct. 13-26, 1968 (42d-43d)-----	94	39, 120	983	2. 5
Oct. 27-Nov. 9, 1968 (44th- 45th)-----	88	39, 120	1, 068	2. 8
Nov. 10-23, 1968 (46th-47th)---	100	39, 120	1, 367	3. 5
Nov. 24-Dec. 7, 1968 (48th- 49th)-----	90	31, 296	1, 347	4. 3
Dec. 8-21, 1968 (50th-51st)---	146	39, 120	2, 813	7. 2
Dec. 22, 1968- Jan. 4, 1969 (52d-1st)-----	74	23, 472	1, 177	5. 0
Jan. 5-18, 1969 (2d-3d)-----	113	39, 120	1, 546	4. 0
Jan. 19-Feb. 1, 1969 (4th-5th)-	86	39, 120	1, 367	3. 5
Feb. 2-15, 1969 (6th-7th)-----	105	39, 120	1, 317	3. 4

the 7-day interval of October 6-12, the week in which the first case was serologically confirmed (table 2 and chart).

Other agents causing respiratory illnesses in the community were also active (table 2), although these agents exerted at most only a minor effect on the course of the influenza epidemic. For example, of 126 cases of respiratory illness among hospitalized patients throughout the city during the epidemic period, 105 (84 percent) were serologically confirmed as Hong Kong influenza, 10 (8 percent) as herpes-virus infections, nine (7 percent) as Eaton agent infections, and two (1 percent) as adenovirus infections.

The data on excess mortality indicated that the number of deaths during the months of September through November 1968 was about normal when compared with the same period during 1966 and 1967. During weeks 49-1 of 1968-1969, there were 152 excess deaths; in January (weeks 2-5 of 1969), there were 103; by February, the number had again dropped to a normal level.

*Criteria for infection.* Six major symptoms of acute epidemic influenza are fever, headache,

generalized aches and pains, marked prostration, and chills, with cough present in the latter part of the illness (6). These symptoms, of course, might be associated with other severe acute respiratory infections. During the res-

**Table 2. Number of serologically confirmed viral infections in hospitalized patients, by week of hospital admission and kind of infection, September 1, 1968-March 1, 1969**

7-day period (ordinal week)	Hong Kong influenza	Herpes- virus	Adeno- virus	Eaton agent
Sept. 1-7, 1968 (36th)-----	0	0	0	0
Sept. 8-14, 1968 (37th)-----	0	0	0	0
Sept. 15-21, 1968 (38th)-----	0	0	1	0
Sept. 22-28, 1968 (39th)-----	0	1	0	1
Sept. 29-Oct. 5, 1968 (40th)----	0	0	0	1
Oct. 6-12, 1968 (41st)-----	1	0	0	0
Oct. 13-19, 1968 (42d)-----	0	0	0	0
Oct. 20-26, 1968 (43d)-----	0	0	0	0
Oct. 27-Nov. 2, 1968 (44th)----	0	0	0	0
Nov. 3-9, 1968 (45th)-----	1	0	0	2
Nov. 10-16, 1968 (46th)-----	0	0	0	0
Nov. 17-23, 1968 (47th)-----	1	0	0	0
Nov. 24-30, 1968 (48th)-----	7	2	1	0
Dec. 1-7, 1968 (49th)-----	14	1	0	1
Dec. 8-14, 1968 (50th)-----	16	1	0	0
Dec. 15-21, 1968 (51st)-----	17	0	0	0
Dec. 22-28, 1968 (52d)-----	24	1	0	0
Dec. 29, 1968- Jan. 4, 1969 (1st)-----	16	1	0	1
Jan. 5-11, 1969 (2d)-----	6	1	0	2
Jan. 12-18, 1969 (3d)-----	2	0	0	0
Jan. 19-25, 1969 (4th)-----	0	1	0	0
Jan. 26-Feb. 1, 1969 (5th)-----	0	1	0	1
Feb. 2-8, 1969 (6th)-----	0	0	0	0
Feb. 9-15, 1969 (7th)-----	0	0	0	0
Total-----	105	10	2	9

NOTE: A fourfold rise in titer occurred between blood samples drawn in the acute and convalescent stages of the infection.

piratory disease epidemic in Milwaukee, however, so few infections were caused by adenoviruses and parainfluenza viruses that they were an insignificant factor in the great number of clinical illnesses observed (table 2). Furthermore, infections caused by these viruses can be ruled out on epidemiologic grounds alone. Infections caused by the adenoviruses are observed occasionally in the community, but they are sporadic and isolated. Acute respiratory disease caused by the adenoviruses occurs primarily among military recruits. Parainfluenza virus infections, primarily diseases of children, have been known to cause explosive epidemics in closed populations, such as children in orphanages. In open populations, these infections are more often sporadic (6).

A significant number of herpes-virus infections (10 of 126) were diagnosed among hospitalized patients. Such infections are often present in the community during severe epidemics of influenza. These infections, however, can be dismissed from the clinical spectrum of the epidemic because they do not cause acute respiratory disease. Of 11 patients hospitalized during 1963-68 with herpes virus infections, eight had fever and only one had a cough; the other symptoms of influenza were absent.

The large group of coryzaviruses can be dismissed since these illnesses are usually mild, afebrile, and self-limiting (6). On the other hand, Eaton agent disease is practically indistinguishable clinically from influenza. Sartwell (6) has reported that Eaton agent infections do not spread rapidly through a susceptible population, are uncommon in persons under 17 years of age, and occur more uniformly throughout the year in contrast to the well-defined epidemics of influenza. Nevertheless, some of the illnesses observed during this epidemic were probably caused by the Eaton agent (table 2).

In short, epidemic influenza with fever, headache, generalized aches and pains, prostration, chills, and cough is the only known disease which spreads rapidly through a community in a relatively short period, attacks all age groups with rates as high as 70 percent, causes heavy morbidity and absenteeism, and typically is associated with an excess number of deaths, usually after complications arise related to bacterial

respiratory disease (6). The epidemiologic character of the 1968-69 epidemic was entirely consistent with this description.

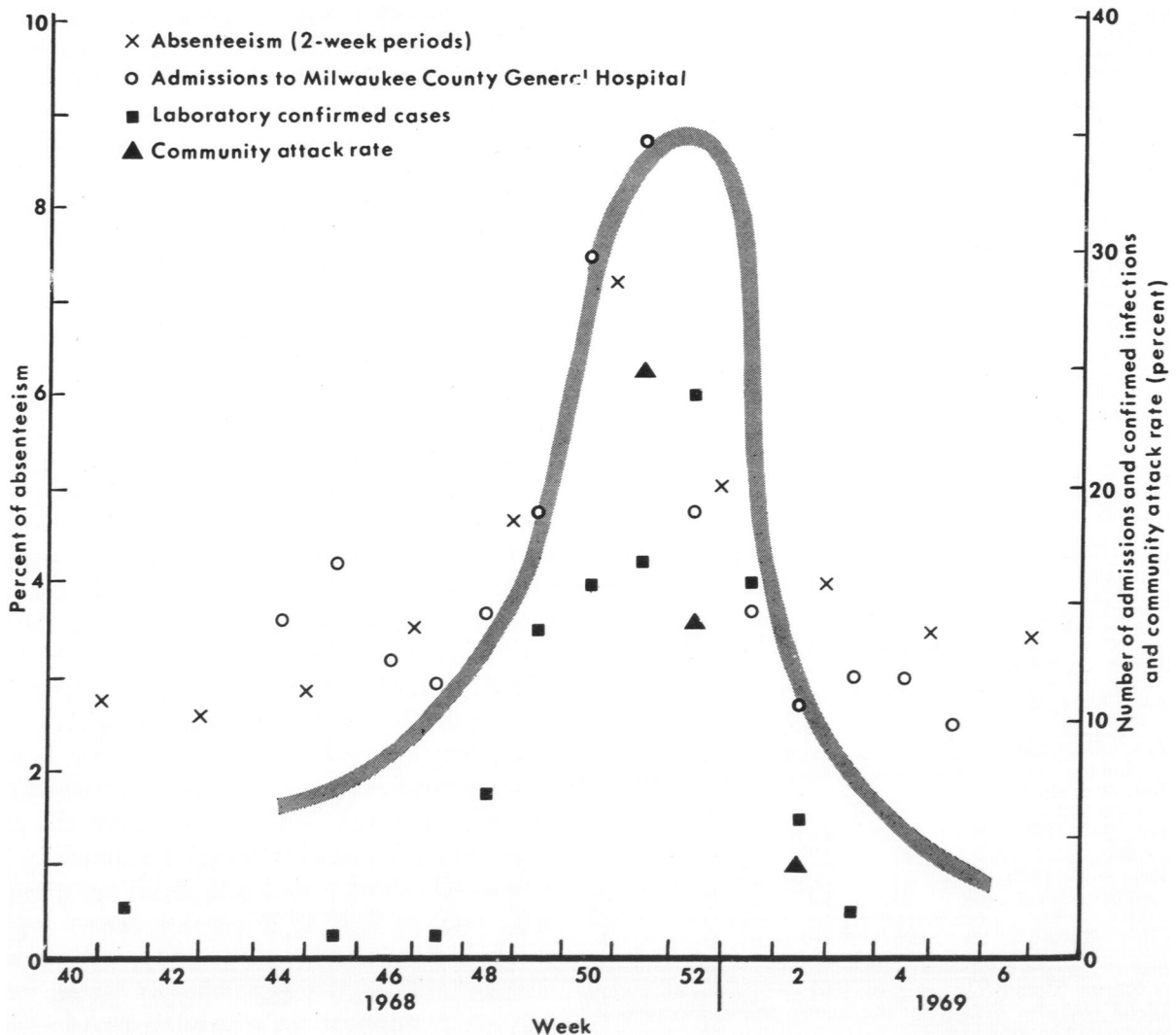
Early in the planning of the study, we decided that an influenza case would be defined in terms of symptoms associated with specific Hong Kong virus antibodies and of absence from work because of illness. We ruled out a specific serologic diagnosis as impractical since paired blood specimens would be required from each person in our large study group. The statistical analysis for this part of the study was therefore done on a sample of 108 employees drawn from the main study group.

A postepidemic blood specimen was drawn from each of these 108 persons during early

February 1969 and tested for HI antibodies to Hong Kong virus. Since most of these employees had previously completed several questionnaires covering the period October 1-January 13 in regard to any influenzalike illnesses and any absences from work, we examined the relationship between single postepidemic Hong Kong virus antibody titers and the employee's previous symptomatology. The choices of symptoms in the questionnaire had been cough, fever, headache, generalized aches and pains, and chills. We believed that a person who had clinical influenza would report most, if not all, of these symptoms.

In table 3, the distribution of the HI titers and of absenteeism for members of this sub-

### Hong Kong influenza epidemic, Milwaukee, Wis., 1968-69



**Table 3. Distribution of the 85 employees with complete clinical histories, by hemagglutination-inhibiting antibody titers and immunization status**

Reciprocal of highest dilution of serum with demonstrable HI antibody	Received Hong Kong vaccine December 1968	Received 1967 vaccine fall of 1968	No influenza immunization in 1968
Less than 10-----	0	0	1
10-----	0	7	9
20-----	1	5	5
40-----	1	12	6
80-----	2	3	5
160-----	1	2	6
320-----	1	2	6
640-----	3	1	2
More than 640-----	1	0	3
Total-----	10	32	43
Employees absent from work during study period:			
Number-----	1	16	24
Percent-----	10	50	56

NOTE: Only employees returning questionnaires for all three periods were examined.

sample who had completed questionnaires for all three periods are shown according to their immunization status as determined by a review of their records at the health department clinic. The data indicate that 24 (56 percent) of those who had not been immunized against influenza in 1968 were absent from work during the study period. Twenty-two (92 percent) of these 24

employees experienced three or more of the five listed symptoms, whereas only one of the 19 (5 percent) without absences experienced as many as three symptoms ( $P < 0.001$ ). In this group of nonimmunized persons, an examination of absenteeism in relation to HI titer by chi-square analysis indicated that absenteeism was significantly associated ( $P < 0.05$ ) with having a HI titer of 80 or over during the period of study. Of those 15 nonvaccinated persons with HI titers of 1:80 or greater who had three or more symptoms, 14 (93 percent) reported cough, 14 (93 percent) generalized aches and pains, 13 (86 percent) fever, 11 (73 percent) headache, and 10 (68 percent) chills.

Subsequent analysis of the attack rates for the health department employees and their families was based on a definition of influenza as any combination of three of the five symptoms listed in the questionnaire.

*Attack rates for all ages.* The overall influenza attack rates for the study group for each reporting period are given by age and sex in table 4. At the bottom of the table, the attack rates for all ages are shown. These data were averaged and corrected for those few instances in which persons reported influenza for more than one period. The corrected attack rates for all ages in the study group for each period were 25, 14, and 4 percent. These percentages are plotted in the chart to permit comparison with the epidemic curve which was constructed with data from other sources.

The attack rates for the study group based on

**Table 4. Persons with influenza in families of health department employees, by age group and sex for each study period, October 1, 1968-January 13, 1969**

Age group (years)	Males						Females					
	Oct. 1- Dec. 16		Dec. 17-30		Dec. 31- Jan. 13		Oct. 1- Dec. 16		Dec. 17-30		Dec. 31- Jan. 13	
	Num- ber	Per- cent	Num- ber	Per- cent	Num- ber	Per- cent	Num- ber	Per- cent	Num- ber	Per- cent	Num- ber	Per- cent
0-5-----	10	22	5	15	3	5	7	10	6	10	3	4
6-12-----	15	20	9	14	3	4	20	22	14	19	1	1
13-20-----	27	27	16	17	2	2	31	30	14	13	9	7
21-40-----	38	24	35	25	11	7	69	30	47	22	14	6
41-60-----	47	28	29	18	12	7	57	26	51	25	29	14
61 or over-----	7	16	2	5	3	7	9	16	10	19	8	15
All ages-----	144	25	96	18	34	6	193	25	142	20	64	8
Total population--	582		535		586		767		721		784	

the clinical criteria for influenza established earlier agree satisfactorily with the prominent features of the epidemic curve. The decrease in attack rates during the study period was associated with a decrease in epidemic activity, as evidenced in fewer hospitalized patients and in less absenteeism among health department employees. Unfortunately, the first questionnaire was unknowingly sent out during the peak of the epidemic. We had originally planned to use the questionnaire period October 1–December 16 to obtain baseline data on influenza during a nonepidemic period. Nevertheless, the 25 percent attack rate for the first study period was arbitrarily chosen to coincide with the peak activity of the epidemic.

Summing the attack rates for the three periods, 43 percent of the health department study group developed clinical influenza. Since there is no reason to doubt that this group represents an adequate sample of the community as a whole, an enormous amount of clinical disease was present in the community during the relatively short period of 8 weeks.

We estimated that less than 1 percent of the study group received Hong Kong influenza vaccine. As we show later, the Hong Kong vaccine produced some protection during the epidemic, but the Asian 67 polyvalent vaccine did not. Therefore, the attack rate of 43 percent for the community as a whole appears to be a reliable estimate of clinical disease.

*Attack rates in families with influenza.* When families of two or more persons in which at least one member had influenza were examined (table 5), the overall attack rates were somewhat higher than those reported in table 4, since families without the disease were excluded. When all ages were examined, there was

**Table 5. Persons with influenza in families of health department employees having at least one case and consisting of two or more persons, by age group and sex, October 1, 1968–January 13, 1969**

Age group (years)	Males		Females	
	Number	Percent	Number	Percent
0–5	15	44	10	24
6–12	23	46	29	41
13–20	37	47	43	48
21–40	70	65	100	61
41–60	75	59	65	55
61 or over	11	41	20	51
All ages	231	54	267	51

no difference in attack rates by sex. Some marked differences were observed, however, when the group was stratified according to age. The attack rates for males were highest in the middle years (21–60) and about the same at the two ends. In females the highest rates occurred in the same age group as in the males, but in the group 0–5 years of age, the rate in females (24 percent) was about half that in males (44 percent). Overall, the attack rates in all age groups were uniformly high, ranging from 41–65 percent.

*Protective effect of immunization.* The immunization clinic of the health department offered a polyvalent 67 A2 vaccine in October and the single antigen Hong Kong vaccine on December 13 (week 50 of 1968). Those employees with a complete clinical history for the study period were examined according to their previous immunization status. Their immunization histories were obtained from the files of the immunization clinic. In table 6, the number

**Table 6. Number of influenza symptoms in 417 employees of the health department, by immunization status in respect to 1968 polyvalent vaccine**

Influenza vaccination status	Number of employees	No symptoms		1–2 symptoms		3 or more symptoms	
		Number	Percent	Number	Percent	Number	Percent
No vaccinations	251	74	29.4	36	14.3	141	56.3
1968 polyvalent vaccine in October	133	34	25.5	23	17.3	76	57.2
Hong Kong influenza vaccine December 13, with or without 1968 polyvalent vaccine	33	16	48.5	6	18.2	11	33.3

of symptoms observed is related to the employee's previous vaccination history. Among those receiving no vaccine, the proportion who had influenza was 56.3 percent; among those receiving the A2 polyvalent 67 vaccine in October, the proportion was 57.2 percent. Thus, vaccine given in October apparently did not protect against the Hong Kong type of influenza.

The percentage of persons with influenza in this group (56-57 percent) agrees reasonably well with the high attack rates in the 21-60 year age group seen in table 5 (55-65 percent). This age group consisted mostly of health department employees.

Of 33 persons given the Hong Kong vaccine in December, either alone or after receiving the A2 polyvalent 67 vaccine in October, 11 (33.3 percent) subsequently developed influenza. This proportion represents about a 40 percent decrease in the disease compared with the controls. A chi-square analysis of these data show that this result is significant at a level of  $P < 0.01$ .

*Antibody titers and immunization status.* Eighty-seven postepidemic blood samples were tested (table 7). Persons who had received Hong Kong vaccinations were excluded. The mean antibody titer of persons not receiving influenza immunizations during 1968 and of those receiving only the 67 polyvalent vaccine in October was determined according to their clinical histories; the differences were analyzed by means of the *t* test for small sample sizes. The means are given as logs to the base 10<sup>1</sup>;

the probability levels (obtained from a *t* table) are given below table 7.

In the nonimmunized groups (a and b), there was a significant difference in the means of antibody titers between those with and without influenza ( $P < 0.01$ ). In the immunized groups the difference was not significant ( $P > 0.10$  but  $< 0.50$ ). When the mean antibody titers of well persons were compared, (a versus c), there was no significant difference ( $P < 0.10$  but  $> 0.05$ ). In a comparison of mean antibody titers between persons with influenza, (b versus d), again there was a significant difference according to vaccination status ( $P < 0.02$ ).

Of nine persons receiving Hong Kong vaccine in this group, none contracted clinical influenza; their individual titers were: one—1:20, one—1:40, two—1:80, one—1:320, three—1:640, and one—1:1280.

Overall, these results suggest that immunization with heterologous 67 polyvalent vaccine in October reduced the Hong Kong antibody response in those persons who subsequently developed clinical influenza during the outbreak.

#### Discussion

During the 8-week period November 10, 1968, to January 11, 1969, about 43 percent of the city's 776,000 residents were clinically ill with epidemic influenza, type Hong Kong 1968. This epidemic severely affected the community in many activities, as the almost daily reports of

**Table 7. Postepidemic Hong Kong hemagglutination-inhibiting antibody titers of 87 health department employees, with and without influenza, by immunization status in respect to 1967 polyvalent influenza vaccine**

Item	Nonimmunized employees		Immunized employees	
	0-2 symptoms a	3 or more symptoms b	0-2 symptoms c	3 or more symptoms d
Number of employees.....	25	26	18	18
Log <sub>10</sub> mean HI titer.....	1. 187	1. 647	1. 409	1. 292
Standard deviation <sup>1</sup> .....	0. 4009	9. 4664	9. 4119	0. 3956

<sup>1</sup> Obtained from the following *t* table:

<i>Analysis of pairs</i>	<i>t value</i>	<i>Degree of freedom</i>	<i>Probability</i>
a versus b.....	3. 7114	49	$P < 0. 01$
c versus d.....	0. 8432	34	$0. 10 < P < 0. 50$
a versus c.....	1. 7237	41	$0. 05 < P < 0. 10$
b versus d.....	2. 6510	42	$P < 0. 02$



the *Milwaukee Journal* and the *Milwaukee Sentinel* indicate. Following are some of the headings of such newspaper reports with the dates on which they appeared:

- December 4, "Hong Kong Flu Diagnosed Here"
- December 13, "Hong Kong Flu Sweeps Milwaukee"
- December 13, "Hong Kong Flu Epidemic Here; More Expected"
- December 16, "Flu's Absenteeism Still Plagues City; City Health Department Not Spared"
- December 17, "Flu Bug Continues Work Force Raids"
- December 19, "Priorities on Flu Calls Started by Physicians"
- December 20, "Hospitals Ask Help in Flu Epidemic"
- December 27, "9 Here Killed by Flu and 23 by Pneumonia"
- January 2, "Hospital Ban Stays to January 15"
- January 3, "Worst of the Flu Epidemic Appears To Be Over Here"
- January 15, "Visitor Ban at Hospitals Ends Here"

Absenteeism in general was high, up to 50 percent in adult groups. During December 1968, many schools were closed. Supplies of antibiotics and other drugs ran alarmingly low, and the resources of the health, police, and fire departments were greatly strained. Hospital services were seriously reduced, and in some hospitals emergency care facilities were temporarily closed.

Laboratory tests conducted in world influenza centers (7, 8) indicated a major antigenic drift in recently isolated Hong Kong influenza viruses. These isolates were characterized as A2 influenza viruses because of their low level of cross-reactions with A2 prototype hyperimmune serums. From our data, it is apparent that for all practical purposes the Hong Kong virus of

1968-69 represented a new strain of A2 influenza virus for which there was little or no previous immunity. The overall attack rate for all ages in the study group was 43 percent.

Carey and associates (9), in a retrospective questionnaire type of analysis of an influenza outbreak in the school children of a Louisiana rural community during August 1957, obtained a subjective attack rate of 65 percent and an inapparent attack rate of 25 percent.

In an outbreak of epidemic influenza, age-specific attack rates best indicate the extent to which a community is affected. The overall clinical attack rate for all ages in the study group was 43 percent. From this figure, we estimated that 333,680 of the 776,000 city residents were influenza victims. The proportion of persons in the city attacked by influenza, by age group, can be estimated from the data in table 4. These calculations are summarized in table 8. An estimated 56 to 60 percent of the persons in the age group 13-60 years experienced influenza. Elementary grade school children experienced only half as much of the disease, and preschool age children and adults over 60, only about one quarter as much.

These estimates are consistent with general observations on the course of the epidemic that were published by local newspapers. For example, quoting from the *Milwaukee Sentinel* of December 13, 1968: "For some reason, grade school children are much less inclined to get it than adults and older youngsters, the State health department said." And quoting again from the same source: "The new strain of flu is hitting hardest at adults by its riddling of

**Table 8. Estimated number and percent of Milwaukee, Wis., residents with clinical influenza during 1968-69 epidemic, by age group**

Age group (years)	Estimated number of residents <sup>1</sup>	Percent of 1960 population	Estimated number with influenza <sup>2</sup>	Estimated percent of age group with influenza
0-5.....	107, 600	13. 9	17, 017	15. 8
6-12.....	97, 822	12. 6	30, 698	31. 4
13-20.....	82, 457	10. 6	49, 051	59. 5
21-60.....	385, 563	49. 7	217, 559	56. 4
61 or over.....	102, 558	13. 2	19, 353	18. 9
<b>Total.....</b>	<b>776, 000</b>	<b>100. 0</b>	<b>333, 680</b>	

<sup>1</sup> 1960 census figures applied to 1968 population.

<sup>2</sup> Estimates based on data in table 4 for both sexes.

school faculties and by comparison at least, ignoring of students." The percentage of persons affected in the age group 21-60 was consistent with the heavy absenteeism reported in such adult groups as employees of hospitals, factories, and public service departments, teachers, and so forth.

The least affected groups appeared to be preschool age children and adults over 60, even though all age groups, with the possible exception of girls under 5 years, appeared to be highly susceptible to the infection (table 5).

That influenza vaccines containing antigens derived from strains which were isolated before the 1968-69 epidemics provided no protection is not surprising (table 6). Nevertheless, the vaccine prepared from the single-antigen Hong Kong influenza virus strain was partially effective. The partial protection afforded by this vaccine may be due to two factors. The vaccine was given near the height of the epidemic, on December 13; the peak week of the epidemic was December 12-19. Possibly, therefore, not enough time had elapsed before the infection occurred to allow maximum development of protective antibodies. Also, only one dose was given instead of the two doses spaced 6-8 weeks apart that are recommended for primary immunization of influenza. Therefore, the single antigenic stimulus was probably less than optimal. Had the Hong Kong vaccine been available early enough to complete the primary immunization schedule, the protection would likely have been much greater.

The observation that prior immunization with heterologous influenza antigens was associated with significantly lower HI titers in the blood of convalescent immunized persons than non-immunized controls is a phenomenon not previously observed and deserves further attention. We hope that these persons can be observed during subsequent years to see if this serologic result is associated with continued susceptibility to current Hong Kong influenza.

### Summary

An outbreak of Hong Kong influenza in Milwaukee, Wis., was studied in a sample of 637 members of the city health department and their families. The study data were obtained

through questionnaires about the medical history and by serologic tests on postepidemic blood specimens.

The attack rates were uniformly high for all ages in the study group, ranging from 41 to 65 percent, the lowest rates being those for preschool-age children and adults over 60 years. The clinical influenza attack rate for all ages in the study group was 43 percent during an 8-week period from November 10, 1968, through January 11, 1969. About one-half of the city's residents were estimated to have been affected.

The epidemic had a great impact on the community as a whole. Up to 50 percent of adult groups were absent from work because of it. City resources were greatly strained. Medical supplies ran low, and hospital services were reduced. Many schools closed.

Studies of influenza immunization among the health department employees indicated that vaccine given in October 1968 which did not contain the new Hong Kong antigen was entirely ineffective. Vaccine given in December 1968, however, which contained only antigens from the Hong Kong strain, reduced clinical influenza by 40 percent compared with the proportion affected in control groups.

### REFERENCES

- (1) U.S. National Communicable Disease Center: Morbidity and Mortality Weekly Report. Vol. 17, No. 46, Dec. 21, 1968.
- (2) U.S. National Communicable Disease Center: Morbidity and Mortality Weekly Report. Vol. 17, No. 51, Dec. 21, 1968.
- (3) Sever, J. L.: Applications of a microtechnique to viral serological investigations. *J Immun* 88: 320-329, March 1962.
- (4) Gorbunova, A. S., Stakhanova, A. N., Loshkina, A. N., and Olli, V. D.: The comparative effectiveness of methods of treatment of sera with carbon dioxide, cholera vibro filtrate and potassium periodate in removing nonspecific inhibitors of hemagglutination of A2 influenza virus. *Vop Virus (Moscow)* 4: 750-753 (1959).
- (5) Wisniewski, H. J., and Piraino, F. F.: Review of virus respiratory infections in the Milwaukee area, 1955-1956. *Public Health Rep* 84: 175-181, February 1969.
- (6) Sartwell, P. E.: Preventive medicine and public health. *Influenza, acute respiratory disease*. Ed. 9. Appleton-Century-Crofts, New York, 1965, pp. 91-119.

- (7) U.S. National Communicable Disease Center: Influenza-respiratory disease surveillance. Report No. 84, Sept. 15, 1968.
- (8) U.S. National Communicable Disease Center: Morbidity and Mortality Weekly Report. Vol. 18, No. 7, Feb. 15, 1969.

- (9) Carey, D. E., et al.: Community-wide epidemic of Asian strain influenza. JAMA 167:1459-1463 (1968).

**Tearsheet Requests**

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## Visual Aids for Poison Prevention

The Education Committee of the American Association of Poison Control Centers has prepared several new and unusual visual aids concerning prevention of accidental poisoning. They will be of particular value to persons planning an active local accident prevention program in connection with the forthcoming National Poison Prevention Week, March 15-21, 1970. These aids include:

Slide Talk, "Little Children and Big Poisons"—new, 1970, 44 slides, 35 mm., color, with annotated script. Covers incidence, hazards, preventive measures, and first aid suggestions (\$13).

Captioned slides—25 slides, 35 mm., color. Suitable for use in an automatic projector with a self-contained screen (\$6).

Microfilm of Proceedings of International Conference on Poison Control (misuse of drugs, household products, hazardous substances and pesticides), New York City, June 3-4, 1969. Each film includes 30 of the 32

papers presented. The total number of pages is 250 (\$2).

Poster, "Potential Killers Around Your Home"—11 inches by 17 inches, three-color poster depicts potentially hazardous household products (1 copy free; \$5 per 100).

First Aid for Poisoning—A 5-inch by 8-inch card of instructions for handling poisoning emergencies. Quantities of 200 or less are free. A reproduction proof suitable for local printing is available free for those who need larger quantities.

Poster, "Syrup of Ipecac"—8½ inches by 11 inches containing a picture of a bottle of syrup of ipecac and the legend "Get Me—Just in Case." Reproduction proof suitable for local printing is available free.

All requests should be made to: American Association of Poison Control Centers, Education Committee, care of Academy of Medicine of Cleveland, 10525 Carnegie Avenue, Cleveland, Ohio 44106.