ASIATIC INFLUENZA EPIDEMIC IN PUERTO RICO

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Puerto Rico was affected by the first wave of the Asiatic influenza pandemic in the late summer of 1957. The country was prepared with a reporting system and dispersion of health education material to the public and physicians, but did not have a vaccine available. Various features of this episode were selected for study to determine primarily the effects of epidemic influenza, unmodified by vaccination, on mortality patterns in a country whose normal mortality rates and standards of medical care are relatively comparable to those of the continental United States.

METHOD OF STUDY

The health officers of the Commonwealth Health Department were called to a meeting previous to the epidemic, instructed on the apparent epidemiology of Asiatic influenza and requested to report cases daily to the Bureau of Communicable Disease Control. Thirteen health centers were selected to provide age and sex information on cases seeking medical consultation. In order to estimate the impact of the disease in different age groups, an age-specific incidence ratio was calculated using as numerator the percentage of reported cases in each age group of the total cases and as denominator the percentage of the population in each age group of the total population. It is easily seen that if the attack rates were randomly distributed in regards to age this ratio would be 1 or close to it, since for a particular age group the percentage of cases in the numerator would be the same or approximately so as the percentage of the population in that particular age group is to the total population.

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A one day per week school and individual absentee survey was devised to estimate the prevalence of disease in these populations. For each Tuesday of the eight weeks so studied (weeks 36-43),* the health officers reported the percentage absenteeism of students in public schools and of employees in the major factories of their respective municipaiities. An island-wide average absenteeism above five percent in schools and above two percent in industries was considered excessive for these weeks of the year.

Deaths and mortality data were compiled from the records of the Bureau of Demographic Registry and Statistics. A method of analyzing deaths by weekly occurrence, employed by the Statistics Section of the Epidemiology Branch of the Communicable Disease Center, was adapted to this study.[1,2] An expected weekly death rate, for all of Puerto Rico, of deaths from all causes and from pneumonia and influenza was obtained for an 18 week period of 1957 (31 through 48) inclusive of the dates July 27, to November 29. This was accomplished by the method of a least squares estimate from a straight line fitted to the comparable rates of the corresponding weeks in the three previous non-epidemic years: 1954, 1955 and 1956. A separate regression coefficient was calculated for each of the weeks. The weekly expected death rates for 1957 were averaged for three week periods, obtaining average expected levels for six successive intervals. An "epidemic threshold"** level was defined at two standard errors above the 1957 expected average death levels. The standard error was obtained from the variation of the weekly expected death rates about its line of regression. The expected rates were converted to expected deaths using the 1957 estimated population and plotted on arithmetic graph paper, connecting the levels by a smooth curve. The curves of expected deaths from all causes and from pneumonia and influenza with their respective "epidemic thresholds" were compared with the 1957 weekly observed experience.

Age-specific expected death rates from all causes and from pneumonia and influenza for the nine week period inclusive of the dates August 31 to November 1, 1957 (36 through 44) were also

* A reporting week which begins on Saturday and ends on Friday was chosen as the standard week in this study so as to concur with morbidity reporting and to exactly center about the day chosen for the absentee survey. The first reporting week of the year is that week which has four or more days in the new year.

** If two successive weeks incidence in excess of the "epidemic threshold" is defined as a "run of two", then with "normal incidence" a "run of two" will be uncommon. When incidence exceeds normal levels a "run of two" will be more likely to occur. Specifically, with normal incidence, the odds against one or more "runs of two" during a period of 52 weeks are four to one. If incidence increases above normal by two standard deviations (or its equivalent, two standard errors) the odds are even that a "run of two" will follow immediately.1

obtained by a least squares estimate from a straight line fitted to the corresponding rates for the comparable weeks in 1954, 1955 and 1956. Upper limits of expected death rates for each age group were defined at two standard errors, corrected for the size of the sample, above the 1957 expected values. The age-specific expected rates were converted to expected deaths using the 1957 estimated population and compared with the 1957 observed experience. Excess deaths and death rates were considered to be those values in excess of the expected. Relative excess fatality in each age group was estimated by dividing age-specific excess mortality by an arbitrary measure of relative age-specific morbidity obtained from the study of persons visiting health centers. It was probable that a significant excess mortality occurring in the period of maximum influenza morbidity may have been a consequence of this situation and that a relative age-specific fatality ratio could henceforth be estimated by dividing such a chosen measure of this excess age-specific mortality by a measure of relative age-specific morbidity. For example, the estimated excess mortality of persons 65 years and over was 8.8 (Table II) and the estimated age-specific morbidity ratio for this age group was 0.58 (Table I), hence dividing 8.8 by 0.58 one derives an estimated age-specific fatality ratio of 15.1. Arbitrarily this ratio was defined to be 1.0 since it was the greatest and the other age-specific ratios were defined as fractions of 1.0 for reasons of rapid comparison. In the group less than 1 year of age, an estimated excess mortality of 5.5 (Table II) divided by an estimated morbidity ratio of 0.50 (Table 1) gives an estimated age-specific fatality ratio of 11.0. This is 0.73 parts of the greatest fatality ratio previously derived for the age group 65 years and over. This calculation is only an estimated relative index of the fatality risk of different age groups during this influenza epidemic and is not meant to be interpreted as a specific rate. It is useful in that one is allowed to realize, according to such estimates (Table II), than an influenza case 65 years of age or older has a 500 fold greater chance of dying from this illness or its complications than a case of 35 years of age and henceforth deserves more intensive medical attention.

Expected death rates by selected causes were determined for the months of September, and October, 1957 by a least squares estimate from a straight line fitted to the corresponding rates for the same interval in the three previous years. The latter type estimate for the same two epidemic months of 1957 was obtained for selected causes of death of children under one year. An upper limit of expectation for each cause of death was defined at two standard errors above the expected values. Excess deaths and death rates for selected causes was obtained in a manner similar

to that previously described. For purposes of comparison with the results obtained for the months of September and October, 1957 and to determine the degree of accuracy of the method used to obtain expected rates, the same technique was employed to estimate expected death rates from selected causes for the 10 remaining months of 1957 and was compared with the observed experience during this period. All rates were converted to an annual basis for each interval studied in order to be directly comparable, but were not proportionally adjusted so that the sum total of the component estimates may vary slightly from the estimated total.

Virus isolation and serologic studies were performed both at the Regional Influenza Collaborating Laboratory of the University of Puerto Rico Medical School and at the Co-ordinating Virus and Rickettsial Diagnostic Laboratory of the Communicable Disease Center. Throat washing with nutrient broth inoculated into chick embryos was the technique employed for virus isolation. Nineteen randomly chosen patients from the San Juan metropolitan area with acute symptoms of less than 48 hours and an oral temperature of greater than 102 F. were selected for contribution of throat washings and serum specimens to be sent to the Communicable Disease Center. Thirty-three throat washings of clinically diagnosed influenza patients but with no specific criteria, were sent to the regional laboratory by health officers. Acute and convalescent serum samples without throat washing were also referred to the San Juan regional laboratory. Both laboratories performed hemagglutination inhibition tests on serum samples using antigens of the A/Jap —305, the A/Denver 56, and the B/Great Lakes 54 strains of viruses. The Communicable Disease Center laboratory in addition did complement fixation tests on its fifteen serum samples.

RESULTS

a) Influenza associated morbidity

Puerto Rico had its first known threat of being seeded with Asiatic influenza on July 19, 1957, when approximately 100 boy scouts returned from the National Jamboree at Valley Forge, Pennsylvania.[3,4] During the early part of August, however, the prevalence of influenza was not noted to be above normal expectation. With the return of students to public schools and universities in the week ending August 23 (week 34), there appeared the first unofficial reports of increased absenteeism isolated institutions. In the succeeding weeks both the number of cases in the island and the affected areas rapidly increased, reaching a peak in the week ending September 21 (week 38) (Fig. I). In this country

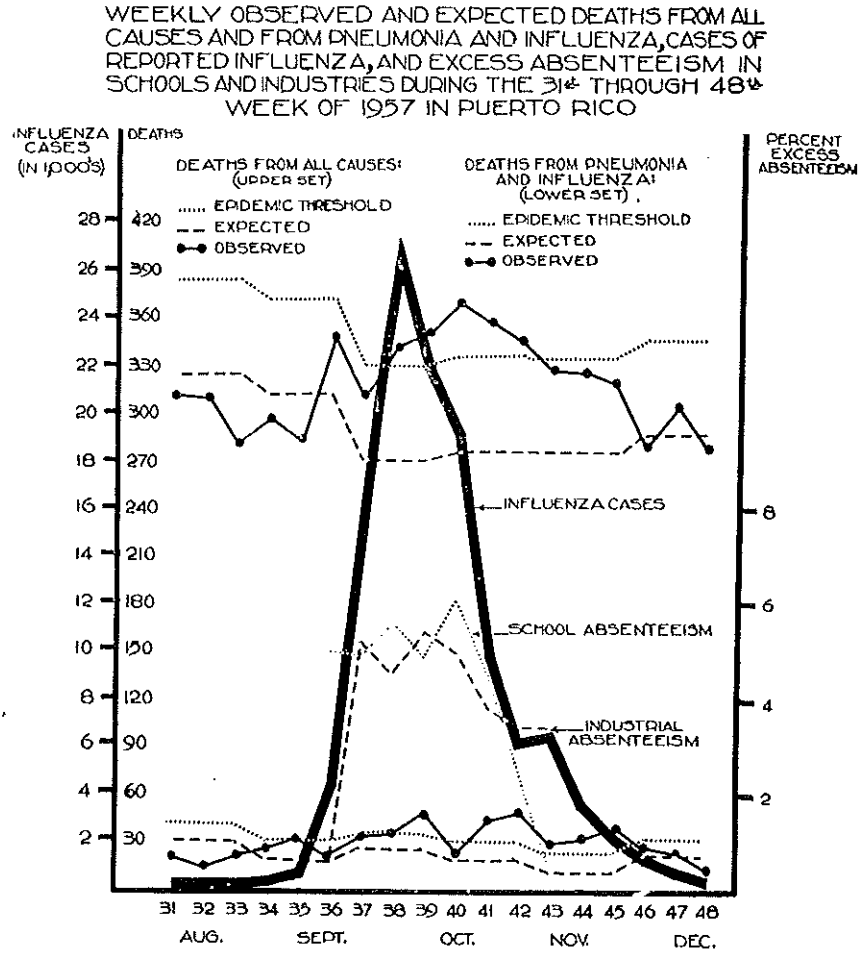

Fig. 1

with a 1957 estimated population of 2,281,000 persons there was a total of 117,111 cases of influenza reported in the 14 week period inclusive of the dates August 24, to November 29, (35 through 48) with 96 percent of the cases reported during the nine weeks 36 through 44.

Age and sex data on patients seen at distributed health centers suggested that females had a slightly higher attack rate than males and especially in the age groups from 5 through 44. The school age group appeared to have the highest attack rate in the sample population (Table I).

School absenteeism was already found to be elevated above the formal expectation during the 36th week when this survey began, whereas industrial absenteeism was approximately within normal limits. Industrial absenteeism rose abruptly during the

TABLE I

AGE AND SEX DISTRIBUTION OF REPORTED INFLUENZA CASES TREATED AT 13 OUTPATIENT HEALTH CENTERS DISTRIBUTED THROUGHOUT PUERTO RICO FROM SEPTEMBER 3 TO OCTOBER 25, 1957.

Age Groups	Cases by Age and Sex Groups		Percent of Total Population* by Age and Sex Groups		Percent of Total Cases by Age Groups	Ratio of Percent Cases to Percent of Total Population
	Males	Females	Males	Females		
1	113	95	1.7	1.7	1.7	0.50
1—4	681	702	6.2	6.0	11.5	0.94
5—14	2073	2392	13.4	12.9	37.1	1.41
15—24	1069	1476	8.8	9.5	21.2	1.16
25—44	840	1139	10.3	12.6	16.5	0.72
45—64	550	592	6.9	5.7	9.5	0.75
65+	173	132	2.1	2.2	2.5	0.58
TOTAL	5499	6528	49.4	50.6	100.0	1.00

* 1957 Estimated Population.

second week of the survey to an excess level equal to that of the schools. Absenteeism in the schools had again returned to normal at the eighth week of the survey (week 43) whereas industrial absenteeism persisted above normal expectation (Fig. I). Forty-six percent of the country's population, divided equally between the schools and industries, were samples in this survey. The average estimated daily excess absenteeism was 4.3 percent for schools and 3.9 percent for industries during the 50 day interval included by the survey.

b) Influenza associated mortality

Weekly observed deaths from all causes was seen to fall within the range of normal variation of the expected death levels for the 31st. through 37th. weeks of 1957 (Fig. I). The first apparently significant increase in deaths for all causes occurred in the 38th. week during the time of greatest case reporting and it continued to increase for the succeeding two weeks reaching a maximum two weeks following the period of peak case reporting. Deaths from all causes subsequently decreased and was again below the "epidemic threshold" by the 43rd. week. No indications of secondary increases were observed within the subsequent five weeks. The weekly observed deaths from pneumonia and influenza apparently increased above normal expectation in the 39th week only to subside to a normal range in the subsequent week when deaths from all causes had reached their summit. However beginning with the 41st. week, deaths from pneumonia and in-

fluenza rose above their "epidemic threshold" and remained so until the 46th. week (Fig. I).

The observed age-specific mortality rates from all causes during the 36th. through 44th week of 1957 appeared to have been elevated above the upper limits of normal expectation in several age groups and especially in the population younger than one year and older than 65 years (Table II). Excess mortality was greatest in the two extremes of age with persons over 65 years showing the greatest increase during the period of the epidemic. Eighty-one percent of all estimated excess deaths by age groups occurred in the two previously mentioned groups with 56 percent derived from the oldest group. This group also seemed to have the highest risk of fatality from all causes of death following an attack of influenza.

Observed mortality from pneumonia and influenza during the epidemic interval appeared to have been excessive in several age groups and again especially in the extremes of age (Table III). Persons over 65 contributed mostly to the total estimated excess mortality and deaths, and had the highest apparent risk of fatality from this cause of death. Children under 1 year showed the second greatest rises above the expected values.

Observed death rates by specific causes during September and October, 1957 appeared to show the greatest increase above normal expectation for pneumonia and influenza although several of the chronic diseases such as those of the heart and blood vessels, and tuberculosis seemed to exhibit increases as well. No increase above the expected values was noted in the death rates for cancer, diabetes or nephritis during the epidemic interval although all causes of death other than those mentioned showed an apparent increase (Table IV). The same type of analysis was done for the ten remaining months of 1957 and it seemed to validate the techniques used for estimating expected deaths and rates by virtue of the general similarity of the 1957 observed and expected values.

Observed death rates from specific causes in children less than one year during September and October, 1957 showed that the greatest apparent excess mortality occurred from pneumonia and influenza and pneumonia of the newborn. The diseases of early infancy such as pneumonia and diarrhea of the newborn and ill defined diseases of early infancy were also slightly elevated above the normal expectation (Table V). Study of the ten months of 1957 excluding September and October revealed that the observed mortality rates were generally in close correlation with expected mortality rates in this infant age group.

TABLE II

AGE SPECIFIC DEATHS AND DEATH RATES[1] PER 1,000 POPULATION FROM ALL CAUSES DURING THE 36th THROUGH 44th WEEK OF 1957 COMPARED WITH THE SAME WEEKS OF THE PREVIOUS THREE YEARS IN PUERTO RICO.

Age Groups	YEARS														
	1954 Observed		1955 Observed		1956* Observed		1957 Expected		1957 Expected plus two standard errors		1957 Observed		1957 Excess		Estimated fatality ratio
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	
1	736	56.2	739	54.6	641	49.7	616	47.0	644	49.1	689	52.5	73	5.5	0.73
1—4	284	5.9	247	5.2	217	4.7	199	4.1	212	4.36	199	4.1	0	0.0	0.0
5—9	67	1.2	59	1.1	56	1.1	55	1.03	60	1.09	69	1.3	14	0.3	0.014
10—14	34	0.7	27	0.6	30	0.6	25	0.5	30	0.61	44	0.9	19	0.4	0.018
15—24	99	1.4	108	1.5	83	1.2	78	1.2	96	1.48	87	1.3	9	0.1	0.005
25—44	261	3.0	251	2.8	249	2.9	251	2.8	282	3.14	255	2.8	4	0.02	0.002
45—64	372	7.9	382	7.8	479	9.7	571	10.3	644	11.62	525	9.5	−46	0.8	−0.065
65+	864	53.8	932	55.8	936	56.1	1057	57.5	1083	58.9	1219	66.3	162	8.8	1.0
TOTAL	2717	7.0	2745	7.0	2691	7.1	2852	7.0	2843	7.22	3087	7.8	235	0.7	0.046

1. Rates converted to an annual basis using the estimated population as of July 1, of each year.

* Based on 61 days of the 63 day interval.

c) Influenza associated laboratory findings.

Of nineteen throat washings analyzed by the Communicable Disease Center laboratory, ten contained the A/Jap —305 virus. Serologic samples were obtained from all ten patients from whom the virus was isolated. Complement fixation reactions revealed that ten of the ten samples had a four fold antibody rise to an antigen of the Asian strain, nine of the ten to the A/Denver strain and three of the ten to the B/Great Lakes strain. Although the hemagglutination reaction was desirably more specific, it proved less sensitive. Positive reactions were obtained in four of the ten proven cases with the Asian virus antigen, in one patient with the A/Denver antigen and in no patients with the B/Great Lakes antigen. Five of the nine patients from whom no virus was obtained also had serologic studies performed. The pattern of positive serologic changes in this group compared closely to the group from whom virus was isolated suggesting a high rate of Asiatic virus infection in this group as well. All fifteen cases were combined for tabular presentation because of no evident differences in the serologic pattersn (Table VI). It was not apparent why the acute serum samples analyzed by the Communicable Disease Center laboratory yielded such high average antibody dilution titers to the hemagglutination inhibition reaction with the Asian strain of virus (18.5, Table VI). The average acute dilution titer was even higher in the ten proven cases at such an early stage when virus was isolated (24.4).

Five throat washings of thirty-three sent to the regional laboratory by health officers yielded Asiatic virus. Fifty-two acute and convalescent serum samples were studied by the hemagglutination reaction in the San Juan laboratory. Twenty-eight or 54 percent of the samples showed four fold antibody rises to the Asiatic virus antigen whereas there were no positive reactions to either the A/Denver or B/Great Lakes antigens. The average antibody dilution titer to Asiatic virus by the hemagglutination reaction of acute samples tested in this laboratory was 7.9 as expected when a population is exposed to a new virus strain. It would appear from the latter results that the Puerto Rican population had little or no previous experience with the Asiatic strain of virus but that there is indication of previous experience with other group A viruses and definitely with the viruses of the B group.

DISCUSSION

One of the great developments in public health has been the ability to produce effective vaccines on a mass production basis.

TABLE III

AGE SPECIFIC AND DEATH RATES[1] PER 100,000 POPULATION FROM PNEUMONIA AND INFLUENZA DURING THE 36th THROUGH THE 44th WEEK OF 1957 COMPARED WITH THE SAME WEEKS OF THE PREVIOUS THREE YEARS IN PUERTO RICO.

Age Groups	YEARS														
	1954 Observed		1955 Observed		1956 Observed		1957 Expected		1957 Expected plus two standard errors		1957 Observed		1957 Excess		Estimated fatality ratio
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	
1	66	504.2	65	480.5	59	443.3	55	415.1	56	424.1	87	663.3	32	248.2	0.77
1—4	49	101.5	49	102.6	48	100.1	49	100.0	50	102.4	52	106.9	3	6.9	0.01
5—9	5	9.2	7	13.0	8	14.7	10	17.8	10	19.2	13	23.7	3	5.9	0.006
10—14	3	6.1	2	4.3	2	4.2	1	3.0	2	4.1	12	24.6	11	21.6	0.02
15—24	1	1.5	5	7.0	1	1.5	2	3.3	7	10.6	2	3.2	—	—	—
25—44	4	4.6	7	7.9	4	4.5	5	5.6	9	10.1	12	13.5	7	7.9	0.016
45—64	7	15.1	20	41.2	13	25.5	21	37.7	36	65.6	20	36.1	—	—	—
65+	33	205.3	38	227.4	31	180.2	33	179.2	41	225.4	104	566.4	71	387.2	1.00
TOTAL	168	43.6	193	49.4	166	42.4	173	43.9	207	52.5	302	76.7	129	32.8	.05

1. Rates converted to an annual basis using the estimated population as of July 1, of each year.

An example of this occurred during the epidemic of Asiatic influenza in the United States when approximately 16 million ml. of Asian strain vaccine were released before the peak of morbidity and before the first evident increase in mortality from pneumonia and influenza.[5] It appears difficult to improve upon this accomplishment the next time an epidemic caused by an unfamiliar strain of influenza virus occurs, especially if it begins in North America.[6] During the epidemic the prophylactic value of strain specific vaccination was proven and furthermore there has been evidence to encourage the outlook for a practical composite vaccine of broad coverage which may be employed effectively during non-epidemic as well as specific epidemic periods.[7] It therefore appears necessary to adequately understand the high-risk population groups in order to accomplish the maximum benefit with prophylactic vaccination during emergency situations and, possibly in the future, as part of routine public health programs. The absence of a prophylactic vaccine in Puerto Rico during the Asian influenza experience has allowed an opportunity to study the epidemic patterns of this virus. Advantage was taken of the compact size of Puerto Rico with its relatively comprehensive reporting facilities to provide this information. The final phase of the Asiatic influenza program of many institutions, or the phase of retrospective evaluations, is in progress at the present time. This study has attempted to define several aspects of recent influenza morbidity and mortality patterns using a relatively small population. It is hoped that the validity of the apparently significant and practical relations encountered may be tested by larger institutions.

The indicators chosen to study morbidity were designed to provide reliable and practical information with the minimum of increased imposition upon the active health officers and at a minimum of cost. It has been shown in one study of the occurrence of Asian influenza in students, that 25 percent who had serologic evidence of infection reported not having any illness.[8] Theoretically therefore, a study of true attack rates from influenza should include such asymptomatic cases. In this study the indicators of age-specific attack ratios introduced a sampling selection in that only diagnosed cases visiting public health facilities have been compared. However, like the National Health Survey which samples persons having one or more days in bed as an illness criterion,[9] the health center reports in Puerto Rico have yielded valuable information. The precision of the health centers reporting technique to estimate age-specific illness ratios in the country at large was found to be comparable with the 5 percent monthly sampling error of the National Health Survey. The proportion of persons in each age group visiting the selected public health centers in Puerto

TABLE IV
DEATHS AND DEATHS RATES[1] PER 100,000 POPULATION BY SELECTED CAUSES FOR SEPTEMBER AND OCTOBER IN PUERTO RICO.

Cause of Death	YEARS													
	1954 Observed		1955 Observed		1956 Observed		1957 Expected		1957 Expected plus two standard errors		1957 Observed		1957 Excess	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All causes	2677	718.6	2671	705.9	2679	709.4	2676	702.1	2684	703.18	2987	783.6	311	81.5
Heart diseases	330	88.6	371	98.1	407	107.8	448	117.4	449	117.56	483	126.7	35	9.3
Cancer	250	67.1	271	71.6	320	84.7	351	92.1	373	97.82	338	88.7	—	—
Tuberculosis	139	37.3	115	30.4	141	37.3	135	35.0	168	44.16	155	40.7	22	5.7
Diabetes	31	8.3	22	5.8	27	7.1	22	5.9	32	8.42	13	3.4	—	—
Nephritis	53	14.2	49	13.0	41	10.9	36	9.4	38	10.0	30	7.9	—	—
Vascular Lesion	117	31.4	143	37.8	147	38.9	166	43.5	179	47.04	193	50.6	27	7.1
Pneumonias & Influenza	160	43.0	188	49.7	163	43.2	173	45.5	207	54.3	321	84.2	148	38.7
Other causes	1597	428.7	1512	399.6	1433	379.4	1347	353.3	1355	355.07	1454	381.4	107	28.1

1. Rates converted to an annual basis using the estimated population as of July 1 of each year:

Population: 1954— 2,229,000; 1956— 2,264,000
1955— 2,260,000; 1957— 2,281,000

Rico correlated well within this five percent limit in each age group as compared with a random sample of influenza case reports from other distributed health officers. The occurrence of new cases by age groups in Puerto Rico concurred with results of the National Health Survey in that the highest occurrence was in the age group from 5 to 14 years with somewhat lower ratios in the age group 0 to 4 years and 15 to 24 years and with progressively diminishing ratios in the groups older than 24 years.[9]

The purpose of the school and industrial survey was to estimate the weekly prevalence of diseases which is considered a better index of the impact of an epidemic than is incidence.[10] Assuming that the excess absenteeism was primarily due to influenza, then an estimate could also be made of the percent of persons from these populations who were attacked. On multiplying the average estimated daily absenteeism of 4.1 percent by fifty which was the interval in days of the survey and dividing by the number of days of absence caused by an average illness, one may calculate the percent of the school and working population which was attacked during the epidemic interval from September 3, to October 22. Assuming that an illness required on the average 5 days absence from normal school and industrial activities then it may be estimated that 41 percent of this population suffered an illness. This is in accord with the estimates of other investigators reporting on Asian influenza in other countries.[9,11] The absentee reports also indicated that there was no industrial or community crisis created during the course of the epidemic in Puerto Rico.

The matter of interpreting excess mortality during an influenza epidemic has become increasingly difficult because of the gradual decline in excess deaths during such epidemics.[12] In Puerto Rico the association of a significant increase in mortality from all causes and from pneumonia and influenza simultaneous with the period of increased influenza morbidity allows one to assume a causal relationship. It is more difficult, however, to precisely interpret the relative effects of influenza upon mortality in the various age groups and upon the selected causes of death investigated. In this study it appears that the techniques used to derive expected mortality values were relatively accurate and perhaps slightly conservative in view of the comparison of the actual death rates during the 10 "non-epidemic" months of 1957 excluding September and October with the expected death rates obtained by the described methods. The predominant trend of death experience during the non-epidemic interval appeared to be lower than the expected rates whereas the trend of selected deaths during the epidemic period appeared greater than expectation although

TABLE V

DEATHS AND DEATH RATES PER 1,000 LIVE BIRTHS BY SELECTED CAUSES OF CHILDREN LESS THAN ONE YEAR OF THE MONTHS OF SEPTEMBER AND OCTOBER IN PUERTO RICO.

Cause of Death	YEARS													
	1954 Observed		1955 Observed		1956 Observed		1957 Expected		1957 Expected plus two standard errors		1957 Observed		1957 Excess	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All causes	723	55.4	720	54.4	637	48.9	596	46.4	616	49.52	662	53.2	66	6.8
Diarrhea & Enteritis	144	11.0	164	12.4	116	8.9	111	8.6	147	11.86	103	8.3	—	—
Diarrhea of the new born	32	2.5	33	2.5	22	1.7	18	1.4	24	1.54	27	2.2	9	0.8
Pneumonia and Influenza	65	5.0	65	4.9	57	4.4	54	4.2	56	4.48	91	7.3	37	3.1
Pneumonia of the new born	43	3.3	29	2.2	23	1.8	12	0.9	36	2.84	49	3.9	37	3.0
Ill defined diseases of early infancy	53	4.1	51	3.9	33	2.5	24	1.9	36	2.92	33	2.7	9	0.8
Other causes	386	29.6	378	28.6	386	29.6	377	29.3	329	30.64	359	28.8	—	—

1. Converted to an annual basis using the total live births in each year studied: 1954—78,008; 1955—79,221; 1956—78,177; 1957—74,444 (Provisional).

not always being in excess of the limits of normal variation. It is believed therefore, that a relative measure of excess mortality is more truly represented by the difference between the observed and the expected rates. An upper limit of expectation, however, has been provided in each analysis for reference.

The most striking effects of influenza on mortality occurred in the oldest segments of the population which was evident regardless of the criterion used to define an excess. There was no other comparable increase in any other age group. This was evident in deaths from all causes as well as those from pneumonia and influenza. The relative increases in mortality from selected causes of death appear significant and should be considered in association with the information derived from analyzing the relative mortality hazards in the various age groups. There appeared to be significant increases in mortality from diseases of the heart and vessels and less so from tuberculosis. The magnitude of the relative increase in mortality in the oldest age group, however, was found to be greater than the magnitude of increase from any selected cause of death. It appears that a simple age criterion would be generally a more valid criterion of risk from influenza than pre-existing disease conditions. The increased deaths in infants was significant, second only to the increase in the oldest age group and was found to be almost entirely due to pneumonia and influenza.

The primary reliance for protection against pandemic influenza should be placed on preventive rather than therapeutic measures,[13] and it therefore appears essential to define as accurately as possible the population groups at highest risk in order to most effectively recommend vaccine priorities.

SUMMARY

The morbidity, mortality and laboratory experiences encountered during the epidemic of Asiatic influenza in Puerto Rico are described. The information offered applies primarily to an analysis of excess mortality during such an epidemic. The significant findings with respect to mortality in the oldest age group are striking and will have an important bearing on planning during future vaccination programs. The epidemic characteristics selected for studying morbidity confirmed previous concepts with regard to disease prevalence, sequence of illness in population groups and age-specific attack ratios. The laboratory efforts demonstrated the specific virus nature of the epidemic and also its continuing homogenious etiology.

TABLE VI

ANTIBODY DILUTION TITERS BY THE COMPLEMENT FIXATION AND HEMAGGLUTINATION INHIBITION REACTIONS OF ACUTE AND CONVALESCENT SERA FROM INFLUENZA PATIENTS. SEPTEMBER AND OCTOBER, 1957, PUERTO RICO.

ANTIGENT	A/ JAP/305/57			A/ DENVER/1/56			B/ GREAT LAKES/1739/54		
Serum Samples	Acute titer[1]	Convalescent titer[1]	Frequency of antibody rise[2]	Acute titer	Convalescent titer	Frequency of antibody rise	Acute titer	Convalescent titer	Frequency of antibody rise
Complement Fixation Reaction*	1.7	53.7	15/15	3.4	53.7	14/15	10.5	34.9	6/15
Hemagglutination Inhibition Reaction*	18.5	49.3	6/15	15.0	37.8	2/15	61.4	60.7	1/15
Hemagglutination Inhibition Reaction+	7.9	35.2	28/52	13.8	18.8	0/52	51.9	52.5	0/52

1 Arithmetic mean of individual antibody dilution titers.

2 Numerator — number of samples showing four fold or greater antibody rise.
Denominator — number of samples studied.

* Studied at the Virus and Rickettsial diagnostic laboratory of the Communicable Disease Center.

\+ Studied at the University of Puerto Rico Medical Laboratory.

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