The US Public Health Service House-to-House Canvass Survey of the Morbidity and Mortality of the 1918 Influenza Pandemic

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See also the COVID-19 & History section, pp. 402–445.

Between November 20, 1918, and March 12, 1919, the US Public Health Service carried out a vast population-based survey to assess the incidence rate and mortality of the influenza pandemic among 146 203 persons in 18 localities across the United States. The survey attempted to retrospectively assess all self-reported or diagnosed cases of influenza since August 1, 1918. It indicated that the cumulative incidence of symptomatic influenza over 6 months had been 29.4% (range = 15% in Louisville, KY, to 53.3% in San Antonio, TX). The overall case fatality rate (CFR) was 1.70%, and it ranged from 0.78% in San Antonio to 3.14% in New London, Connecticut. Localities with high cumulative incidence were not necessarily those with high CFR. Overall, assuming the survey missed asymptomatic cases, between August 1, 1918, and February 21, 1919, maybe more than 50% of the population was infected, and about 1% of the infected died. Eight months into the COVID-19 pandemic, the United States has not yet launched a survey that would provide population-based estimates of incidence and CFRs analogous to those generated by the 1918 US Public Health Service house-to-house canvass survey of influenza. (*Am J Public Health*. 2021;111: 438-445 https://doi.org/10.2105/AJPH.2020.306025)

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The influenza pandemic of 1918 is often used as comparison with that of COVID-19 because it indeed appears to have behaved very similarly, catching the whole world off guard almost simultaneously and killing so many people that it became a milestone in family histories. It is common to read estimates of its quantitative impact, such as "From 25 to 40% of people in affected communities were sick"[1(p2193)] or "case fatality rate was >2.5%,"[2(p15)] but the original sources of this information have rarely, if ever, been provided in publications after 1935.

This article critically reviews the source of the estimate of incidence, mortality, and case fatality for the 1918 influenza pandemic in the United States and discusses the relevance of this information for the 2020 response to the COVID-19 pandemic. This survey by the US Public Health Service (PHS) began in the fall of 1918, was mostly carried out in the fall of 1918, and ended in March 1919 (Figure 1). It involved a canvassing of randomly selected houses, in which 146 203 persons resided. Its unique population-based information provided nationally representative numbers of infections and deaths, and cumulative incidence and case fatality rates (CFRs)—a type of information we are still lacking today for COVID-19 in the United States in October 2020.

As shown in Figure 1, which is a redrawing of the US data shown by Frost[3] in Chart 3 and provided as an Appendix (available as a supplement to the online version of this article at http://www.ajph.org), in the United States, a generalized epidemic of influenza occurred mostly in a single wave, during September, October, and November 1918. There were local epidemics in March and April 1918, which did not have an impact on the overall mortality, but which, in hindsight, were interpreted as a possible first phase. The same is true for a possible third phase lasting from December 1918 to January 1919. The main contextual element was the entry of the United States in the First World War in 1917. The war ended November 11, 1918. The movement of US troops from the United States to

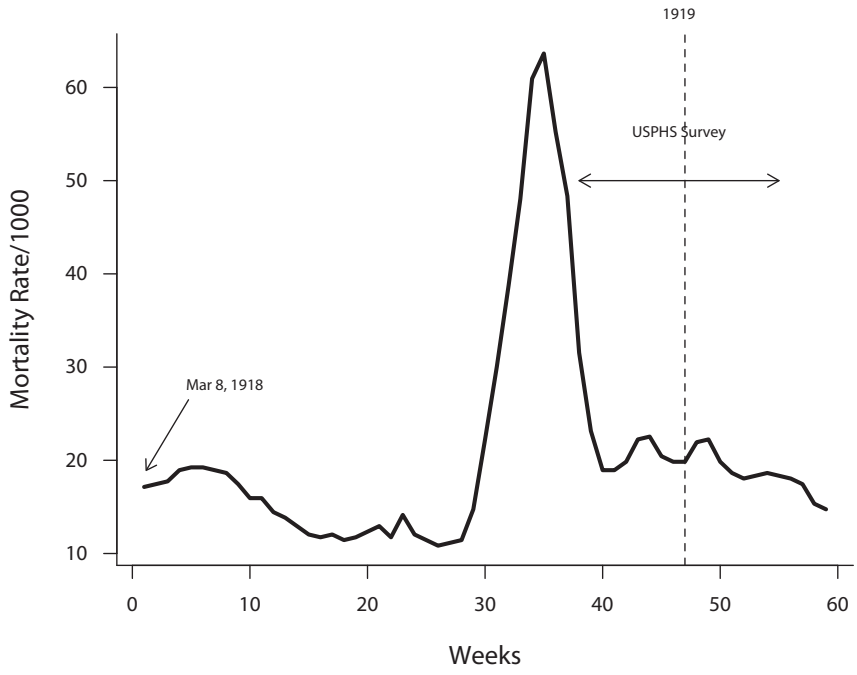

FIGURE 1— Annual Death Rates From All Causes in 45 American Cities, March 2, 1918, to April 5, 1919

Source. Redrawn from Frost.[3]
Note. The segment indicates that the US Public Health Service Survey was conducted between November 20, 1918, and March 12, 1919.

Europe and back seems to have played a major role in the dissemination of the pandemic.[4]

The severity of the pandemic wave that began in August 1918 made the PHS realize the "utter inadequacy and lack of uniformity of morbidity reporting in the United States" and their incompleteness.[5(p2306)] Excess mortality rates from all causes afforded the closest figure of severity of the 1918 influenza compared with previous epidemics.[6,7] The PHS did not routinely collect incidence data. Death certificates were not specific enough to separate influenza deaths from those of other respiratory diseases, such as pneumonia. In April 1918, US Surgeon General Rupert Blue established an Influenza Task Force of the PHS. He named Wade Hampton Frost (1880–1938) head of the task force. Frost was a health officer of the PHS. Eighteen months later, Frost would become the founding chair of the Department of Epidemiology of the newly opened The Johns Hopkins University School of Hygiene and Public Health. The task force also comprised Edgar Sydenstricker (1881–1936), principal statistician at the PHS, who had been previously working with Joseph Goldberger on the South Carolina 1916 pellagra cohort study[8] and who, in 1921, would help launch the Hagerstown, Maryland, survey[9] and the National Health Survey of 1935–1936.[10]

THE HOUSE-TO-HOUSE CANVASS

The surveys and most of the analyses, made under the direction of Frost and Sydenstricker, are described by them in several papers[11–13] but most thoroughly 14 years later by Britten.[14] The surveys were conducted between November 20, 1918 (Baltimore, MD) and March 12, 1919 (Charles County, MD).[14(p305)] The "purpose" was "ascertaining as accurately as possible the proportion of the population affected."[11(p491)]

Data were collected in 18 localities: the first report provided detailed results for Baltimore and 7 smaller towns and districts of Maryland.[11] Further reports provided the results for 10 additional localities in widely separated sections of the United States with populations ranging from 25 000 to 600 000[14]: New London, Connecticut; Spartanburg, South Carolina; Louisville, Kentucky; Little Rock, Arkansas; San Antonio, Texas; San Francisco, California; Des Moines, Iowa; and Macon and Augusta, Georgia. The 18th locality, Charles County, was added in March 1919: its survey was commissioned by the PHS but incorporated into the Census data collection procedures.

This was a multistage survey. In most of the localities, the PHS had previously established organizations prepared to collect data reliably and efficiently.[13(p585–586)] With the exception of the far West (San Francisco was the only city west of San Antonio and Des Moines), the communities represented the different geographical sections of the United States. Areas were selected for the house-to-house canvass in each locality to be situated within a town or city and to have similar population sizes. In each locality, the house-to-house canvass was performed in 10 or more enumeration districts, selected as to give, presumably, "a fair sample of the general population."[13(p585–586)] For the purpose of statistical power, 5000 persons or more were canvassed in each city. In cities of more than 100 000 population, at least 5% of the total population was canvassed.

As shown in Figure 1, soon "after the epidemic appeared to have definitely subsided,"[13(p586)] the survey technicians, referred to as the "enumerators,"

interviewed the housewife or other responsible member of every household of the selected areas. The sociodemographic information comprised name, "color," sex, and age at last birthday of each household member; for the household, the number of rooms occupied and the enumerator's impressions of the economic status of the family, whether well-to-do, moderate, poor, or very poor. The influenza-specific data comprised the date of onset and duration of each case of influenza, "flu" or "grippe," or pneumonia since August 1, 1918, and the date of each death from influenza or pneumonia. These included cases lasting at least three days, with one full day of bed confinement. Persons who had only been "feeling badly," or who had a "cold," were categorized as "doubtful" cases. The total morbidity from influenza during the epidemic period included cases classified as "influenza," "grippe," "pneumonia," and "doubtful." Other causes of illness besides influenza, pneumonia, or colds were not recorded. There was no further validation of the families' statements as to diagnosis, but some of them had been made by an attending physician.

As for the quality of the data, it was noted that "for a small proportion" of cases of influenza, ascertained retrospectively by canvass, the dates of onset may not have been accurately recalled. However, these errors were expected to occur randomly and, therefore, "it was believed that a sufficiently large mass of data would reduce the errors arising from faulty memory on the part of some informants, and the inquiries were sufficiently simple to permit even untrained persons to obtain the data with detailed written instructions and under careful supervision."[11(p492)]

Overall, the investigators "believed that such inquiries, made quite simply and covering a very definite epidemic period, afford a fairly accurate idea of the incidence of the disease among representative groups of persons."[11(p492)]

MEASURES OF DISEASE OCCURRENCE

Frost and Sydenstricker used the following measures of disease occurrence:

1. Total number of persons included in canvas (N)
2. Number of cases of influenza (I)
3. Number of deaths from influenza and pneumonia (all forms; D)
4. Case incidence rate (CIR) per 1000: CIR = (I/N)*1000
5. Death rate (DR) per 1000: DR = (D/N)*1000
6. CFR per 100: CFR = (D/I)*100

They also computed the following ratios (i and j refer to any two groups compared):

1. CIR ratio: $(CIR_i)/CIR_j)*100$
2. DR ratio: $(DR_i)/DR_j)*100$
3. CFR ratio: $(CFR_i)/CFR_j)*100$

Table 1 shows how these measures were used for the preliminary report focusing on the Baltimore survey, in which 46 535 persons were canvassed, of whom 33 776 were in the 32 districts or areas selected in Baltimore City.[11(p493)] Expressed in percentage, the CIR ranged from 23.3% to 59.4%, while the CFRs ranged from 1.1% to 2.5%.

RESULTS OF THE NATIONAL HOUSE-TO-HOUSE SURVEYS

The house-to-house canvassing began in November 20 (Baltimore). Besides San Francisco (February 21, 1919) and Charles County (March 12, 1919), the survey was completed by January 31, 1919. In 1920, Frost reported a total of 130 033 persons, 36 365 cases, and 583 deaths.[13] But, in his apparently more thorough analysis, Britten reported 146 203 persons, 42 920 cases, and 730 deaths.[14]

The full survey results are shown in Table 2: the crude case cumulative incidence was overall 29.4% and varied from 15% in Louisville to 53.3% in San Antonio. The overall CFR was 1.70%, and it varied from 0.78% in San Antonio to 3.14% in New London.

Additional age-specific analyses showed that the incidence was highest among those aged 5 to 9 years, fell off progressively for those aged from 10 to 24 years, rose to a minor second mode among those aged 25 to 29 years, and then declined progressively in successive age groups.[14(p311–312)] There was no marked difference between genders.

The CFR rose to nearly 3% in the group aged 25 to 29 years and fell to less than 1.5% among those aged 45 to 49 years, but in people aged 70 years and older it rose again, reaching 5.1%.[14(Table 28, p332)] The nominal CFR was higher among men than among women, mostly among those aged 20 to 40 years. No statistical tests were performed.

Economic Status and Crowding

The data for the economic status and crowding of the households have been reported for Whites only in New London, Baltimore, Augusta, Macon, Des Moines, Louisville, Little Rock, San Antonio, and San Francisco.[15]

The age-adjusted incidence rates of influenza by economic status were 25.2%, 27.2%, 32.6%, and 36.4%,

TABLE 1— Absolute Incidence, Case Fatality, and Mortality and Respective Ratios in the Maryland Influenza Survey Conducted by the US Public Health Service Influenza Task Force, November 10 to December 11, 1918

					Case Incidence Rate[a]		Death Rate[b]		Case Fatality Rate[c]	
	Total Population	Persons in Canvass	Cases Influenza	Deaths (I+P)	Rate/1000	RR	Rate/1000	RR	Rate/100	RR
All	733 490	46535	13 037	243	280.2	...	5.2	...	1.9	...
Baltimore	680 000	33 776	7868	156	232.9	100[d]	4.6	100	2.0	100[d]
Salisbury	9000	1735	796	9	458.8	197	5.2	113	1.1	57
Frederick	11 340	2420	777	9	321.1	138	3.7	81	1.2	58
Cumberland	27 300	5234	2147	38	410.2	176	7.3	158	1.8	88
Lonaconing	2000	1840	1093	22	594.0	255	12.0	260	2.0	101
3 rural districts[e]	3850	1530	356	9	232.7	100	5.9	128	2.5	126
Men, 20–44 y		7644	2192	78	286.8	100	10.2	100	3.6	100
Women, 20–44 y		9936	3030	51	305.0	106	5.1	50	1.7	47

Note. I = influenza; P = pneumonia; RR = rate ratio.

Source. Frost and Sydenstricker[11]; Britten.[14]

[a] Cases of influenza/persons in canvass.
[b] Deaths from influenza and pneumonia/persons in canvass.
[c] Deaths from influenza and pneumonia/cases of influenza.
[d] Baltimore is the reference.
[e] Rural district (canvassed/total population): Quantico (114/2000), Linganore (688/1000), Downsville (718/850).

respectively, for well-to-do, moderate, poor, and very poor. "The ratio of the rate for the 'very poor' to that for the 'well-to-do' [was] 1.3 to 1.0 for the nine localities as a group."[15(p159)] The differences were consistent across ages. The age-adjusted CFRs were, respectively, 1.5%, 1.5%, 1.7%, and 2.8%—that is, "nearly twice as great among the 'very poor' as among the 'well-to-do.'"[15(p160)] The mortality rates per 1000—adjusted for age using the 1910 Census as standard—were, respectively, 3.8, 3.8, 5.2, and 10.0.[15(p159)]

For crowding, the age-adjusted incidence rates of influenza were 26.5%, 32.8%, and 40.5%, respectively, for "1 or less," "more than 1 but not over 2," and "more than 2" persons per room, respectively.[15(p164)] Sydenstricker noted "a quite definite association of household congestion and influenza," which "might be nothing more than a reflection of economic status."[15(p164)]

"Colored"–White Differences

The observed differences between Whites and the "colored" population comprised in the canvass were difficult to interpret. Numbers were available for Louisville, Baltimore, Augusta, Macon, Spartanburg, Maryland minor towns, Little Rock, and Charles County, for a total of 79 712 Whites and 21 312 "colored" persons, among whom 23 322 and 6000 cases occurred, respectively.[14] In Charles County, in which "colored" represented about 50% of the population, incidence rate was 14% greater among the "colored," but the CFR was not reported. However, in the seven other localities, the incidence rates among the "colored" were uniformly lower than among the White population, on average by 33%, the differences persisting after adjustment for sex and age.[14(p318)] Also, excluding Charles County, the CFR of influenza was 1.7% in Whites and 1.9% in the "colored" population, but the pneumonia CFRs in the White and "colored" populations were 28.8% and 39.8%, respectively. Britten concluded that "we are probably warranted in concluding that the case fatality was really higher in the colored populations of the surveyed communities."[14(p336)]

CONCLUSIONS

In 1918, when the PHS was given the leadership to conduct the response to the terrible pandemic, there was a

TABLE 2— Absolute and Adjusted Incidence, Mortality, and Case Fatality of the National Influenza Survey Conducted by the US Public Health Service Influenza Task Force, November 20, 1918, to March 12, 1919, Ordered by Case Incidence Rates

			Influenza Cases			Deaths		
	Total Population	Persons in Canvass	No.	Rate/100 (Crude)[a]	Rate/100 (Adjusted)[b]	No. (I+P)	Rate/1000[c]	CFR[d]
All	1 954 496	146 203	42 920	29.4	30.0	730	[4.3][e]	1.70
San Antonio, TX	150 000	12 534	6701	53.5	52.2	52	4.2	0.78
Maryland minor towns	51 170	12 482	5060	40.5	41.7	84	6.4	1.66
Charles County, MD[f]	18 326	16 147	6546	40.5	40.5	147	9.1	2.25
Little Rock, AR	65 000	9920	3565	35.9	35.4	39	3.9	1.09
Augusta, GA	55 000	4123	1405	34.1	35.9	18	4.4	1.28
Baltimore, MD	680 000	33 361	8199	24.6	25.8	172	5.2	2.10
Des Moines, IA	115 000	5857	1353	23.1	23.3	22	3.8	1.63
San Francisco, CA	475 000	18 682	4021	21.5	21.2	90	4.8	2.24
Spartanburg, SC	25 000	5257	1126	21.4	21.8	10	1.9	0.89
Macon, GA	50 000	7905	1681	21.3	21.2	25	3.2	1.49
New London, CT	25 000	7933	1466	18.5	18.8	46	5.8	3.14
Louisville, KY[g]	245 000	12 002	1797	15.0	16.5	25	2.1	1.39

Note. CFR = case fatality rate; I = influenza; P = pneumonia.

Source. Britten.[14]

[a] Cases of influenza/persons in canvass.
[b] Age–sex standardized. The standard population used is the total population of the continental United States, males and females, by five-year age periods, as per census enumeration of 1910.
[c] Deaths from influenza and pneumonia/persons in canvass.
[d] Deaths from influenza and pneumonia/cases of influenza.
[e] Median computed by A. M.
[f] Universal survey incorporated to the 1919 Census data collection.
[g] Canvass concluded before epidemic had run its full course.

concern about obtaining representative population data. The PHS launched a considerable house-to-house survey collecting information on more than 146 000 persons. The PHS survey was the largest, but similar population-based designs had been used in Oswego, New York (n = 12 952); Watertown, New York (n = 20 473); Millville, New Jersey (n = 11 686); Gloucester, New Jersey (n = 11 969); Bridgeton, New Jersey (n = 13 319); New Britain, Connecticut (n = 2757)[14]; and Boston, Massachusetts (n = 10 000). Also, immediately after the 1928–1929 influenza epidemic, the PHS made surveys in 10 cities in the United States similar to surveys made in 1918 to 1919, including house-to-house canvassing.[16(p124)]

The trait of the PHS survey that stands out is the swift attempt to obtain representative data for the US population using state-of-the-art survey methods. The main national wave of the pandemic began in August 1918. Three months later—as soon as possible "after the epidemic appeared to have definitely subsided,"[13(p586)]—the PHS survey was fielded. More than 140 000 people in 16 localities were surveyed in two months (November 20, 1918, to January 31, 1919).

Whether the samples were representative of the localities surveyed has not been shown. It would be possible to compare the age–sex–"color" distributions in the survey data with those of the 1919 Census, but the First World War had depleted the young male population in many areas, making these assessments speculative.

Limitations

The PHS survey had several limitations. The absence of biological tests precluded the identification of asymptomatic, incubating, and subsymptomatic cases resulting in an underestimated cumulative incidence.

The lack of specific diagnosis may also have been a source of misclassification.

TABLE 3— Data and Statistics Reported on Centers for Disease Control and Prevention Web Sites Providing Insights Into the Incidence, Mortality and Overall Death Impact of the COVID-19 Pandemic, as of October 2020

Survey	Location	Population Base	Reports	Limitations
COVID-19–Associated Hospitalization Surveillance Network (COVID-NET) is a population-based surveillance system that collects data on laboratory-confirmed COVID-19–associated hospitalizations among children and adults through a network of more than 250 acute care hospitals in 14 states: https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covid-net/purpose-methods.html	70 counties in 14 states: CA, CO, CT, GA, IA, MD, MI, MN, NM, NY, OH, OR, TN, UT	29 million persons	Laboratory-confirmed hospitalized case rates. By age groups and sites. Denominator: entire number of people residing in that area. Updated weekly.	No information on asymptomatic or nonhospitalized cases
Commercial Laboratory Seroprevalence Survey: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/commercial-lab-surveys.html	Commercial laboratories in 10 sites: CT; LA; MN; MO; New York City; Philadelphia, PA; San Francisco, CA; southern FL; UT; western WA		People who had blood specimens tested for reasons unrelated to COVID-19. Aim: about 1800 samples collected from each of these 10 areas, approximately every 3–4 wk. Percentage of people tested already have antibodies against SARS-CoV-2, and how that percentage changes over time in each area. https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/commercial-labs-interactive-serology-dashboard.html.	No denominator; still preliminary.
Mortality: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/us-cases-deaths.html https://www.cdc.gov/nchs/nvss/vsrr/COVID19/index.htm	US	US	Number of deaths and infection fatality ratio for each of the communities under serosurveillance and the United States: https://www.cdc.gov/coronavirus/2019-ncov/hcp/planning-scenarios.html.	No denominator
Provisional death counts for COVID-19; excess deaths associated with COVID-19: https://www.cdc.gov/nchs/nvss/vsrr/COVID19/index.htm https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm#dashboard	US	US	Excess deaths (difference between the observed numbers of deaths in specific time periods and expected numbers of deaths in the same time periods). By race/ethnicity. By cause of death.	Reporting lags and underreporting

The PHS survey relied on self-report of physician diagnosis of influenza. However, data from the 1918–1920 pandemic in Bergen, Norway, indicate that medical visits were more systematic in severe waves than in milder waves[17] suggesting that the fall 1918 PHS survey may have ascertained most severe cases. Collins also noted that "the number of doubtful cases reported was so small that it appears that only the more severe colds were remembered by the informants."[16(p124)]

It is also unclear if the large differences in morbidity and mortality from place to place (see Table 2) are real or reflect the differences in timing of the survey resulting in localities being at different stages of the epidemic curve. In other parts of the world, such as in Bergen,[17] there was a summer wave and a winter wave, preceding and following the fall wave. If this were the case in the United States, the PHS captured part of these waves as it ascertained events from August 1, 1918, to March 12, 1919, but it captured them differentially across localities and may have failed to capture the full magnitude of the pandemic overall.

Herd Immunity and Fatality

The final analyses of the PHS survey indicate that the cumulative incidence rate for all localities was 29.4% over the 6-month period. In other words, one out of every three or four persons in the canvassed populations reported that they had some symptoms compatible with influenza during the autumn wave of the epidemic and the recurrence. The highest rate was in San Antonio, where one out of every two persons reported having the disease. Influenza killed 1.8% of the cases.

As already mentioned, the cumulative incidence was also underestimated because the assessment excluded asymptomatic cases, incubating cases, and subsymptomatic cases. A Spanish SARS-CoV-2 seroprevalence survey in 2020 found that about one third of seropositive individuals are asymptomatic.[18] Extrapolating this asymptomatic proportion to the estimated 1918 CIR, the average increases to about 40%, and varies between about 20% in Louisville and 70% in San Antonio. For the same reason, the CFR was overestimated by the house-to-house canvass, and must have been closer to 1.1% in average, varying from 0.6% in San Antonio to 2.4% in New London.

The case of Charles County is special. Because the influenza survey was coupled with the 1919 Census, the whole resident population was counted. The CIR was 40% (53% after correction for the asymptomatic cases), and the CFR was 2.3% (1.7% after correction for the asymptomatic cases). These figures were higher than the average.

Overall, we can conclude that the brunt of 1918 influenza in the United States lasted 6 months, from September 1918 to March 1919, but that a substantial proportion, maybe more than 50%, of the population was infected, and that about 1% of the infected died.

Social Determinants of Health

The 1918 canvas included questions about economic status, crowding, and "color." These were, of course, confounded markers but, as expected, they showed that incidence and mortality was higher among the poor. In many areas, Whites had greater rates of infection but died less than the people of color. This question has been extensively explored and discussed.[19] However, in Charles County, where enumeration was exhaustive for both Whites and people of color as part of the 1919 Census, both incidence and mortality were greater among the "colored" population. Therefore, selection and ascertainment biases, including access to medical diagnosis, must have been at work in the localities in which "colored" people had an apparent lower morbidity.

1918 VERSUS 2020

The pandemical context of the 1918 PHS survey is very different than that of the COVID-19 pandemic in 2020. Throughout the whole 1918–1919 pandemic, the nature of the micro-organism causing the influenza syndrome had not been identified.[20] The PHS knew it was an infectious agent, but it had not been demonstrated yet that it was a virus and the extent of the syndrome it could cause.[3(p158)] Attempts were made to develop killed whole cell bacterial vaccines, which would not have prevented influenza. Influenza viruses would not be isolated and identified until the 1930s, and the first commercial influenza vaccines were not licensed in the United States until the 1940s.[21] Nonpharmaceutical interventions were used in most US cities. They included social distancing measures (e.g., closure of schools, theaters, and churches; the banning of mass gatherings), mandated mask wearing, case isolation, making influenza a notifiable disease, and public disinfection and hygiene measures.[22] But the efficacy of preventive measures had not been proved.[3(p158)]

Today we know that COVID-19 is a respiratory virus, transmission of which can be slowed down by personal protection and social distancing. But current systems for surveillance are not where they should be. We are more than 8 months into the COVID-19 pandemic and nothing analogous to the 1918 PHS survey is available in the United States. The Centers for Disease Control and Prevention has done an impressive job at drawing all possible advantages from routinely collected data in private and public institutions of the United States. These resources are tabulated in Table 3. They allow for a quick representation of the state of the routinely collected data in the United States, with nimble graphical visualization. However, despite good intentions and expertise, we still are missing what was the core of the 1918 survey (i.e., data to assess population-based incidence and CFRs, and to compare them across time, people, and places). A modern surveillance system, using real-time collection, analysis, and visualization of population-based estimates of infection, hospitalization, and fatality, is warranted, but survey data, such as those collected by the 1918 PHS survey, remain indispensable to estimate reliable population-based morbidity and

fatality rates. Surely, we can do better throughout this COVID-19 response than was done knocking on doors in 1918. AJPH

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CONFLICTS OF INTEREST

I have no conflict of interest with the contents of this article.

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