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THOMAS FRANCIS, JR

*1900—1969*

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*A Biographical Memoir by*  
JOHN R. PAUL

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*Biographical Memoir*

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Thomas Francis Jr.

# THOMAS FRANCIS, JR.

*July 15, 1900–October 1, 1969*

BY JOHN R. PAUL \*

**T**HOMAS FRANCIS, JR., was born in Gas City, Indiana, on July 15, 1900, the son of Thomas and Elizabeth Anne (Cadogan) Francis. His father had emigrated from Wales shortly before Thomas, Jr., came into the world. He was the third of four children, but the first to be born in this country.

Thomas Francis, Sr., had studied for the ministry as a young man, but had decided later to join his father in the tin mills of South Wales. He had married Elizabeth Anne Cadogan, a graduate of a Salvation Army Training School in London. It is said that she kept "her Salvation Army ideals" throughout her entire life. At least she strove to do her part in supplying a firm religious background to her brood of four children.

In 1897 the Francis family had been persuaded to visit America. Their destination was a small colony of Welsh families which had settled in and about Gas City, Indiana. For a while this venture was considered to be temporary, but when the family moved to New Castle, Pennsylvania, and Mr. Francis became associated with the steel mills of that town, it became permanent. After Thomas Francis, Sr.'s, retirement from the steel mills he turned again to religious ideals and became or-

\* Prior to his death, the author asked Dr. Dorothy M. Horstmann of the Yale School of Medicine to make certain revisions in this memoir. The final version of the memoir owes a great deal to Dr. Horstmann's careful and constructive review, as well as to the faithfulness with which she adhered to the author's style.

dained as a lay minister. Henceforth he was known as the Reverend Thomas Francis. For several years he preached at a small New Castle church.

Both parents had very definite ideas about the home life of the Francis family: what it should be and how the children were to act. There were strict rules of behavior, and yet, in spite or because of them, the family life was a happy one. As a boy, Tommy led the normal existence of a lad in a small town environment in which his natural inclinations included fishing and baseball. At the local high school he became quite active in dramatics, which, according to his sister, were usually of the Shakespearean variety.

With regard to the rest of Tommy's immediate family, I shall not dwell, although they all enjoyed successful lives. His younger brother, Herbert, graduated in medicine from Yale. The bulk of Herbert's professional career was spent at the School of Medicine, Vanderbilt University, as professor and chairman of the roentgenology department and also as a consultant to the Institute of Nuclear Studies at Oak Ridge, Tennessee.

With high school over, where all records maintain that Tommy was an able student, he attended Allegheny College at Meadville, Pennsylvania, and received the B.S. degree in 1921. He entered medical school the following fall. I am not aware of the reason why he made the decision to study medicine but he told me often about his choice of a medical school. In this he was influenced by a brother-in-law (a successful surgeon, Dr. Edgar R. McGuire of Buffalo, New York), whose views he had sought during his last years at college. He was advised to consider seriously the idea of applying for admission at the rejuvenated Yale University School of Medicine, which had been completely overhauled by Yale's new President, James R. Angell, who had recently come from the University of Michigan, and by the new Dean of the Medical School, Dr. Milton C. Winternitz, who was also a newcomer at Yale from Johns Hopkins.

Although the Yale medical school was a venerable school of medicine as far as this country was concerned, having been founded jointly by the Connecticut State Medical Society and Yale College in 1810, it had never achieved its hoped for goals during the nineteenth and early twentieth centuries. Indeed, prior to World War I, it was definitely a second-rate school with only a handful of students. And yet, oddly enough, in 1915 it had on its faculty an unusually distinguished group of men: Yandell Henderson, as professor of physiology, and Lafayette Mendel, of vitamin fame, in biochemistry, both members of the National Academy of Sciences; and two very able and wise clinicians, George Blumer and Wilder Tileston, in internal medicine, both members of the Association of American Physicians.

But luckily the school made a sudden rightabout-face when in 1917 Winternitz arrived from Baltimore to assume the position of chairman of the Department of Pathology. He had previously been an associate professor of pathology at the Johns Hopkins medical school under that dean of pathologists, medical educators, and medical historians, Dr. William H. Welch. Dr. Welch had been a loyal graduate of Yale College and his hope was to do something along the lines of a salvage operation for the Yale School of Medicine. Winternitz was an able emissary to perform this duty. His move to Yale had come just at the time when the medical schools of this country were undergoing a state of ferment. The cause of this was the recent issuance, and the recognition of the worth, of the Abraham Flexner *Report on Medical Education in the United States and Canada*, which introduced a timely reform that was to go into sharp reverse within the next fifty years. Flexner's report was beginning to have its effect in 1917 and Winternitz was quick to take advantage of this. The recommendations concerned, in part, the introduction of the full-time system into the clinical departments of the medical schools of North America—an idea that

heretofore had been foreign to the rank and file of American physicians, academic or otherwise.

Within two years of Winternitz's coming to Yale, the medical faculty, sensing that here was no ordinary professor of pathology, elected him dean. His plan for Yale was modeled to a certain extent along the lines that made the Johns Hopkins School of Medicine great, that is, close personal contact between scholars and carefully picked students, and a devotion to research. So Winternitz, having made his decisions, went about his first task, which was that of gathering together the best young medical scientists and physicians that he could lay his hands on to fill the recently created full-time professorships in the clinical departments: Dr. Francis G. Blake, John P. Peters, and William T. Stadie from the Hospital of the Rockefeller Institute in internal medicine, all three of whom were subsequently to become members of the National Academy of Sciences; and Dr. Edwards A. Park in pediatrics.

It was at this stage, in 1921, coincident with Dr. Blake's arrival at the school as chairman of the Department of Internal Medicine, that the young Francis, having submitted his application, was accepted, and entered the newly rejuvenated Yale University School of Medicine as a first-year student. He was taking a chance not to have chosen one of the *established* and better known medical schools of this country. But, as it turned out, it was a chance worth taking. The reason for dwelling so long in this memoir on his academic background is that I am convinced that the training the young Thomas Francis received at Yale opened up a vista of new paths and new opportunities which he eagerly followed.

All accounts testify that he was a fun-loving, attractive, and able student, quick to learn and quick to appreciate the idea that the Yale school was supposed to do something out of the ordinary—and to act as a spearhead in a movement of reform

in medical education for the nation and for Yale University.\* Most of the members of the clinical faculties, especially those in internal medicine and pediatrics, whose combined members in the 1920s could not have amounted to more than fifteen or eighteen, had put their hearts and souls into making the new scheme work. They were determined to put the Yale school on the map and to establish beyond peradventure that the organization of the clinical departments on a full-time basis was not a theoretical pipe dream.

The young Thomas Francis became keenly aware of the intimate attention that was being bestowed on this first small group of medical students who had been admitted under the new regime. He soon fell under the spell of the newly appointed faculty members, who besides being clinicians were inspiring and high-minded teacher: men such as Francis G. Blake † and James D. Trask in medicine, and Edwards A. Park and Grover F. Powers in pediatrics. Dr. Blake was especially quick to recognize Francis's ability and his early grasp of what the school was supposed to do. As a result, a mutual respect developed that lasted throughout their lives.

With Dr. Blake he had almost a filial rapport. He admired Francis Blake as an astute diagnostician, a wise teacher, a physician and medical scientist of complete integrity, and an able clinical investigator. Besides, Blake had something akin to an epidemiological instinct long before that science had received the attention in this country that it deserved. This last characteristic accounted for Blake's being chosen as the first president to head the Army Epidemiological Board (AEB) during the years of World War II and for some years afterward.

\* The few instructors in the Department of Medicine in the Yale University School of Medicine of the 1920s who are living today all testify to this estimation of his character.

† See memoir of Francis G. Blake, by Dr. J. R. Paul, in *National Academy of Sciences, Biographical Memoirs*, 28 (1954):1-29.

Some of these qualities must have rubbed off on the young medical student who was eventually to become Dr. Blake's successor as president of the AEB [subsequently the AFEB (Armed Forces Epidemiological Board)] in the years 1958-1960.

When Dr. Francis graduated as an M.D. in 1925, he was immediately appointed as an intern on the medical service of the New Haven Hospital, the next year as resident, and the next as an instructor in Blake's Department of Internal Medicine. This was a prime example of the apprenticeship type of instruction in which the professor did not have to preach but resorted instead to imparting the principles of clinical medicine by personal example. As a result, the young Dr. Francis was inspired to set his sights to emulate Dr. Blake, who in turn recognized that his pupil, having fulfilled his post of house officer and instructor admirably, had also begun to show signs of promise as a clinical investigator. Blake's early estimate of Francis's talents was not far wrong, for sixteen years later Francis was to become the president of the American Society for Clinical Investigation.

In any event, Blake decided that here was no ordinary young physician—indeed, Thomas Francis was one who might go far. So he advised him to prepare himself further by a period of training at the best contemporary institution that was available for this kind of instruction, namely, the Hospital of the Rockefeller Institute. Blake had no hesitancy in recommending Dr. Francis to Rufus I. Cole, the director of this hospital, as a promising candidate. Francis was a young man who possessed all the talents of an able house officer and the qualifications of a budding research worker (assets which were highly sought after by Dr. Cole in any candidate he was to take on as a junior member of his staff). This sophisticated center of learning and research was a far cry from New Castle, Pennsylvania.

Had Francis pursued this course of in-service training to its obvious end, it should have led him straight down the path



of an academic career in internal medicine—to an assistant, then associate, and eventually a full professorship at one of the full-time medical schools in this country. But other career goals eventually proved more attractive to him.

Among the group which Dr. Cole had assembled on the Rockefeller hospital staff at this time were included Drs. Thomas M. Rivers, William T. Tillett, Oswald T. Avery, Donald D. Van Slyke, Alfred E. Cohn, Homer F. Swift, and several others whose names were to rank high during the 1930s—an era which is understandably considered by some as *the* age of the flowering of American Medicine—spelled with a capital M.

It was during this period that the young Thomas Francis began to gain a feeling of confidence that he had arrived as a person to be reckoned with in the field of full-time clinical investigation. Besides his qualifications as an investigator, his clinical abilities as a young physician also came to the fore on the the wards of the Rockefeller hospital. He often told me that he must have been appreciated as “a doctor” at this time. Among his prominent “private patients” were members of the Rockefeller family, and for a time he almost rated as their private physician.

Indeed, during the first half of his long and distinguished career, he did not relinquish the hope that he might be considered as a suitable candidate for a position as chairman of the Department of Medicine in one or another of the country's leading medical schools. This hope was not based on the fact that he possessed a knowledge of medicine that was of encyclopedic nature, but he felt the important thing was that he had acquired from his parents and his respected teachers—Drs. Blake and Cole—the altruistic principles of a physician, as well as the ideals of clinical medicine and, incidentally, of clinical investigation—and this was enough. Talents which Dr. Francis had developed at this time were those that had to do with both clinical and experimental medicine in infectious disease, micro-

biology, and epidemiology. He could have filled an academic position in any of these various fields, as well as a professorship in internal medicine.

On arrival at the Hospital of the Rockefeller Institute, Dr. Francis pursued the line of work that he had started under Dr. Blake at Yale. His interest had been aroused by studies which had to do with the various types of the pneumococcus, both rough and smooth varieties, and with the respiratory diseases including lobar pneumonia, a subject of great interest in that pre-antibiotic age. In an article written immediately after Dr. Francis's death, Colin M. MacLeod said:

"On coming to Avery's laboratory, Francis and William Tillett worked together on cutaneous and serological reactions to products of pneumococcus, particularly the specific capsular polysaccharides and the 'C' or somatic carbohydrate, now known to be a constituent of the bacterial cell wall. Over the three-year period of their collaboration two remarkable findings came forth.

"The first of these was that there occurs in the blood of patients with many acute infections a new substance, not an antibody in the usual sense, which reacts specifically with the 'C' carbohydrate of pneumococcus to give a precipitation reaction. During recovery from the disease the 'C-reactive protein,' as it came to be known, diminishes in amount and within a few days disappears entirely. This is an enigmatic reaction whose function in man and animals is still unknown but which provides a useful clinical test to measure the activity of a variety of infectious processes, for example the activity of the inflammatory process in rheumatic fever.

"Francis and Tillett also discovered that minute amounts of specific capsular polysaccharides of pneumococcus injected intracutaneously in man cause the development of specific antibodies and that the antibodies are protective. . . .

"While Francis was in Avery's laboratory, Dubos and Avery

had developed their famous studies on an induced enzyme obtained from a soil bacterium which specifically hydrolyzes the capsular polysaccharide of pneumococcus Type III whether the latter is in solution or attached to the living, virulent pneumococcus." \*

Dr. MacLeod went on to say: "Francis, with Terrell, devised methods for producing Type III pneumonia in monkeys and published meticulous studies of its clinical course. In collaboration with Dubos and Avery they then went on to demonstrate in this experimental disease of primates, which simulates pneumococcal pneumonia in man, that the S III enzyme has striking curative properties. Unfortunately, test of the therapeutic effect in man was never carried out."

Discontinuance of this line of investigation was due to Dr. Francis's departure from the pneumonia service when he entered upon his work on influenza. But Francis must have derived not a little satisfaction from his early work at the Rockefeller hospital, for in recounting the memory of it some forty years later in his address entitled "Moments in Medical Virology," presented at the First International Congress for Virology in Helsinki, Finland, he recalled events that had occurred while he had been working enthusiastically on the transformation of pneumococcus types. He said:

"So I spent the mornings in the laboratory learning of these phenomena and the afternoons in the library and on the tennis court developing a model of the double fault. Being convinced that the induced change of pneumococcus types in the animal host was a true bill, I began very primitive efforts to obtain transformation in the test tube. (It is worth noting that a healthy air of skepticism surrounded the entire phenomenon—that probably some live organisms were persisting in the heated, supposedly, killed preparation.) It became clear that the

\* Colin M. MacLeod, "Thomas Francis, Jr., 1900-1969," *Arch. Environmental Health*, 21 (1970):226-29.

capsular polysaccharide, with all its divine properties, was not the effective agency. But then it seemed likely that whatever the transforming principle was, it needed special care and I began making extracts by freezing and thawing organisms in the cold under relatively anaerobic conditions so as to avoid an enzymatic destruction of the principle. One day at noon I thought I was all alone in the lab. I was occupied with the tedious procedure of freezing and thawing. I had put my head down on my arms on the desk. Unexpectedly, a quiet voice said, 'What's the matter, boy?' Startled, I said I hated to see another pneumonia season start with the great time and attention required for clinical work; that I thought what was in these flasks was more exciting. Then I received a very sharp lecture from Dr. Avery reminding me that we were physicians; that the major concern of this laboratory was lobar pneumonia and that what was done here was in effect to understand the disease and to lick the pants off the pneumococcus—a theme that was developed under Avery and Dubos with the Type III decapsulating enzyme. This is a true view of Avery's intellectual commitment to the clinical problem.

"New lines of effort were freely allowed even if they were not always enthusiastically supported. I found this when I studied transformation of the rough Type III to virulent in rabbits; there was a lot of specificity involved and much work, but it never was published until later (by others) . . . Things were apparently dormant for 10 years.

"Then came the epochal study by Avery, MacLeod and McCarty in 1944. . . .

"Somewhere in these early days I rode on the train from New York to Princeton, New Jersey, with two leaders in virology, Thomas Rivers and Christopher Andrewes, to see a third, Dick Shope. In those days, virology had not yet descended to the level of the common man and I listened, as the privileged young

man, to their sage and effete comments on viruses and their behavior. The conversation turned to pneumococcus transformation and the nature of the principle. In my immaturity I asked if it were not like a virus—but this did not fit. Again today with the many accumulations of knowledge on many sides, one can still ask is it not a virus?—call it what you like in reply. It is a major part of virology—reactivation—recommendation and all.”

It was during the period when he was on the staff of the pneumonia service at the Rockefeller hospital that he married Dorothy Packard Otton, in 1933. The Francises had two children: Mary Jane and Thomas Francis III (“T”). Francis used to tell me over the years, with some wonderment and great interest, of the growth and development of their offspring. Theirs was a closely knit family.

He had begun at this early stage in his career not only to take an interest in literature but to match wits with critical minds in adroit and articulate conversation. He derived great pleasure from sitting among his friends talking about abstractions and the scientific fields with which he was acquainted; discussing personalities and what made men do the things they did, and indeed the affairs of the world in general. He developed early in life the characteristic of combining seriousness with an excellent sense of humor, but at the same time he was a tough and resilient opponent. At college he had been an amateur boxer and he never lost the opportunity of being combative—on occasions.

After his withdrawal from the pneumonia service at the Hospital of the Rockefeller Institute his work became concentrated solidly on the newly discovered influenza virus which Smith, Andrewes, and Laidlaw had turned up in London in 1933. Francis was almost the first microbiologist in this country to take advantage of the discovery. He proceeded to make what

was the first isolation of influenza virus on this side of the Atlantic—the PR-8 strain. In July 1934, an outbreak that had all the earmarks of influenza had occurred on the island of Puerto Rico, and Francis was considering a trip to that island (by boat) to try to isolate the virus. He was debating with himself and others (actually at the lunch table one day) whether the virus would withstand this prolonged travel and whether he could bring it back alive. Francis had to forgo the trip but he had gotten the idea that his objective could be achieved by a simpler method. Thus the proper specimens for virus isolation were obtained by the process of mailing some bottles containing a mixture of saline solution and glycerin to Puerto Rico for collection of sputum specimens from patients suffering from influenza-like symptoms in the current epidemic there. The bottles were then mailed back to New York. The use of glycerine to stabilize viruses present in clinical specimens had been introduced only a few weeks previously as an effective means of transporting and preserving poliovirus present in oropharyngeal washings obtained from patients suffering from poliomyelitis. This was before the days of dry ice and freeze-drying.

Together with his colleague Dr. Stuart-Harris (eventually Sir Charles Stuart-Harris) of England, Francis and his team were to make many a contribution in the field of experimental influenza using ferrets as the test animal. Indeed this work precipitated Francis promptly into a position of authority and leadership in the field of influenza in the United States, much as Flexner had found himself in a similar position in the poliomyelitis field when the news of Landsteiner's discovery of poliovirus had come across the Atlantic in 1908, and been confirmed at the Rockefeller Institute. Influenza being the kind of disease that it is, and with the 1918 pandemic fresh in almost everyone's mind, Dr. Francis was pitched forcibly into the field of epidemiology. I shall not attempt to describe all or even part of the

work done by Dr. Francis and his colleagues in the experimental laboratory. Many of their contributions were fundamental developments and of these several descriptions are contained elsewhere.\* Those accounts may be familiar enough by this time, but they were excitingly new in the late 1930s.

In the words of Sir Charles, written some thirty-five years after he had collaborated with Dr. Francis in New York:

“Of all the achievements for which Dr. Thomas Francis will be remembered, none surpasses his contributions to the elucidation of the problem of influenza. As the first American to recover and to study influenza virus in the laboratory, Dr. Francis lit in his own hand the torch of discovery which still burns brightly in the hands of others. When the first evidence of antigenic variation of the influenza A viruses was published in 1936 by Dr. Thomas Magill and Dr. Francis, it was received with incredulity by the London team of influenza workers of the Medical Research Council, Dr. Christopher Andrewes, Wilson Smith and Patrick Laidlaw. The latter, however, examined their viruses by neutralization with a hyperimmune horse serum whereas the Rockefeller workers used a more specific rabbit serum. On such apparently small differences may turn matters of great moment, and the great importance both epidemiologically and immunologically of the antigenic diversity of both influenza viruses A and B is now recognized universally.

“Dr. Francis’s demonstration that subcutaneous immunization with influenza vaccine can protect against epidemic influenza was an equally significant finding. The reasons why vaccine has yet to provide control over the disease [has been the source of constant argument]. . . . In truth the pioneer observation was but the end of the beginning, and much hard work and faith is required even now after 26 years. The inspiration of such men as Dr. Francis lives on in the lives of those whom

\* The Thomas Francis, Jr., Memorial Festschrift, *Arch. Environmental Health*, 21 (1970):225-474.

they have influenced, and I count it a privilege and a source of pride to have been an assistant to Dr. Francis many years ago at the Rockefeller Institute, New York." \*

It was inevitable that the talents of Thomas Francis were such that he should become a desirable choice for a chair in many a prominent U.S. medical school. His qualifications were so varied that he could command a professorship in any one of the fields in which he had been active. So, it was no surprise when he was offered and accepted in 1938 the chairmanship of the Microbiology Department at New York University College of Medicine, which carried a supplementary appointment as visiting physician at New York City's Bellevue and Willard Parker Hospitals. Dr. Francis had requested that he be allowed to pursue his clinical interests on the wards of these New York hospitals, and the authorities at N.Y.U., recognizing his clinical ability, had had no hesitancy in granting him hospital privileges. He was only thirty-eight years old at the time.

During his short period at N.Y.U., Dr. Francis continued to pursue influenza work with vigor. He had plenty of irons in the fire by this time and he had begun to make his influence known throughout the nation. He had many loyal students. One, in particular, was the bright young Jonas E. Salk, who in due time was to become a junior colleague and a devoted admirer.

A characteristic feature of Dr. Francis's long and variegated career was that he did not consider himself a specialist in any field, even in microbiology, the field in which he held a professorship. He had started out as a clinical investigator in the field of experimental medicine, an area in which he had already excelled. Although he branched out in many directions, he was always sympathetic to this—his most rewarding line of work. He was to be associated with the activities of various

\* C. H. Stuart-Harris, "Control of Influenza. Lack of Knowledge versus Lack of Application of Knowledge," *Arch. Environmental Health*, 21 (1970):276-85.



specialty societies; for example, as an active Fellow of the American Public Health Association, in which he served on numerous important committees; as a member of the Society of American Bacteriologists, of which he served as president in 1947; and as a member of the American Epidemiological Society, and its president in 1954–1955. But what is more remarkable, he identified himself continuously with clinical societies besides. Not only did he keep up with old friends at the annual Atlantic City meetings of the American Society for Clinical Investigation, of which he was president in 1945–1946, but of the Association of American Physicians—and he got tremendous pleasure out of these contacts. They provided a chance to renew old ties with friends who had continued in clinical medicine. To have maintained loyalty and a sustained interest in all of these variegated groups would have seemed well-nigh impossible. But Francis not only continued to attend an astronomical number of meetings—a fearfully time-consuming activity in itself—but he entered into the spirit and discussions of many of these gatherings with enthusiasm. Perhaps that was what made him such an excellent epidemiologist.

After three years at New York University, Francis changed his location in 1941. He had been invited by Dr. Henry F. Vaughan, the former Commissioner of Health in the city of Detroit, and the first dean of the newly established School of Public Health at the University of Michigan, to become Professor of Epidemiology and chairman of that department there. For twenty-eight years Francis was to administer this truly great department. It became for him more than just a department where the statistical methods of epidemiology were taught; it was a place where the whole philosophy of epidemiology was constantly explored. During this period he was to train such men as F. M. Davenport, his successor, Jonas E. Salk, and Gordon C. Brown, to mention but a few.

As early as 1941 his pioneer studies on influenza virus were

about to be put to a severe trial. Such a test would have probably come about in due time, but it was hastened by this country's precipitation into World War II. At this time the 1918 pandemic of influenza of World War I was still fresh in everyone's mind. That disastrous epidemic had taken a toll of U.S. servicemen (46,992) almost equal to those who had died of wounds received in combat (50,385). The Preventive Medicine Service in the Surgeon General's Office, Department of the U.S. Army, was determined, if it could do anything about it, not to let such a catastrophe happen again. Accordingly, the Board for Investigation and Control of Influenza and other Epidemic Diseases in the Army, soon to be shortened to the Army Epidemiological Board (AEB), was brought into being.\* It had been created by the newly appointed chief of Preventive Medicine Service in the Surgeon General's office, Col. (later Brig. Gen.) J. S. Simmons, M.C.; Dr. Francis G. Blake was its first president, and Col. (later Brig. Gen.) S. Bayne-Jones served as its first executive officer. Among these three men (Simmons, Blake, and Bayne-Jones) there had been no difficulty in selecting Thomas Francis, Jr., as director of the Board's first Commission on Influenza. Thus the happy relationship with Dr. Blake was renewed.

Fortunately the assignment was one that carried a minimum of the usual red tape and strict military responsibilities that might have ensued. Had it not been for the leaders who guided its course, this Board might well have had a pedestrian life. But all of those whose names have been mentioned had a reputation throughout the length and breadth of the land of fairness, scientific integrity, and an ability to get things done.

Soon Dr. Francis was to realize that not only had he been put in charge of the important task of protecting against in-

\* Bayne-Jones, "Board for the Investigation and the Control of Influenza and other Epidemic Diseases in the Army," *U.S. Army Med. Dept. Bull.*, 64 (1942):1-22.

fluenza the largest wartime army that had ever been assembled by the United States, but that his control measures would be followed eagerly and soon imitated or rejected by the U.S. Public Health Service—as well as the country at large. He had been the elected leader of a program of momentous importance. It was enough to have struck terror into the hearts of lesser men. But with his customary courage he rose to meet the challenge. He had not only the timely knowledge but the fortitude to take on such a responsible assignment.

The emergency posed by wartime conditions brought him the necessary confidence and also gave a boost to his own program on human vaccination against influenza, experiments which had been going on slowly heretofore. But now the way was open not only to improve technical methods in the preparation of influenza vaccines but to streamline the logistics of their administration as well. Also he was in a position that enabled him to devise tests of the effectiveness of his vaccines, paying particular attention to statistical adequacy in the design of the trials. To many members of the AEB commissions it had come as a surprise that here was an opportunity to conduct experimental trials on a scale hitherto impossible. No large body of men, no population of comparable age, had ever submitted to such controlled conditions. For these influenza trials had a decided advantage because they could be carried out under military jurisdiction, with the vaccinees being followed closely and compared with a matched control group of unvaccinated men.

Results of these early tests of 1943 conducted by the Commission on Influenza (AEB) were reported in a series of seven papers.\* As was practically inevitable, revisions in the conduct of the trials were made as work proceeded. New strains of influenza virus had to be incorporated into the vaccine as they

\* Members of the Commission on Influenza, Board for the Investigation and Control of Influenza and other Epidemic Diseases in the Army, Office of the Surgeon General, U.S. Army, *Am. J. Hyg.*, 42 (1945):1-105.

came along; and the addition of Freund's adjuvant was introduced as one of the best methods of enhancing the immune response to vaccine preparations of uncertain potency and for prolonging the protective effect of those vaccines of established value. And, as a useful procedure, frequent serum surveys spaced at intervals up to a year and more could occasionally be made to determine levels of antibodies which had been actually produced and retained by the vaccinees.

During subsequent postwar years, the work of the Influenza Commission was published promptly in a second series of papers. The fact that Salk's name headed the list of authors in one of these is a measure of his early accession to a position of leadership.

Salk's ability to design the vaccine trials and to carry them through to completion was of great help to Francis. The experience was also of signal help to the young Jonas Salk when it came later to the designing of his own experimental trials of the inactivated poliovirus vaccine. Interesting as the whole influenza vaccine story is and the part that the Commission on Influenza played at the very start, there is not room to include it here. It has been extensively reviewed in Francis's *Festschrift* volume.\*

On one feature, however, it is necessary to dwell, and that is the antibody response induced by the whole heterogeneous family of influenza viruses. There were infinite complexities, for it was found that when an individual became infected sequentially with a variety of different strains of influenza virus, apparently each one left its footprint, whether heavy or light. Francis, with Davenport and other collaborators, made the astute observation that it made a difference what the order of previous exposure to various strains of influenza had been. In other words, the individual's first influenza experience determined what his subsequent responses were to be and shaped

\* *Arch. Environmental Health*, 19 (1970):267-92.

the influenza antibody pattern of that particular individual. This was the doctrine of "original antigenic sin," as Francis was wont to call it. It was a subject that never ceased to fascinate him.

During the war years he was busy enough with matters pertaining to the study and control of influenza. But he did not spend all of his time on laboratory problems having to do with influenza viruses and the composition of vaccines: As a restless and inquisitive fieldworker he visited places far and near to see how the various vaccines were working. Incidentally, he branched out to try his talents on other virus diseases at this time, among which was infectious hepatitis.

In 1946, with the war over, he took a third viral disease under his wing—poliomyelitis. By this time the National Foundation for Infantile Paralysis (NFIP) had been in existence a dozen years, and Francis felt that here was an organization with which he could establish a firm relationship. As long as Thomas M. Rivers, his old colleague at the Hospital of the Rockefeller Institute, was its scientific mentor, he was willing to throw in his lot with the National Foundation. In the poliomyelitis field, after a few faltering steps, he quickly became an accomplished worker, and soon slid easily into a position of leadership.

It was during the period of the late 1940s and early 1950s that the NFIP had begun to change its image from that of an essentially philanthropic organization, operating in much the same way as The Rockefeller Foundation, to an organization that dominated to a certain extent the whole field of poliomyelitis. The NFIP had received an enormous and justifiable boost in confidence to do just this—as a result of the successful operation with an *ad hoc* interuniversity group which had set up a collaborative project and proved beyond doubt that the poliovirus family could be broken down into three types—I, II, and III. This early and important step in developmental research ultimately led to the control of the disease by vaccination. The

success of the typing program strengthened the NFIP's view that it could solve many problems by fostering cooperation among its interuniversity grantees—the leverage being that of continued financial support. To promote this scheme and to signify the confidence that the NFIP placed in Dr. Francis, in 1953 he was called upon to administer the truly colossal task of conducting a field trial on the Salk-type vaccine—the largest trial to test the effectiveness of any vaccine that had ever been attempted anywhere.

But here I should retrace my steps to indicate that by mid-century Thomas Francis had reached a stage in his career when he had branched out beyond being a specialist in influenza or in the two other diseases he had investigated to date—polio-myelitis and infectious hepatitis. In reality he had become an epidemiologist capable of covering the whole broad field of medicine.

By this time most of his old friends had become medical administrators or full-time clinicians. But his bond with clinical medicine was so strong that he was ready to take his place among clinical societies and hold his own among the discussions, be they ever so erudite, even though over the years the sheer number and variety of these meetings had taxed him beyond endurance. And yet he always was ready to discuss a question which in any way touched his heart.

An episode which occurred at the Atlantic City meetings provides an indication of his devotion to clinical medicine and to the old clinical days in New York that represented his first love. Thus, some five or more years after he had settled in Ann Arbor, he sprang to his feet to engage in a discussion on the floor. I believe the occasion was a meeting of the Association of American Physicians. His first words through the microphone were: "Francis, of New York City." It was a Freudian slip due, I believe, to an attempt to retain the image

of the old days when he had combined his eager clinical interest in infectious disease and in experimental medicine; in this combination lay the makings of a great epidemiologist.

When Francis became president of the Armed Forces Epidemiological Board (during the period 1958–1960), his ability to understand this group of clinicians, lately turned amateur epidemiologists, was where much of his strength lay. As was his wont, he fought frequent bitter battles with these clinicians, particularly over the question of their innate disparagement and disregard of the use of biostatistics. But he was nonetheless able to understand them, for he had been brought up with them. By keeping abreast of clinical medicine through attendance at various meetings he bridged the gap between the specialty of epidemiology and the whole broad field of the medical sciences. This ability enabled him to take the change in emphasis from infectious diseases to noninfectious diseases in his stride.

But to return to the year 1953. During September, while on sabbatical leave from the University of Michigan, Tommy Francis had been attending a meeting in Geneva of the World Health Organization's (WHO) Expert Committee on Viruses—a meeting which had been called to discuss not only poliomyelitis in general but the impending vaccination trials. Subsequently he made his way gradually through northern Italy, visiting the art treasures and galleries in Florence and other Italian cities.

Tommy recounted to me several times how he became saddled with the huge job of directing the NFIP's 1954 field trial on the inactivated Salk-type poliovirus vaccine. It was about Thanksgiving time, 1953, as he was visiting friends in London, that he received a telephone call from Hart Van Riper in New York putting the question abruptly to him as to whether he would consider an assignment as director of the field trial. This was shortly after Dr. Joseph Bell (of the Na-

tional Institutes of Health) had submitted his resignation from this difficult position.

The upshot was that, after a bit of soul-searching on Francis's part and a number of conferences including a session with Professor Bradford Hill, the eminent biostatistician at the London School of Tropical Medicine and Hygiene, he came to New York about Christmastime and there laid down in no uncertain manner the only terms under which he would accept the responsibility of running such a trial. These included the crucial point that an equal or greater number of children than those who were to receive the vaccine should receive an injection of an inert solution (the placebo controls), so that the two groups could be followed in exactly the same manner. He also insisted on noninterference on the Foundation's part. Not until all these conditions were agreed to did he accept the assignment. Thus the Poliomyelitis Vaccine Evaluation Center was quickly established in early 1954 at the University of Michigan.

It was anticipated that the field trial would begin in the latter part of March 1954 and would be concluded in early June, that is, before the beginning of the poliomyelitis season. The collection and testing of matched samples of sera from the vaccinees and their fellow schoolmates who acted as placebo controls was a huge task. Had not the field trial had excellent planning by Dr. Francis and had it not been carried out under such carefully controlled conditions, it probably would not have succeeded. As it was, the experiment did not escape criticism. But probably never in the history of medicine has a new public health measure been tested on such a wide scale and so thoroughly. It was risky doing so many vaccinations with an unknown product that might be potentially dangerous, but as events turned out, the trial came through without mishap. The venture had proved to be eminently worthwhile.

During a period of seven or eight months the nation waited expectantly to see what results would be forthcoming in the



widely heralded field trial. Inevitably as the trial drew to its close, interest in the public press, which had been alerted to the fact that "big news" was in the offing, mounted accordingly. Dr. Francis often recounted to me how repeated attempts were made by several news agencies to obtain a release—a preview of results—before he or anyone else was ready, even before a comparison of the results in vaccinees and controls had been completed. One news agency is reported to have announced sometime in late February or early March 1955 that it had learned "from an unimpeachable source that the vaccine had proved 100 per cent effective." Immediately thereafter other newspapers began to storm Dr. Francis's office by telephone for a verification or a denial. Accordingly Dr. Francis's words to the reporter on the wire were: "I have absolutely nothing to say. If I said: Yes, it is true; or if I said: No, it is not true, my statement would be taken as if I had something to say, but to tell you the honest truth I *really* have nothing to say. If you are so anxious for news at this point, I advise you to go back to that unimpeachable source from whence the rumor originally came."

The field trial had been inadvertently taken out of its proper setting as a scientific experiment and had emerged as a prime dramatic spectacle. Perhaps it was inevitable, for by this time a far larger audience than the medical profession had been aroused. More than 1,800,000 children throughout the length and breadth of the land had participated in the great "experiment," and all were anxious about the results.

Describing the day of the news release, April 12, 1955, Dr. Francis had occasion some years later to write:

"It may be worthwhile to visualize the circumstances which prompted the undertaking. Just think: after years of theoretical consideration, of investigating and speculating, here was a vaccine which was a natural development of accumulated technical advances and experimental demonstrations that antibody is

directly correlated with protection against poliomyelitis. Here was substantial evidence that children receiving the material developed significant levels of antibody without harmful effect. Here was an agency, headed by a forceful imaginative administrator, possessing the financial resources, the staff, the nationwide organization, the public support and the desire to subject the material to a critical test of effectiveness. Moreover, it was highly desirable to determine for the guidance of future research whether or not the currently accepted hypotheses of pathogenesis and immunity to poliomyelitis were sound. . . . This was the situation in December 1953, when the proposal was made that the evaluation be conducted at the University of Michigan.” \*

For a time it seemed appropriate that the news of the outcome of the trial be made public at a meeting of an important scientific society. The annual meeting of the National Academy of Sciences was suggested as a place where the report might have at least a slim chance of being discussed dispassionately. The annual meeting of the American Epidemiological Society was considered, but the body was excluded as being too small an organization to handle such big news. Gradually the forces of publicity and sensationalism took over and since the Poliomyelitis Vaccine Evaluation Center had been established at the University of Michigan, it seemed that this university had the right to capitalize on the project which had become such a national issue. Furthermore, the university had an appropriately large hall to accommodate the army of newsmen that was expected to be on hand to hear the momentous announcement. A full-dress meeting was therefore set to be held in Ann Arbor on April 12, 1955, which incidentally turned out to be the tenth anniversary of President Franklin D. Roosevelt's death.

The abbreviated report which Dr. Francis gave at the meet-

\* T. Francis, Jr., *et al.*, *Evaluation of the 1954 Field Trial of Poliomyelitis Vaccine; Final Report* (Ann Arbor, Mich., Edwards Brothers, Inc., 1957), p. xxvii.

ing, unequivocally established the product developed by Dr. Salk and further tested by Dr. Francis as an effective vaccine for the prevention of poliomyelitis. The latter stressed that he was not presenting a preliminary report but a summary of objective analyses of valid data from records that were essentially complete. No one can say that the result was not a triumph. History had indeed been made. The inactivated Salk-type vaccine eventually was to have a tremendous effect in reducing the rate of paralytic poliomyelitis in this country and around the world.

And yet the circumstances under which the report was released proved to be a temporary disaster for American science. Dr. Francis, who had done his work with such care and scientific integrity, was unhappy to have it so exploited. One witness described the scene as being set to the tune of "the rockets' red glare and flash bulbs bursting in air." The information which had been gathered so painstakingly at the Evaluation Center and at such an expense of time, money, and energy by Francis and his earnest staff of workers, did not deserve to be so cheapened by the hysterical outburst that ensued. It is said that one excuse for the response was that it was "the American way of doing things." In any event, the triumphant manner in which the news was announced to a waiting public was almost bound to have a backlash. And when one came just fifteen days later in the form of the Cutter incident, which involved a number of cases of vaccine-induced paralysis due to a faulty lot of vaccine, the accident led fortunately to only a temporary upset in the program, although the setback might have proved to be a major tragedy. The publicity-minded exploiters of the situation had practically asked for it.

And yet, although his scientific reputation had been jolted, through it all Tommy Francis kept his head. He had not been responsible for the manner in which his excellent field trial had been downgraded, or for events which had followed close

upon the heels of the spectacular news release. He had performed his colossal task with an adroitness and a thoroughness that characterized his whole professional career.

The strenuous life that he led nevertheless took a toll. Early in his career Tommy Francis had begun to suffer from recurrent symptoms of peptic ulcer, an affliction that was to plague him for the rest of his life and was eventually to be responsible for his death. As he took on an increasing load of major tasks and responsibilities, symptoms had increased; but once he had achieved the confidence that comes from dealing with extensive projects, he felt he could get on with them, come what may.

At about the time of the completion of the vaccine trial, Francis, having sensed the fact that epidemiology did not deal exclusively with infectious diseases, made the decision to branch out and consider more important, and certainly more prevalent, noninfectious diseases, that is, ailments which were to prove a major plague to mankind during the second half of the twentieth century; they were very different ones from those of the first half. As Sigerist, the medical historian, had said: "Every civilization makes its own diseases." It was such a philosophy that enabled Francis to make the transition easily from microbiology and the epidemiology of infectious diseases to the epidemiology of the whole broad field of noninfectious conditions, such as heart disease, cancer, and other chronic illnesses including mental illness. After all, for the epidemiologist the shift was not to a different field but was just a matter of applying epidemiological methods to other conditions.

His immediate approach to this wider field was to select a town population (the town of Tecumseh, Michigan) and to initiate there a continuing study. Its objective was to observe, as a doctor observes his patient, the diseases or illnesses that various segments of the population suffer—in other words, what

happens to the life of that community and various sections of it in the ordinary passage of time.

Well do I remember when Francis first brought up the subject for discussion before one granting agency. The reaction of certain individuals was: "Surely, this is not epidemiology." And his application was immediately voted down. But Francis persisted. He knew that it "was the latest and most forward looking kind of epidemiology." The members of the Tecumseh staff, to whom the project had been entrusted, wrote some twenty years later:

"It was toward the understanding of fundamental disease processes that his [Dr. Francis's] deep interest and concern was primarily directed. His plan for a comprehensive study of health and disease in what he called a 'natural community' evolved in the late 1940s and early 1950s. The great vision was to observe people of all ages, as individuals, members of families and various social groupings, to determine the factors which preserve health and predispose to disease." \*

The study, in which the emphasis was on cardiovascular disease, had been a model for many another epidemiological project. It also has become an integral part of the teaching program of the Department of Epidemiology of the School of Public Health at the University of Michigan.

Yet not content with large and small projects close to home, he embarked on another one which was to take him on frequent trips halfway round the world. Whenever and wherever, in either the western or the eastern hemisphere, the opportunity arose to deal with a project that appealed to him, and was important enough, he must have a look at it. Such was the impetus behind his contribution to the work of the Atomic Bomb Casualty Commission (ABCC).

\* F. H. Epstein *et al.*, "The Tecumseh Study Design, Progress and Perspective," *Arch. Environmental Health*, 21 (1970):402-7, p. 402.

When President Harry Truman issued a directive in 1946 requesting the National Academy of Sciences–National Research Council to initiate and conduct a study of the delayed effects of radiation on the survivors of the bombings which had taken place over Hiroshima and Nagasaki, Japan, he probably had little awareness of what a tremendous time-consuming and expensive undertaking such a study involved. During the subsequent twenty-five years, in the words of Dr. Keith Cannon, it has been “a story of a continuing struggle to pursue intellectually valid investigative goals in the face of uncontrollable variables and in the changing winds of recruitment of investigators, of national economic policies, and of international relationships. Work has been continuous for 22 years and the end is not yet in sight. . . .

“There were, however, no adequate rosters of survivors nor were there means to establish a physical estimate of the amount of radiation to which each survivor was exposed. Japanese estimates indicated that there might be as many as 300,000 survivors. If acceptable epidemiologic principles were to be applied, it would be necessary to seek out each one of these individuals, record his current residence, his medical history, his exact location at the time of the bomb, and the kind of shielding from radiation that was afforded by his surroundings.”

Dr. Francis’s report on this colossal survey was, in the words of Dr. Cannon, “a blueprint for a ‘Unified Study Program’ for ABCC. It was based on a broad strategy of detection designed to be sensitive to the emergence of diseases that might be uniquely associated with exposure to ionizing radiations, but designed also to record significant alterations in the incidences of and in the natural histories of, known diseases and changes in physiological status not detected in evidences of overt diseases.” \*

\* R. K. Cannon, “Contribution to the Work of the Atomic Bomb Casualty Commission (ABCC),” *Arch. Environmental Health*, 21 (1970):263–66.

This investigation would not be accomplished in a year or two. Indeed, it was only through the resolute leadership of George B. Darling, D.P.H., director of ABCC since 1957, that the study continued and achieved important results. Dr. Francis laid down the rules. His contribution to this venture is remarkable in its enduring quality.

Over and above supplying the necessary leadership of his department at the University of Michigan, Francis developed a new interest which continued during the latter part of his professional career. In 1963 he became a member of the Board of Scientific Advisors of the Jane Coffin Childs Memorial Fund for Medical Research. This is a granting agency, established in association with the Yale University School of Medicine, concerned with cancer research. The field was new for him, but even then he never felt at a loss to tackle something new. How he had gotten into it in the first place is partially explained by his great friendship with Dr. Richard Shope of the Rockefeller University, also on the Childs Fund Board. Shope was a great friend and his path had constantly intertwined with that of Dr. Francis from the early days on. As a measure of his success in this venture, Francis became the director of the Board from 1965 to 1969.

Perhaps his interest in the subject of neoplasms had been stimulated as far back as the 1950s, when Francis recorded a great moment in his varied career. This event occurred after lunch one day at the Rockefeller Institute when he encountered Dr. Peyton Rous, and Rous asked if he could talk to him briefly.

“He seemed a bit agitated and I thought he wanted some medical advice. We went to the library where he told me they had just found that a number of rabbits they had kept for a long period after inoculation with the Shope papilloma had developed genuine cancers. I’m told he had been in England for three months, and one didn’t work in summers. It was clear

that he was not just agitated, but really excited. So was I. Moreover, it was quite surprising that he decided to tell me. His reason, he said, was that he believed we observed and thought in similar ways—very complimentary—but I believe I was the first one he ran into.” \*

And so we have but skimmed over briefly the career of this remarkably able, knowledgeable, and friendly man. Not that he was unable to be tough at times, and indeed he could drive people sometimes to the brink of distraction. But in the words of Dr. Myron E. Wegman, who succeeded Henry Vaughan as the dean of the Michigan School of Public Health: “Everyone knew that he never drove anyone else harder or farther than he would have driven himself, and that Tommy would be as pitilessly critical of the work of his most senior associate colleague as he was of the junior associate.” †

That was the characteristic that made him in constant demand on important government and international committees. There he was a combination of articulateness, humor, wisdom, and sound criticism—yoked to friendliness. He was at his best in discussions where he was both sharply critical of what he considered to be wrong and equally generous of what was right.

When he came to New Haven in the later years of his life to attend a meeting of the Board of the Childs Fund, he seldom forgot his old friends. Although I had retired from Yale University and was living some fifteen miles in the country at this time, he almost always called me up, and on occasion visited me.

On these visits our talks used to range widely—over the current state of the political and social scene—and even in general about what was good for mankind; but most of all about the good friends we had known in the past, and what had made them do what they did. We shall miss him sorely.

\* *Op cit.*, “Moments in Medical Virology,” pp. 226–28.

† Myron E. Wegman, “Thomas Francis Jr.: An Appreciation,” *Arch. Environmental Health*, 21 (1970):230–33.



IN WRITING this memoir I have drawn heavily upon the Thomas Francis, Jr., Memorial Festschrift Number of the *Archives of Environmental Health*, 21 (Sept. 1970):225-418. This issue contains many articles describing in detail Dr. Francis's career and scientific achievements.

I am also greatly indebted to Mrs. Thomas Francis, Jr., and Mrs. Arthur J. Lacey (widow and sister, respectively, of Dr. Francis), for their accounts of the background of the Francis family.

## CHRONOLOGY

- 1900 Born July 15, Gas City, Indiana
- 1921 B.S., Allegheny College
- 1925 M.D., Yale University School of Medicine
- 1927–1928 Instructor in Medicine, Yale University School of Medicine
- 1928–1936 Hospital of the Rockefeller Institute
- 1933 Married June 29 to Dorothy Packard Otton; children: Mary Jane, Thomas Francis III
- 1936–1938 Member of staff of International Health Division, The Rockefeller Foundation (in charge of influenza research)
- 1938–1941 Professor of Bacteriology and Director of Bacteriological Laboratories, New York University College of Medicine
- 1938–1941 Visiting Physician, Bellevue Hospital; Third Medical Division, New York University
- 1940–1941 Visiting Physician, Willard Parker Hospital, New York City
- 1941 D.Sc. (Hon.), Allegheny College  
M.S. (Hon.), Yale University School of Medicine
- 1941–1969 The Henry Sewall University Professor of Epidemiology and Chairman of the Department of Epidemiology, School of Public Health, University of Michigan
- 1941–1969 Professor of Epidemiology, Department of Pediatrics and Communicable Diseases, University of Michigan Medical School
- 1961–1968 Director, Center for Research on Diseases of the Heart, Circulation, and Related Disorders, University of Michigan
- 1968 University of Freiburg, Germany, Dr. Med. (Hon.)

## MILITARY SERVICE

- 1941–1955 Director of the Commission on Influenza, Armed Forces Epidemiological Board, Department of Defense; Member, from 1941 onward
- 1955–1967 Member, Armed Forces Epidemiological Board, Department of Defense; President, 1958–1960

1955-1967

(Continued)

Lecturer, Tropical and Military Medicine, Army Medical School, Washington, D.C., during World War II  
Overseas missions to Natoussa, Etoussa, Antilles, and Pacific area during the war

BIOGRAPHICAL MEMOIRS  
HONORS AND DISTINCTIONS

## AWARDS

- 1946 Medal of Freedom, United States Army
- 1947 Lasker Award for influenza research, American Public Health Association
- 1952 Howard Taylor Ricketts Award and Medal, University of Chicago
- 1953 James D. Bruce Memorial Lecturer for 1953 and Medal in Preventive Medicine, American College of Physicians
- 1953–1954 Henry Russell Lectureship, University of Michigan
- 1955 Phi Delta Epsilon Fraternity, Annual Award of Merit
- 1955 Wolverine Frontiersman Award
- 1956 SPHINX, Honorary Society, Junior Class Honorary Society, University of Michigan
- 1960 Faculty award for distinguished achievements, Development Council of the University of Michigan
- 1961 Michigan Health Council Hall of Fame in Health
- 1967 Outstanding Civilian Service Medal, U.S. Army
- 1967 The Memorial Medal and Badge of the Gamaleya Institute of Epidemiology and Microbiology, Academy of Medical Sciences of the USSR, for recognition of his contribution in advancing biological research
- 1969 ABCC, NRC Commemorative Medal for distinguished service

## MEMBERSHIPS IN PROFESSIONAL, HONORARY, AND LEARNED SOCIETIES

- Harvey Society (Secretary, 1938–1941)
- Society of American Bacteriologists (Chairman, Medical Section, 1940; Editorial Board, *Bacteriological Reviews*; Vice President, 1946; President, 1947)
- American Society for Clinical Investigation (Editorial Board, 1940–1944; President, 1945–1946)
- Society for Experimental Biology and Medicine (Editorial Board, *Proceedings*, 1941–1946)
- American Medical Association
- American Public Health Association, Fellow (Member of the Governing Council; Chairman, Committee on Research and Standards, 1947–1950; Chairman, Epidemiological Section, 1951; Chairman, Subcommittee on Diagnostic Procedures; Editor,

*Diagnostic Procedures for Virus and Rickettsial Disease*, 1st edition, 1948)

American Association of Immunologists (Editorial Board; Councillor; President, 1949–1950)

American Academy of Microbiology

American Epidemiological Society (President, 1954–1955)

American Philosophical Society (Committee on Membership, Class II, Geological and Biological Sciences)

American Society of Experimental Pathology

Association of American Physicians

Association of Schools of Public Health

Constantinian Society

Central Society for Clinical Research

History of Science Society

National Academy of Sciences, elected 1948 (Member of the Governing Council, 1958–1961; Member of the Executive Committee and Member at Large of the Division of Medical Sciences, 1960–1963; Member of the Kovalenko Fund, 1954–1959; Chairman, Section on Pathology and Microbiology, 1963–1966; Chairman, Marsh Fund Committee, 1963; Editorial Board, *Proceedings*, 1958–1961)

New York Academy of Medicine

New York Academy of Sciences

American Academy of Arts and Sciences, Fellow, 1960

American Heart Association, Fellow in the Council on Epidemiology, 1965

## BIBLIOGRAPHY

*KEY TO ABBREVIATIONS*

- Am. J. Hyg. = American Journal of Hygiene  
 Am. J. Med. Sci. = American Journal of Medical Sciences  
 Am. J. Public Health = American Journal of Public Health  
 Am. Rev. Resp. Diseases = American Review of Respiratory Diseases  
 Ann. Internal Med. = Annals of Internal Medicine  
 Ann. N.Y. Acad. Sci. = Annals of the New York Academy of Sciences  
 Brit. J. Exp. Pathol. = British Journal of Experimental Pathology  
 Bull. N.Y. Acad. Med. = Bulletin of the New York Academy of Medicine  
 Bull. World Health Organ. = Bulletin of the World Health Organization  
 J. Am. Med. Assoc. = Journal of the American Medical Association  
 J. Clin. Invest. = Journal of Clinical Investigation  
 J. Exp. Med. = Journal of Experimental Medicine  
 J. Immunol. = Journal of Immunology  
 J. Infect. Diseases = Journal of Infectious Diseases  
 J. Lab. Clin. Med. = Journal of Laboratory and Clinical Medicine  
 J. Mich. Med. Soc. = Journal of the Michigan Medical Society  
 Med. Clin. N. Am. = Medical Clinics of North America  
 Milbank Mem. Fund Quart. = Milbank Memorial Fund Quarterly  
 Oral Surg., Oral Med., Oral Pathol. = Oral Surgery, Oral Medicine, Oral Pathology  
 Proc. Soc. Exp. Biol. Med. = Proceedings of the Society for Experimental Biology and Medicine  
 Trans. Assoc. Am. Physicians = Transactions of the Association of American Physicians  
 Univ. Mich. Med. Bull. = University of Michigan Medical Bulletin  
 Yale J. Biol. Med. = Yale Journal of Biology and Medicine

1928

Studies on pathogenesis and recovery in erysipelas. *J. Clin. Invest.*, 6:221.

1929

With W. S. Tillett. Cutaneous reactions to the polysaccharides and proteins of pneumococcus in lobar pneumonia. *J. Exp. Med.*, 50:687.

1930

With W. S. Tillett. Serological reactions in pneumonia with a non-protein somatic fraction of pneumococcus. *J. Exp. Med.*, 52:561.  
 With W. S. Tillett. Cutaneous reactions in pneumonia: the development of antibodies following the intradermal injection of type-specific polysaccharide. *J. Exp. Med.*, 52:573.

1931

With W. S. Tillett. Cutaneous reactions in rabbits to the type-specific capsular polysaccharides of pneumococcus. *J. Exp. Med.*, 54:587.

1932

The identity of the mechanisms of type-specific agglutinin and precipitin reactions with pneumococcus. *J. Exp. Med.*, 55:55.

1933

The value of the skin test with type-specific capsular polysaccharide in the serum treatment of type I pneumococcus pneumonia. *J. Exp. Med.*, 57:617.

1934

Antigenic action of the specific polysaccharide of pneumococcus type I in man. *Proc. Soc. Exp. Biol. Med.*, 31:493.

With T. J. Abernethy. Cutaneous reactions in pneumonia to the somatic ("C") polysaccharide of pneumococcus. *J. Clin. Invest.*, 13:692.

With E. E. Terrell. Experimental type III pneumococcus pneumonia in monkeys. I. Production and clinical course. *J. Exp. Med.*, 59:609.

With E. E. Terrell, R. Dubos, *et al.* Experimental type III pneumococcus pneumonia in monkeys. II. Treatment with an enzyme which decomposes the specific capsular polysaccharide of pneumococcus type III. *J. Exp. Med.*, 59:641.

Transmission of influenza by a filterable virus. *Science*, 80:457.

1935

Immunological relationships of strains of filterable virus recovered from cases of human influenza. *Proc. Soc. Exp. Biol. Med.*, 32:1172.

Diagnosis and management of pneumonia in the United States. *Ugeskrift for Laeger*, 24:639.

Recent advances in the study of influenza. *J. Am. Med. Assoc.*, 105:251.

With T. P. Magill. Rift Valley fever: a report of three cases of laboratory infection and the experimental transmission of the disease to ferrets. *J. Exp. Med.*, 62:433.

- With T. P. Magill. Immunological studies with the virus of influenza. *J. Exp. Med.*, 62:505.
- With T. P. Magill. Cultivation of human influenza virus in an artificial medium. *Science*, 82:353.
- Localization and development of the lesion in experimental pneumonia. *Archives of Pathology*, 19:860.

1936

- Etiological and immunological aspects of influenza. *Health Examiner*, 5:13.
- With T. P. Magill. Vaccination of human subjects with virus of human influenza. *Proc. Soc. Exp. Biol. Med.*, 33:604.
- With R. E. Shope. Neutralization tests with sera of convalescent or immunized animals and the viruses of swine and human influenza. *J. Exp. Med.*, 63:645.
- With T. P. Magill. The incidence of neutralizing antibodies for human influenza virus in the serum of human individuals of different ages. *J. Exp. Med.*, 63:655.
- With T. P. Magill. Studies with human influenza virus cultivated in artificial medium. *J. Exp. Med.*, 63:803.
- With R. E. Shope. The susceptibility of swine to the virus of human influenza. *J. Exp. Med.*, 64:791.
- With T. P. Magill. Antigenic differences in strains of human influenza virus. *Proc. Soc. Exp. Biol. Med.*, 35:463.

1937

- Studies in influenza. *Pennsylvania Medical Journal*, 40:249.
- With T. J. Abernethy. Studies on the somatic C polysaccharide of pneumonococcus. I. Cutaneous and serological reactions in pneumonia. *J. Exp. Med.*, 65:59.
- With T. P. Magill. The antibody response of human subjects vaccinated with the virus of human influenza. *J. Exp. Med.*, 65:251.
- Epidemiological studies in influenza. *Am. J. Public Health*, 27:211.
- With T. P. Magill. Direct transmission of human influenza virus to mice. *Proc. Soc. Exp. Biol. Med.*, 36:132.
- With T. P. Magill. Direct isolation of human influenza virus in tissue culture medium and on egg membrane. *Proc. Soc. Exp. Biol. Med.*, 36:134.
- With T. P. Magill. The action of immune serum on human influenza *in vitro*. *J. Exp. Med.*, 65:861.



- With M. D. Beck, T. P. Magill, *et al.* Studies with human influenza virus during the influenza epidemic of 1936-1937. *J. Am. Med. Assoc.*, 109:566.
- With T. P. Magill, E. R. Rickard, *et al.* Etiological and serological studies in epidemic influenza. *Am. J. Public Health*, 27:1141.
- Rift Valley fever. In: *Practitioner's Library of Medicine and Surgery*, ed. by G. Blumer. New York, Appleton-Century Company.
- Recent advances in our knowledge of the etiology of influenza. In: *Practitioner's Library of Medicine and Surgery*, ed. by G. Blumer. New York, Appleton-Century Company.

## 1938

- With E. R. Rickard. The demonstration of lesions and virus in the lungs of mice receiving large intraperitoneal inoculations of epidemic influenza virus. *J. Exp. Med.*, 67:953.
- The immunology of epidemic influenza. *Am. J. Hyg.*, 28:63.
- With T. P. Magill. A flocculation phenomenon with human sera and suspensions of the virus of epidemic influenza. *Proc. Soc. Exp. Biol. Med.*, 39:81.
- With T. P. Magill. An unidentified virus producing acute meningitis and pneumonitis in experimental animals. *J. Exp. Med.*, 68:147.
- With T. P. Magill. Antigenic differences in strains of epidemic influenza virus. I. Cross-neutralization tests in mice. *Brit. J. Exp. Pathol.*, 19:273.
- With T. P. Magill. Antigenic differences in strains of epidemic influenza virus. II. Cross-immunization tests in mice. *Brit. J. Exp. Pathol.*, 19:284.
- With C. H. Stuart-Harris. Studies on the nasal histology of epidemic influenza virus infection in the ferret. I. The development and repair of the nasal lesion. *J. Exp. Med.*, 68:789.
- With C. H. Stuart-Harris. Studies on the nasal histology of epidemic influenza virus infection in the ferret. II. The resistance of regenerating respiratory epithelium to reinfection and to physico-chemical injury. *J. Exp. Med.*, 68:803.
- With C. H. Stuart-Harris. Studies on the nasal histology of epidemic influenza virus infection in the ferret. III. Histological and serological observations on ferrets receiving repeated inoculations of epidemic influenza virus. *J. Exp. Med.*, 68:813.

1939

Quantitative relationships between the immunizing dose of epidemic influenza virus and the resultant immunity. *J. Exp. Med.*, 69:283.

The diagnosis of virus diseases. *Minnesota Medicine*, 22:807.

Epidemic influenza. Studies in clinical epidemiology. *Ann. Internal Med.*, 13:915.

1940

Intranasal inoculation of human individuals with the virus of epidemic influenza. *Proc. Soc. Exp. Biol. Med.*, 43:337.

Influenza. In: *Modern Medical Therapy in General Practice*, ed. by D. P. Barr, Vol. 2, pp. 1597-1605. Baltimore, Williams & Wilkins Company.

Inactivation of epidemic influenza virus by nasal secretions of human individuals. *Science*, 91:198.

With C. C. Stock. The inactivation of the virus of epidemic influenza by soaps. *J. Exp. Med.*, 71:661.

With A. E. Moore. A study of the neurotropic tendency in strains of the virus of epidemic influenza. *J. Exp. Med.*, 72:717.

With J. E. Salk and G. I. Lavin. The antigenic potency of epidemic influenza virus following inactivation by ultraviolet radiation. *J. Exp. Med.*, 72:729.

A new type of virus from epidemic influenza. *Science*, 92:405.

Differentiation of influenza A and influenza B by the complement-fixation reaction. *Proc. Soc. Exp. Biol. Med.*, 45:861.

1941

The problem of epidemic influenza. *Transactions of the College of Physicians of Philadelphia*, 8:218.

The significance of nasal factors in epidemic influenza. In: *Problems and Trends in Virus Research*, Vol. 1, pp. 41-54. Philadelphia, University of Pennsylvania Press.

Epidemic influenza. *Bull. N.Y. Acad. Med.*, 17:268.

With M. V. de Torregrasa. The intracerebral infection of mice with *Haemophilus influenzae* as an index of strain virulence and the protective value of immune serum. *J. Infect. Diseases*, 68:59.

With I. J. Brightman. Virus-inactivating capacity of nasal secre-

tions in the acute and convalescent stages of influenza. Proc. Soc. Exp. Biol. Med., 48:116.

1942

- Present trends in the study of epidemic influenza. *Advances in Internal Medicine*, 1:169.
- With A. E. Feller, L. B. Roberts, and E. P. Ralli. Studies on the influence of vitamin A on certain immunological reactions in man. *J. Clin. Invest.*, 21:121.
- Factors conditioning resistance to epidemic influenza. *Harvey Lectures*, 37:69-99, 1941-42.
- With B. Eddie. Occurrence of psittacosis-like infection in domestic and game birds of Michigan. *Proc. Soc. Exp. Biol. Med.*, 50:291.
- With B. A. Friedman. Gall formation by *Phytomonas tumefaciens* extract and indole-3-acetic acid in cultures of tomato roots. *Phytopathology*, 32:762.
- With L. E. Farr and W. C. McCarthy. Plasma amino-acid levels in health and in measles, scarlet fever and pneumonia. *Am. J. Med. Sci.*, 203:668.
- With C. E. Krill, J. A. Toomey, *et al.* Poliomyelitis following tonsillectomy in five members of a family: an epidemiologic study. *J. Am. Med. Assoc.*, 119:1392.
- An epidemiological study of poliomyelitis following tonsillectomy. *Trans. Assoc. Am. Physicians*, 57:277.
- Epidemic influenza. In: *Nelson New Loose-Leaf Medicine*, ed. by W. W. Herrick, Vol. 1, pp. 583-617. New York, Thomas Nelson & Sons.
- With J. E. Salk. A simplified procedure for the concentration and purification of influenza virus. *Science*, 96:499.

1943

- A rationale for studies in the control of epidemic influenza. *Science*, 97:229.
- With C. C. Stock. The inactivation of the virus of lymphocytic choriomeningitis by soaps. *J. Exp. Med.*, 77:323.
- Epidemiology of influenza. *J. Am. Med. Assoc.*, 122:4.
- With H. E. Pearson, E. R. Sullivan, *et al.* The effect of subcutaneous vaccination with influenza virus upon the virus-inactivating capacity of nasal secretions. *Am. J. Hyg.*, 37:294.

- With C. C. Stock. Additional studies of the inactivation of the virus of epidemic influenza by soaps. *J. Immunol.*, 47:303.
- With R. C. Rendtorff. Survival of the Lansing strain of poliomyelitis virus in the common house fly. *Musca domestica* L. *J. Infect. Diseases*, 73:198.
- With E. Herrarte. Efforts toward selective extraction of poliomyelitis virus. *J. Infect. Diseases*, 73:206.

## 1944

- Virus pneumonia. *Canadian Journal of Public Health*, 35:49.
- With J. E. Salk and W. J. Menke. Identification of influenza virus type A in current outbreak of respiratory disease. *J. Am. Med. Assoc.*, 124:93.
- With J. E. Salk, H. E. Pearson, *et al.* Protective effect of vaccination against induced influenza A. *Proc. Soc. Exp. Biol. Med.*, 55:104.
- A clinical evaluation of vaccination against influenza. Members of the Commission on Influenza, Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, Preventive Medicine Service, Office of the Surgeon General, United States Army. *J. Am. Med. Assoc.*, 124:982.
- With J. E. Salk, H. E. Pearson, and P. N. Brown. Protective effect of vaccination against induced influenza B. *Proc. Soc. Exp. Biol. Med.*, 55:106.
- With H. E. Pearson, J. E. Salk, *et al.* Immunity in human subjects artificially infected with influenza virus, type B. *Am. J. Public Health*, 34:317.
- Comments on immunity to virus diseases. *Yale J. Biol. Med.*, 16:401.

## 1945

- With M. V. de Torregrosa. Combined infection of mice with *H. influenzae* and influenzae virus by the intranasal route. *J. Infect. Diseases*, 76:70.
- With G. C. Brown. The virus-neutralizing action of serum from mice infected with poliomyelitis virus. *J. Exp. Med.*, 81:161.
- With H. E. Pearson, G. C. Brown, R. C. Rendtorff, and G. M. Ridenour. Studies of the distribution of poliomyelitis virus. III. In an urban area during an epidemic. *Am. J. Hyg.*, 41:188.

- Influenza: methods of study and control. *Bull. N.Y. Acad. Med.*, 21:337.
- The development of the 1943 vaccination study of the Commission on Influenza. *Am. J. Hyg.*, 42:1.
- With J. E. Salk and W. J. Menke, Jr. A clinical epidemiological and immunological evaluation of vaccination against epidemic influenza. *Am. J. Hyg.*, 42:57.
- With J. E. Salk, H. E. Pearson, *et al.* Protective effect of vaccination against induced influenza A. *J. Clin. Invest.*, 24:536.
- With J. E. Salk, H. E. Pearson, and P. N. Brown. Protective effect of vaccination against induced influenza B. *J. Clin. Invest.*, 24:547.
- With G. C. Brown and H. E. Pearson. Rapid development of carrier state and detection of poliomyelitis virus in stool 19 days before onset of paralytic disease. *J. Am. Med. Assoc.*, 129:121.
- With J. E. Salk, H. E. Pearson, P. N. Brown, and C. J. Smyth. Immunization against influenza with observations during an epidemic of influenza A, one year after vaccination. *Am. J. Hyg.*, 42:307.

## 1946

- With A. W. Frisch and J. J. Quilligan, Jr. Demonstration of infectious hepatitis virus in presymptomatic period after transfer by transfusion. *Proc. Soc. Exp. Biol. Med.*, 61:276.
- With J. E. Salk and W. M. Brace. The protective effect of vaccination against epidemic influenza B. *J. Am. Med. Assoc.*, 131:275.
- The progress of research in poliomyelitis. *Ohio Medical Journal*, 42:838.
- With J. E. Salk. Immunization against influenza. *Ann. Internal Med.*, 25:443.
- Biological beachheads. *J. Clin. Invest.*, 25:906.
- A consideration of vaccination against influenza. *Trans. Assoc. Am. Physicians*, 59:197.

## 1947

- Dissociation of hemagglutinating and antibody-measuring capacities of influenza virus. *J. Exp. Med.*, 85:1.
- A consideration of vaccination against influenza. *Milbank Mem. Fund Quart.*, 25:5.

- Control of virus infections. J. Mich. Med. Soc., 46:566.
- Apparent serological variation within a strain of influenza virus. Proc. Soc. Exp. Biol. Med., 65:143.
- With G. C. Brown. Studies on the relation of wild rats to poliomyelitis. J. Infect. Diseases, 81:55.
- With J. E. Salk and J. J. Quilligan, Jr. Experience with vaccination against influenza in the spring of 1947. Am. J. Public Health, 37:1013.
- The present status of vaccination against influenza. Am. J. Public Health, 37:1109.
- Mechanisms of infection and immunity in virus diseases of man. Bacteriological Reviews, 11:147.
- With G. C. Brown. The neutralization of the mouse-adapted Lansing strain of poliomyelitis virus by the serum of patients and contacts. J. Immunol., 57:1.
- Respiratory viruses. Annual Review of Microbiology, 1:351.
- With J. J. Quilligan, Jr. Serological response to intranasal administration of inactive influenza virus in children. J. Clin. Invest., 26:1079.
- Infectious hepatitis. In: *Handbook of Communicable Diseases*, 2d ed., ed. by F. H. Top. St. Louis, The C. V. Mosby Company, Medical Publishers.

## 1948

- With G. C. Brown and J. Ainslie. Studies of the distribution of poliomyelitis virus. V. The virus in familial associates of cases. J. Exp. Med., 87:21.
- Viruses as agents of disease. Oral Surg., Oral Med., Oral Pathol., 1:153.
- The prevention of virus diseases. Oral Surg., Oral Med., Oral Pathol., 1:160.
- With G. C. Brown. Studies of the distribution of poliomyelitis virus. IV. In rural schools following an epidemic. J. Infect. Diseases, 82:163.
- With G. C. Brown and L. R. Penner. Search for extrahuman sources of poliomyelitis virus. J. Am. Med. Assoc., 136:1088.
- With J. J. Quilligan, Jr., and E. Minuse. Homologous and heterologous antibody response of infants and children to multiple injections of a single strain of influenza virus. J. Clin. Invest., 27:572.

- With E. Minuse. Influence of saliva upon hemagglutination by influenza virus. *Proc. Soc. Exp. Biol. Med.*, 69:291.
- Parasitism and disease. In: *Bacterial and Mycotic Infections of Man*, ed. by R. J. Dubos. Philadelphia, J. B. Lippincott Company.
- Response of the host to the parasite. In: *Bacterial and Mycotic Infections of Man*, ed. by R. J. Dubos. Philadelphia, J. B. Lippincott Company.
- With C. Armstrong, D. Bodian, A. B. Sabin, and J. R. Paul. A proposed provisional definition of poliomyelitis virus. *Science*, 108:701. (Committee on Nomenclature of the National Foundation for Infantile Paralysis.)

## 1949

- With G. C. Brown and J. D. Ainslie. The incidence of poliomyelitis virus in cases of mild illness during a severe urban epidemic. *Am. J. Hyg.*, 49:194.
- Immunity in poliomyelitis. *Phi Chi Quarterly*, October, 1949. (First Annual Dr. Eben J. Carey Memorial Lecture, Omaha.)
- With G. C. Brown. Evaluation of the effect of Darvisul upon infection with SK strain of virus in mice. *Proc. Soc. Exp. Biol. Med.*, 70:535.
- With J. J. Quilligan, Jr., and E. Minuse. Resemblance of a strain of swine influenza virus to human A-prime strains. *Proc. Soc. Exp. Biol. Med.*, 71:216.
- With J. J. Quilligan, Jr., and E. Minuse. Reactions to an influenza virus in infants and children. *American Journal of Diseases of Children*, 78:295.
- The family doctor: an epidemiologic concept. *J. Am. Med. Assoc.*, 141:308.
- Immunization Contra Influenza*, Vol. 3. (One of a series of medical articles prepared exclusively for the physicians of Peru by distinguished authorities of the United States.)
- With K. Penttinen. The failure of Merodicein to modify influenza virus infections. *J. Immunol.*, 63:337.

## 1950

- Immunity and vaccination in influenza. In: *Handbuch der Virusforschung*, ed. by R. Doerr and C. Hallauer, pp. 66-86. Vienna, Springer-Verlag. II. Ergänzungsband.

- With J. J. Quilligan, Jr., Richard J. Rowe, *et al.* The action of Terramycin on the growth of strains of influenza, herpes simplex, and rabies viruses in chick embryos and mice. *Ann. N.Y. Acad. Sci.*, 53:407.
- With H. B. Kurtz. The relation of herpes virus to the cell nucleus. *Yale J. Biol. Med.*, 22:579.
- With W. W. Ackermann. Some biochemical aspects of herpes infection. *Proc. Soc. Exp. Biol. Med.*, 74:123.
- The significance of multiple immunological types of influenza virus. *Cincinnati Journal of Medicine*, 31:97.
- With others. An agglutination-inhibition test proposed as a standard of reference in influenza diagnostic studies. *J. Immunol.*, 65:347. (Committee on Standard Serological Procedures in Influenza Studies.)
- Immunology and preservation of the norm. *J. Immunol.*, 65:437.
- With J. J. Quilligan, Jr., and E. Minuse. Identification of another epidemic respiratory disease. *Science*, 112:495.
- With J. D. Ainslie and J. L. McCallum. Failure to demonstrate antibody in feces of monkeys vaccinated with poliomyelitis virus, Lansing strain. *Proc. Soc. Exp. Biol. Med.*, 75:699.

## 1951

- With F. M. Davenport. A comparison of the growth curves of adapted and unadapted lines of influenza virus. *J. Exp. Med.*, 93:129.
- With J. D. Ainslie and P. K. Stumpf. Serum alkaline phosphatase in monkeys and man during poliomyelitis. *Am. J. Hyg.*, 53:58.
- Immunity in virus diseases. *Cornell Veterinarian*, 41:190.
- Plan for the evaluation of vaccination against influenza. *Am. J. Public Health*, 41:62.
- With J. D. Ainslie and G. C. Brown. ACTH in experimental poliomyelitis in monkeys and mice. *J. Lab. Clin. Med.*, 38:344.

## 1952

- With G. C. Brown, J. D. Ainslie, A. G. Gilliam, and A. R. Zintek. Studies of the distribution of poliomyelitis virus. VI. In a small community in an epidemic area. *Am. J. Hyg.*, 55:49.
- Distribution of poliomyelitis virus in the epidemic community. *Trans. Assoc. Am. Physicians*, 65:176.
- Distribution of poliomyelitis virus in a community. In: *Polio-*



*myelitis*, pp. 355-63. Proceedings of the Second International Poliomyelitis Conference. Philadelphia, J. B. Lippincott Company.

Developing a philosophy for the Committee on Research and Standards. *Am. J. Public Health*, 42:85.

Significance of antigenic variation of influenza viruses in relation to vaccination in man. *Federation Proceedings*, 11:808.

Parasitism and disease. In: *Bacterial and Mycotic Infections of Man*, 2d ed., ed. by R. J. Dubos, pp. 68-74. Philadelphia, J. B. Lippincott Company.

Response of the host. In: *Bacterial and Mycotic Infections of Man*, 2d ed., ed. by R. J. Dubos, pp. 98-118. Philadelphia, J. B. Lippincott Company.

## 1953

Research in poliomyelitis at Michigan. *Michigan Alumnus Quarterly Review*, February.

Influenza: method of Thomas Francis, Jr. In: *Current Therapy*, ed. by H. F. Conn. Philadelphia, W. B. Saunders Company.

With K. E. Jensen. Antigen-antibody precipitates in solid medium with influenza virus. *J. Immunol.*, 70:321.

Vaccination against influenza. *Bull. World Health Organ.*, 8:725.

Influenza: the new acquaintance [sic]. *Ann. Internal Med.*, 39:203.

With L. W. Chu. The interaction *in vitro* between poliomyelitis virus and nervous tissue. In: *Proceedings of the Sixth International Congress of Microbiology*, Rome, Italy, 1953. Vol. 8, p. 162. (A)

With A. V. Hennessy, E. Minuse, and F. M. Davenport. An experience with vaccination against influenza B in 1952 by use of monovalent vaccine. *Am. J. Hyg.*, 58:165.

Correlations in clinical and epidemiological investigation. *Am. J. Med. Sci.*, 226:376.

With G. C. Brown and J. D. Ainslie. Poliomyelitis in Hidalgo County, Texas, 1948: poliomyelitis and Cocksackie viruses in privy specimens. *Am. J. Hyg.*, 53:310.

With K. E. Jensen. The antigenic composition of influenza virus measured by antibody-absorption. *J. Exp. Med.*, 98:619.

With F. M. Davenport and A. V. Hennessy. Epidemiologic and

immunologic significance of age distribution of antibody to antigenic variants of influenza virus. *J. Exp. Med.*, 98:641.

1954

The teaching of epidemiology. In: *Proceedings of the First World Conference on Medical Education*, London, 1953. London, Oxford University Press.

With W. W. Ackermann. Characteristics of viral development in isolated animal tissues. *Advances in Virus Research*, 11:81.

With E. Minuse and J. J. Quilligan, Jr. Type C influenza virus. I. Studies of the virus and its distribution; II. Intranasal inoculation of human individuals. *J. Lab. Clin. Med.*, 43:31.

Evaluation of gamma globulin in prophylaxis of paralytic poliomyelitis in 1953: summary of the Report of the National Advisory Committee for Evaluation of Gamma Globulin. *J. Am. Med. Assoc.*, 154:1086.

Immunological and epidemiological problems. *Proceedings of the Royal Society of Medicine*, 47:561.

With L. R. Penner and G. C. Brown. Some observations on the ecology of a North American chigger *Trombicula (Eutrombicula) lipovskyana*, Wolfenbarger, 1952, in a Tennessee community. *Journal of the Kansas Entomological Society*, 27:113.

With G. C. Brown and A. Kandel. Effect of fluoroacetate upon poliomyelitis in monkeys. *Proc. Soc. Exp. Biol. Med.*, 85:83.

With K. W. Cochran and G. C. Brown. Antiviral action of a mold filtrate on experimental poliomyelitis in cynomolgus monkeys. *Proc. Soc. Exp. Biol. Med.*, 85:104.

The teaching of epidemiology. *Journal of Medical Education*, 29:15.

1955

Approach to control of poliomyelitis by immunological methods. *Bull. N.Y. Acad. Med.*, 31:259.

With R. F. Korns, R. B. Voight, *et al.* *An Evaluation of the 1954 Poliomyelitis Vaccine Trials; Summary Report*. Ann Arbor, Michigan, Poliomyelitis Vaccine Evaluation Center, University of Michigan. 50, 63 pp. (Sponsored by the National Foundation for Infantile Paralysis.) Also in *Am. J. Public Health*, Vol. 45, May, Part II, special issue.

With R. F. Korns. Evaluation of 1954 field trial of poliomyelitis vaccine: synopsis of summary report. *Am. J. Med. Sci.*, 229:603.

- Poliomyelitis issue. Univ. Mich. Med. Bull., 21:153-55.
- Evaluation of the 1954 poliomyelitis vaccine field trial: further studies of results determining the effectiveness of poliomyelitis vaccine (Salk) in preventing paralytic poliomyelitis. J. Am. Med. Assoc., 158:1266.
- The current status of the control of influenza. Ann. Internal Med., 43:534.
- With F. M. Davenport, A. V. Hennessy, and C. H. Stuart-Harris. Epidemiology of influenza: comparative serological observations in England and the United States. Lancet, 2:469-74.
- Summary and review of poliomyelitis immunization. Ann. N.Y. Acad. Sci., 61:1057.
- Virus problems in medicine. Illinois Medical Journal, 108:257.
- With A. V. Hennessy and F. M. Davenport. Studies of antibodies to strains of influenza virus in persons of different ages in sera collected in a postepidemic period. J. Immunol., 75:401.
- With D. Bodian, C. Larson, *et al.* Interim report, Public Health Service Technical Committee on Poliomyelitis Vaccine. J. Am. Med. Assoc., 159:1444.

## 1956

- With K. W. Cochran. Antiviral action of helenine on experimental poliomyelitis. Proc. Soc. Exp. Biol. Med., 92:230.
- With J. F. Enders, J. A. Bell, J. H. Dingle, *et al.* Adenoviruses: group name proposed for new respiratory tract viruses. Science, 124:119.
- With K. E. Jensen, F. M. Davenport, and A. V. Hennessy. Characterization of influenza antibodies by serum absorption. J. Exp. Med., 104:199.
- Approaches to the prevention of poliomyelitis. Univ. Mich. Med. Bull., 22:433.
- With J. Napier and F. M. Hemphill. Poliomyelitischutzimpfung. Münchener Medizinische Wochenschrift, 98:1349-55.

## 1957

- Symposium on controlled vaccine field trials. Poliomyelitis. Am. J. Public Health, 47:283.
- With K. E. Jensen and E. Minuse. Serologic comparisons with lines of influenza virus isolated and serially transferred in different experimental hosts. J. Immunol., 78:356.

- Epidemiology and the future of medicine. University of Tennessee Record, Vol. 60, No. 6.
- With L. Blair, M. Jacobs, *et al.* The role of the physical therapist in the evaluation studies of the poliomyelitis vaccine field trials. *Physical Therapy Review*, 37:437.
- With F. M. Davenport and A. V. Hennessy. Influence of primary antigenic experience upon the development of a broad immunity to influenza. *Trans. Assoc. Am. Physicians*, 70:81.
- Mobilization against influenza. *Science*, 126:1267.
- Vaccination against Asian influenza: basis for recommendations and a preliminary report on efficacy. Members of the Commission on Influenza of the Armed Forces Epidemiological Board, Office of the Commission on Influenza, School of Public Health, University of Michigan, Ann Arbor. *J. Am. Med. Assoc.*, 165:2055.
- With J. A. Napier, R. B. Voight, *et al.* *Evaluation of the 1954 Field Trial of Poliomyelitis Vaccine; Final Report*. Ann Arbor, Michigan, Edwards Brothers, Inc. xxxi + 563 pp.
- Facts and perspectives of a large-scale field trial. Special Publications of the New York Academy of Sciences, 5:99.

## 1958

- A New Year's fantasy. *Univ. Mich. Med. Bull.*, 24:1.
- With K. G. Kohlstaedt, M. Moser, *et al.* Panel discussion on genetic and environmental factors in human hypertension. *Circulation*, 17:728, Part II.
- Immunization. *J. Mich. Med. Soc.*, 57:742.
- Immunity to virus diseases. In: *Symposium on Viruses: Current Advances with Clinical Applications*, p. 123.
- Influenza. In: *Communicable Diseases: Preventive Medicine in World War II*, ed. by E. C. Hoff, Vol. 4, pp. 85–128. Washington, D.C., Department of the Army, Office of the Surgeon General.
- With D. E. Craig. Contact transmission of poliomyelitis virus among monkeys. *Proc. Soc. Exp. Biol. Med.*, 99:325.
- Frederick George Novy 1864–1957. *Trans. Assoc. Am. Physicians*, 71:35.
- Viral inhibition. In: *Poliomyelitis*, pp. 361–65. Proceedings of the Fourth International Poliomyelitis Conference. Philadelphia, J. B. Lippincott Company.

## 1959

- Influenza. In: *Viral and Rickettsial Infections of Man*, 3d ed., ed.

by Thomas M. Rivers and Frank L. Horsfall, Jr., pp. 633-72. Philadelphia, J. B. Lippincott Company.

With F. H. Epstein, W. D. Block, and E. A. Hand. Familial hypercholesterolemia, xanthomatosis and coronary heart disease. *American Journal of Medicine*, 26:39.

Adventures in preventive medicine: the Founder's Day address. *Allegheny College Bulletin*, June.

Influenza. *Med. Clin. N. Am.*, 43:1309.

Serological variation. In: *Animal Viruses*, Vol. 3 of *The Viruses: Biochemical, Biological, and Biophysical Properties*, ed. by F. M. Burnet and W. M. Stanley, pp. 251-73. New York, Academic Press, Inc.

The epidemiological approach to human ecology. *Am. J. Med. Sci.*, 237:677.

## 1960

Research in preventive medicine. *J. Am. Med. Assoc.*, 172:993.

Preventive medicine in 1985 and a re-emphasis on the preservation of health. *What's New*, 220:26.

On the doctrine of original antigenic sin. *Proceedings of the American Philosophical Society*, 104:572.

## 1961

Influenza in perspective. *Am. Rev. Resp. Diseases*, 83:98.

Biological aspects of environment. *Industrial Medicine and Surgery*, 30:374.

Aspects of the Tecumseh study. *Public Health Reports*, 76:963.

With W. D. Peterson and F. M. Davenport. A study *in vitro* of components in the transmission cycle of swine influenza virus. *J. Exp. Med.*, 114:1023.

Problems of acute respiratory disease. *Yale J. Biol. Med.*, 34:91, 1961-62.

## 1962

With G. C. Brown. Incidence of heterologous antibodies in virus-confirmed cases of poliomyelitis. *New England Journal of Medicine*, 266:642.

With B. J. Neff, W. W. Ackermann, and F. H. Epstein. Inhibition of vaccinia hemagglutinins by sera of patients with coronary heart disease and other chronic illnesses. *Circulation Research*, 10:836.

- With E. Minuse, P. W. Willis III, and F. M. Davenport. An attempt to demonstrate viremia in cases of Asian influenza. *J. Lab. Clin. Med.*, 59:1016.
- With B. J. Neff, G. L. Brady, and F. H. Epstein. Serologic and pathologic changes in rats on atherogenic diets. *Journal of Atherosclerosis Research*, 2:306.

## 1963

- Epidemic influenza. *Am. Rev. Resp. Diseases*, 88:148.

## 1964

- With A. V. Hennessy, F. M. Davenport, R. J. Horton, and J. A. Napier. Asian influenza: occurrence and recurrence, a community and family study. *Military Medicine*, 129:38.
- With F. M. Davenport, A. V. Hennessy, J. Drescher, and J. Mulder. Further observations on the relevance of serologic recapitulations of human infection with influenza viruses. *J. Exp. Med.*, 120:1087.
- Ernest William Goodpasture (1886–1960). In: *American Philosophical Society Yearbook 1964*, pp. 111–20. Philadelphia, American Philosophical Society.

## 1965

- A portrait of Henry F. Vaughan. *University of Michigan Medical Center Journal*, 31:100.
- With H. F. Maassab. Influenza virus. In: *Viral and Rickettsial Infections of Man*, 4th ed., ed. by F. L. Horsfall and I. Tamm, pp. 689–740. Philadelphia, J. B. Lippincott Company.
- In honor of Richard E. Shope. In: *Perspectives in Virology IV*, ed. by M. Pollard. New York, Hoeber Medical Division, Harper & Rowe, Publishers.
- With F. H. Epstein, N. S. Hayner, *et al.* Prevalence of chronic diseases and distribution of selected physiologic variables in a total community, Tecumseh, Michigan. *American Journal of Epidemiology*, 81:307.
- Genetics and epidemiology. In: *Genetics and the Epidemiology of Chronic Diseases*, ed. by J. V. Neel, M. W. Shaw, and W. J. Schull. Public Health Service publication 1163. Washington, U.S. Govt. Print. Off.
- With F. H. Epstein. Tecumseh, Michigan. *Milbank Mem. Fund Quart.*, 43:333.

- With F. H. Epstein, L. D. Ostrander, Jr., B. C. Johnson, M. W. Payne, N. S. Hayner, and J. B. Keller. Epidemiological studies of cardiovascular disease in a total community. *Ann. Internal Med.*, 62:1170.
- Standards for research in new drug testing. In: *Proceedings of the Fourth International Congress of the International Federation for Hygiene and Preventive Medicine*, 2d ed. Vienna, May 1965. Vienna, Wiener Medizinische Akademie.
- With G. C. Brown, H. F. Maassab, and J. A. Veronelli. Detection of rubella antibodies in human serum by the indirect fluorescent antibody technique. *Archiv für die Gesamte Virusforschung*, 16:459.
- With L. D. Ostrander, N. S. Hayner, *et al.* The relationship of cardiovascular disease to hyperglycemia. *Ann. Internal Med.*, 62:1188.
- Standards required in vaccine field trials. In: *Proceedings of the Cholera Research Symposium*, Honolulu, January 24–29, 1965, publication 1328, pp. 352–54. Washington, U.S. Govt. Print. Off.
- With N. S. Hayner, M. O. Kjelsberg, and F. H. Epstein. Carbohydrate tolerance and diabetes in a total community, Tecumseh, Michigan. *Diabetes*, 14:413.
- With N. S. Ling and T. Krasteff. Transcholesterin, a cholesterol-binding globulin: serological demonstration of a specific interaction between cholesterol and serum globulin. *Proceedings of the National Academy of Sciences*, 53:1061.
- With E. Minuse, J. L. McQueen, and F. M. Davenport. Studies of antibodies to 1956 and 1963 equine influenza viruses in horses and man. *J. Immunol.*, 94:563.

## 1966

- The polyvalent vaccine: reasons for inclusion of earlier virus prototypes and contemporary virus strains into current and future vaccines. (Read before Division of Biologics Standards Conference on Formulation of Influenza Virus Vaccines. National Institutes of Health, October 1966.)

## 1967

- With L. D. Ostrander, Jr., B. J. Neff, W. D. Block, *et al.* Hyperglycemia and hypertriglyceridemia among persons with coronary heart disease. *Ann. Internal Med.*, 67:34.

Summary. In: *Working Conference on Smallpox Rapporteurs' Reports*, pp. 23-26. Sponsored by the U.S.-Japan Cooperative Medical Science Program, Office of International Research, National Institutes of Health.

Epidemic influenza: immunization and control. *Med. Clin. N. Am.*, 51:781.

Immunization of selected population groups against influenza. *Archives of Environmental Health*, 14:747.

With T. O. Anderson, F. W. Denny, *et al.* *Epidemiologic Studies for Vaccine Development*. U.S. Department of Commerce, PB 176 814, National Bureau of Standards Institute of Applied Technology.

## 1968

Transcholesterin titers and their biological significance in experimental atherogenesis in rats. *Proc. Soc. Exp. Biol. Med.*, 128:197.

Experience with vaccines: general comments. In: *Conference on Cell Cultures for Virus Vaccine Production*, Bethesda, Maryland, November 1967. National Cancer Institute Monograph 29.

## 1969

Faktoren der Immunität gegen respiratorische Infekte. *Deutsche Medizinische Wochenschrift*, 94:355.

With F. M. Davenport, E. Minuse, and A. V. Hennessy. Interpretation of influenza antibody patterns of man. *Bull. World Health Organ.*, 41:453.

With A. S. Monto, F. M. Davenport, and J. A. Napier. Effect of vaccination of a school-age population upon the course of an A<sub>2</sub>/Hong Kong influenza epidemic. *Bull. World Health Organ.*, 41:537.

With H. F. Maassab, F. M. Davenport, *et al.* Laboratory and clinical characteristics of attenuated strains of influenza virus. *Bull. World Health Organ.*, 41:589.

Moments in medical virology. In: *International Virology, 1*, ed. by J. L. Melnick, p. 224. Proceedings of the First International Congress for Virology. Basel, Switzerland, S. Karger, A.G.