

room and had use of a lounge and the hospital library. There were fifty-four men but only one woman in my class. A Veteran's Hospital was across the street, and the New York State Laboratory and Health Department were within walking distance.

Although I'd already been acquainted with many aspects of medicine, including autopsies, while working at St. Clare's lab during college, the AMC years gave my fragmentary lab experience a medical perspective. The first two years of the curriculum were devoted to basic sciences like human anatomy, physiology, pharmacology, and pathology. Like all anatomy courses then, ours involved the yearlong process of dissecting a corpse. Our corpse was a male who looked like an unwrapped Egyptian mummy. It was hard to believe that this person was ever alive. The tissues were leathery hard and dark brown. The contrast between how the tissues looked in our corpse as compared to how they looked at autopsy or in a living person during surgery was striking.

I lived at home, worked nights at the New York State Laboratory as a biochemist, and in my four years, contrary to popular med-student stereotype, managed never to take a book home. I found plenty of time during the day to study and learned that medicine was in fact as much of an art as it was a science.

The third and fourth years were when we learned how to be doctors. We rotated through the various specialties, learning how to diagnose and treat actual patients. All the specialties were interesting, but in pondering what to do after medical school, I began a triage of what kind of medicine I *didn't* want to do.

Psychiatry was out. It had no pathologic foundation. Psychiatry also had treatments I found repugnant. I didn't like the use of electroconvulsive therapy back then and am sickened to see it making a comeback now. I also thought that psychoanalysis had no scientific basis.

My obstetrical rotation, on the other hand, was a happy service, because it involved young women doing what comes naturally. Every delivery of a baby was exciting to me, and I enjoyed helping the mothers get through their labor. There was a lot of induced labor back then,

ALBANY MEDICAL COLLEGE (AMC)

AFTER FOUR YEARS at a good liberal arts college, I thought that medical school was an intellectual step backward. It was trade school in the literal sense of the word. The scientific basis of medical education could be boiled down to the study of pathology, which is the physical, pathologic, and cellular basis of all disease. There was no formal course in medical history, but reading about those who went before us and how they solved the medical mysteries of their time inspired me then, and it still does. Most doctors arrive at their choice of practice by a process of elimination, balancing the positive and negative aspects of each specialty. Helping patients in their time of need and watching how the good doctors went about their craft was the best part of the process, and how I really learned. In terms of teaching medicine, I don't think that the apprentice system has ever been improved upon. I also think that it would be a very good experience for every med student to be an inpatient for a while.

When I attended the AMC medical school beginning in 1954, it was physically part of The Albany Hospital. The students had a locker

mostly for the convenience of the obstetricians. I also thought that the cesarean section rates were way too high. Though rewarding, I crossed obstetrics off my list because it was too much of the same thing, with very little diagnostic challenge.

I did find pediatrics very interesting, but heartbreaking. I couldn't handle watching an innocent child die. Pediatric oncology was the worst, because in those years, all childhood leukemia was fatal. At the time, we used Nelson's *Textbook of Pediatrics*. In each section was a brief discussion of the epidemiology of a given condition. I quickly discovered that the epidemiology of a disease, and how it was understood, was a lot more interesting to me than how to actually treat a disease. After more independent reading, especially about how the acute communicable diseases of childhood were understood, I suspected I had found my medical niche.

We also had a surgical rotation. I liked the diagnostic part of surgery, because you could use your clinical, detective, and laboratory skills to reach a diagnosis and could find out directly if you were accurate.

However, I saw some things at the operating table and on the wards that made me wonder how anyone could survive hospitalization. Eventually, I crossed surgery off my list, because only the diagnostic part was interesting to me.

I did like internal medicine. The teacher I admired most and tried to emulate was a tall, soft-spoken gentleman named Gilbert Beebe. He said many times that listening to the patient was critical and that the patient, if properly questioned, would always tell you the diagnosis. That wisdom would later come in handy with my work on dirty electricity and with people who had become hypersensitive to electromagnetic fields. Their doctors typically don't believe them, but they are being given the diagnosis.

Throughout the various rotations, it had become increasingly obvious to me that I was a lot more interested in understanding what brought people into the hospital than in how to treat them. My path toward epidemiology became stronger by the day.

My personal life had also taken some interesting turns during medical school. Between my sophomore and junior years at AMC, I taught archery at a summer camp in Vermont. There, I met an attractive school teacher named Lorna Galbraith, who taught tennis and had a car. We married a year later in 1956 and had our first of three children, a son named Richard, in 1957. By the time I graduated, I was a husband and a father. A daughter, Suzanne, was born in 1959, during my internship in Boston; and a son, Sam, was born in 1961, while I was at Johns Hopkins in Baltimore getting a masters degree in Public Health.

One recollection I have about medical school graduation was that as each of us walked across the stage to get the piece of paper we had worked so hard for, I asked myself which of my fifty-four classmates could I trust with the life of my kids. Sadly, I came up with only six names. It's probably a good thing that I have absolutely no say in who gets to practice medicine.

With only the rhythm method for birth control, Catholics had lots of babies. The work was forty-eight hours on call, followed by twenty-four hours off. In busy periods, it was hard to get any sleep.

We had to do circumcisions every day, using a crushing clamp. I still can hear the cries of those little guys. While doing the circumcisions, I noticed that a few of the babies were mildly jaundiced. After a little record checking, I found that they were all delivered by one obstetrical group that used a lot of heavy-duty narcotics to knock the mothers out to the point that they didn't remember anything about their labor or delivery. I think the technique was called "twilight sleep." It was bad for the mothers and especially bad for the babies. The mothers would thrash about on their cots, sometimes soiling themselves, and pulling out IVs. The babies were born depressed and difficult to resuscitate. They also were jaundiced. When I reported my findings to the hospital director, he told me to keep my mouth shut or they would terminate my training. What an auspicious start to my research career. It was a hectic, exhausting, exciting, and rewarding time, but two months of it was enough.

I transitioned right from obstetrics to pediatrics at Boston City Hospital. Dr. Sidney Gellis was chief of service then, and I think I saw him once. I had no ward responsibilities, but worked the evening shift in the pediatric emergency room, as well as the following afternoon in specialty clinics. When I saw interesting cases at night, I could refer them to the clinics the next day, when there were senior pediatricians around for consultation. The emergency room (ER) was a crowded, busy, chaotic place. Assuming all that responsibility right out of medical school was something I never anticipated. There were four experienced nurses who showed me the ropes, and because of them, I survived. I learned in all my new clinical assignments that it was critical to get the head nurse, oftentimes someone who had been there for twenty years, on my side. To my misfortune, I started my pediatric rotation in the middle of an epidemic of aseptic meningitis. The kids would come in with fever, stiff neck, and vomiting. There was no effective treatment,

INTERNSHIP

INTERNED AT A U.S. Public Health Service (PHS) Hospital in Boston called Brighton Marine, which is no longer there. The PHS looked after fishermen, U.S. Coast Guard personnel, and other military dependents. With no money and a growing family, I needed a paycheck to stay afloat during internship and residency, so my internship options were few. PHS offered a small but livable stipend for interns and residents, unlike most private hospital training programs.

We packed up our Studebaker Commander V8 and headed east to Boston. By then, Lorna was pregnant with our daughter Suzanne. I was the last intern to arrive, and learned that I would immediately begin a two-month obstetric rotation at St. Margaret's Hospital in Dorchester. After that, I would have two months at Boston City Hospital learning pediatrics, before coming back to the PHS hospital.

It was a difficult year. Lorna had a first trimester bleed and was put to bed, and Richie, our toddler, had recurring streptococcal throat infections.

St. Margaret's was a very busy place. Boston was a Catholic city.

since the disease was caused by a number of different viruses. Every meningitis patient needed a spinal tap, and I had to do the lab work myself. During the epidemic, this meant one or two cases per evening, and the spinal fluid always ran clear, indicating that it was a viral meningitis. One night before the night shift took over, however, another meningitis case showed up. I was tempted to bypass the spinal tap, but a little inner voice said, "What if ...?" That one turned out to be bacterial meningitis, the only such case I saw in my two months. Instead of a clear spinal tap, pus ran out of the needle. Any delay in treatment could have been fatal. The children in the ER were wonderful, and I loved treating them.

After pediatrics, I returned to PHS to begin rotations in medicine, surgery, orthopedics, and the emergency room. I had been away from PHS for four months at St. Margaret's and Boston City Hospital, and was disappointed to learn that all the specialized clinical residencies for the next year had been assigned. That left me the choice of working in the hospital ER for another year and then getting a clinical residency, or taking a public health residency, which was still open. I decided on the latter.

Working on the wards was very interesting, because this was real "doctoring." I got to admit the patients, decide what was wrong with them, work out a treatment program, check on their progress, and finally send them home if everything worked out well. There were some memorable cases that taught valuable lessons.

A young fisherman was admitted with swollen lymph nodes, fever, tiredness, and a general malaise (feeling lousy). His working diagnosis was some sort of lymphoma or Hodgkin's disease, and I remember the tears and the anguish when his wife and family got the news. But something about the diagnosis just didn't ring true. There was no weight loss, and the onset of his illness was sudden. Usually, cancers develop slowly, with symptoms evolving over time. The first indication of a lymphoma is often a painless swollen lymph node in the neck.

One condition that causes a similar presentation is a bacterial

infection called cat scratch disease or cat scratch fever. The intern and resident on his floor had asked the patient on a number of occasions about being "scratched" by a cat. He said he had not. One of the residents also agreed that something about the case didn't seem right, so we decided to reread the literature on cat scratch disease, which mentioned that it can also be caused by a cat bite. When asked the right question (just like my medical school professor, Dr. Beebe, correctly taught us), the patient remembered having been bitten by a kitten. His skin test was positive for cat scratch disease, and he was discharged to recover at home.

The case that taught me a most important lesson about listening to patients was a seventy-year-old woman who had been plaguing the hospital staff for years with an assortment of vague complaints. Patients who had been seen at the hospital before arrived with their medical records. This woman arrived with a file that weighed almost as much as she did. I waded through her records, and it became clear that in recent years, no one had taken her seriously due of her past history of frequent complaints. I decided that she was going to get the same exam as any other admission. It turned out that she had a fatal, inoperative colon cancer, and she died before I finished my internship. The moral is that even seeming malingerers get sick and die, and they shouldn't be dismissed out-of-hand.

One very difficult two-week period involved a tanker collision in Narragansett Bay off Providence, Rhode Island. A number of merchant seamen were severely burned when they were forced to jump into water aflame with burning oil. I learned how difficult burns are to manage, for both patients and the people treating them. I can see why special burn treatment centers have evolved over time. The care of burn patients is a science unto itself.

I was sent in a small ambulance to transport about a dozen burn victims, two at a time, from Providence to the PHS Hospital in Boston. I remember the smell of burnt flesh and the cries of pain every time the ambulance hit a bump. From the way that "just" a dozen burn cases

tied up practically our entire hospital, it was obvious that there would never be a way to handle large numbers of people injured in a major natural or man-made disaster.

Another interesting case involved me, and illustrated the power of therapeutic electromagnetic fields on the body. During medical school I had been plagued with a nagging, painful case of plantar warts on the soles of both feet near the toes, and on the ball of my right big toe. I also had a small ordinary wart near my knee. The plantar warts had been whittled, frozen, and burned, but they kept coming back. Then one slow night in the ER, I used an electrocautery needle to burn off the small wart on my leg above the knee. It bubbled when the current was delivered, after which I just brushed it off with the side of a scalpel. I applied the current to the empty crater once more with the needle, put a band-aid over it, and went back to work. Amazingly, in less than a week, all my plantar warts were shrinking, even though they had not been treated. In two weeks they were completely gone, never to return. My guess is that somehow I'd immunized myself to the wart protein when I burned off the little wart, or that some aspect of the electric current had affected my immune system. This would be a prescient guess, years before the biological effects of low-level EMFs had been studied.

My pull toward epidemiology had only deepened throughout my internship. We saw so many of the same diseases that I had become profoundly interested in backing the process up to the prevention stage, not just routine treatment after-the-fact. This seemed like only common sense. The great public health triumphs of the last two centuries were achieved by understanding what was causing disease and then intervening. Prevention seemed a lot more important to me than treatment.

The epidemic intestinal diseases, including cholera and typhoid, were prevented by confining human waste inside sewage pipes and by providing clean drinking water. Other nasty diseases like small pox, polio, diphtheria, and the acute communicable diseases of childhood had largely been tamed through understanding immunity and using it

to prevent them. I read with great interest the story of John Snow, who unraveled how cholera spread through contaminated water supplies in London. This was long before he or anyone knew about the cholera bacillus. I came to think that these same techniques might work for understanding and preventing our modern plagues too. I really started to believe that good epidemiology as exemplified by Peter Panum's work on measles and Joseph Goldberger's work on pellagra (a serious, multi-system disease caused by a dietary niacin and protein deficiency), could one day prevent cancer, diabetes, and other contemporary diseases of civilization. I still feel that way fifty years later. In fact, I believe it more than ever after our work linked cancer to dirty electricity.

fresh in my mind. Like all medical school graduates, I had the option of going into private practice. It was a tempting idea, but I didn't do it.

I got busy running a well-baby clinic and a venereal disease clinic at the health department, but my first real practical epidemiology experience involved the Sabin oral polio vaccine trials in Rochester that the health department participated in. We would visit schools and drop the vaccine on small, extended tongues. The kids looked like baby birds with their mouths open and their heads tilted back to receive the vaccine from an eyedropper. For me, the most interesting part of the trial was gathering and evaluating complaints about reactions to the vaccine. I traveled all over Rochester and saw some very sick children, but none of them had a vaccine-related problem. I saw my first and only case of acute glomerulonephritis, a life-threatening kidney disease with characteristic smoky urine as one sign. I had to convince the parents that this disease was not caused by the vaccine.

Now I was conducting hands-on epidemiology, working with whole segments of the population. Simply put, epidemiology is the study of the distribution of diseases in populations. Epidemiologists attempt to determine disease causation by studying attributes associated with disease. They use some intuitively simple study designs, which can be very difficult to execute at times. Epidemiology, for instance, proved that cigarette smoking caused lung cancer. In a case-control study, people with lung cancer (cases) are compared with people without lung cancer (controls) for a history of cigarette smoking (exposure). In a cohort study, populations are followed in time. In a large cohort study involving British physicians, a smoking history was taken, and the cohort was followed. It was found that two-pack-a-day smokers had a twenty-fold greater lung cancer mortality rate than physicians who never smoked; and three times the lung cancer mortality of one-pack-a-day smokers.

While at Monroe County, I designed and conducted my first small study in a high school population to determine diphtheria immunity levels, and how they related to previous immunization. It's remarkable

RESIDENCY

WHEN IT came time to decide what further medical training to undertake, I chose a public health residency. The other clinical residency slots were already filled, and my only option was to spend another year in the ER while waiting for a clinical residency. I felt it was time to move on.

Lorna and I now had two children. My daughter, Suzanne Elaine Milham, had been born in The Boston Lying-In Hospital in 1959. She came home with streptococcal disease and had to have a couple of her tiny little fingers cut open to drain the pus.

I was assigned to the Monroe County Health Department in Rochester, New York, for my first year of public health residency. We rented a house in Honeyoye Falls, New York, and I drove sixteen miles to work each day.

The first week on the new job, I came close to quitting. At the health department, I was assigned an antique desk in a cavernous loft in an old school building with no one in sight and nothing to do. This was in stark contrast to the busy, exciting internship in Boston that was still

that most of the physicians of my generation have never seen a case of diphtheria. This was testimony to the success of our early public health efforts and the efficacy of using the DPT vaccine. Diphtheria became rare in my lifetime.

Near the end of my time at Monroe County, some family problems arose unexpectedly. We were having dinner in the basement of our rented house, since the upstairs was too hot during the summer months. My mother was visiting and somehow forgot that a gas burner was left turned on under an oil fryer in the kitchen upstairs. I heard a crackling sound as the wood cabinets above the stove caught fire. I dashed upstairs, shut the gas off, grabbed the pot with the burning oil, and headed toward the outside door. But when I opened the door, the wind blew the flames back into my face and scorched the part of my hand not covered by the potholder. Now I really understood what those merchant mariners felt back in Rhode Island when they were so badly burned in that tanker fire. In the end, I wasn't burned too badly, but I still have a small burn scar on my right hand. The most troubling aspect was that the landlady asked us to leave.

We found a small summer cabin on Canandaigua Lake for the six weeks I had left at the health department. A few days after we moved in, my infant daughter, Suzanne, became quite ill with a high fever and a bright red throat. I took a throat culture and drove to town to get some penicillin. The throat culture grew out beta hemolytic streptococcus. Further investigation revealed that the same bacteria grew out of the milk we were drinking. Additional checking with neighbors proved that our little lake community was in the middle of a milk-borne strep epidemic. Since the store that sold the milk was in a different country from the laboratory that would routinely handle cultures from our community, no one in a position of authority ever tracked down the source of the contamination. This was a clear example of a public health failure, and I've been witness to many others.

SCHOOL OF PUBLIC HEALTH

At the end of my year-long residency in Rochester, we packed up again and headed to Maryland, where I started my Master of Public Health year at Johns Hopkins University School of Public Health. We rented a house in Glen Burnie.

At Hopkins, I had a new director from the Public Health Service named Leslie Knott, but I only saw him at the beginning of the year and at the end.

The class was made up of young-to-middle-aged physicians and nurses from all over the world. Interacting with my peers from different cultures was among the best parts of the Hopkins experience. One of my classmates, a burly Yugoslav named Fred Zerkav, would eventually deliver our third and last child, Samuel Glen Milham, while we were in Baltimore.

There were some outstanding faculty members, such as Abraham Lilienfeld, who taught some of the epidemiology course. He would later be in charge of studying the effects of microwave radiation on U.S. State Department personnel at our embassy in Moscow, Russia. Dr. Lilienfeld began his first lecture with a simple statement: "The problem with epidemiology is the controls." No truer words about the field were ever spoken. Identifying and characterizing cases is easy, but getting proper controls is often difficult, even impossible. By way of example, recent cell phone/brain cancer case-control studies had control participation rates of only about 50 percent. Now, there are many reasons why people who agree to participate might be different from people who refuse, including concerns about privacy, time constraints, and individual temperaments. Unless a researcher can somehow prove that the participating controls are representative of a broad, accepted, and recognized control group, all such work is ripe for dismissal. This is one of the inherent, vexing aspects of epidemiology. But despite this, epidemiology is the only way to capture data for human populations.

When I first started publishing papers in the 1960s, we were held

to a much higher standard than is the case today. If a researcher didn't have 90 percent control participation, he couldn't get a study published. Philip Sartwell, then editor of the *American Journal of Epidemiology*, presided over the Hopkins Epidemiology Lab with assorted assistants who were also well known in the field. Over the years that he was editor, Dr. Sartwell sent me some important papers to review, including one authored by Nancy Wertheimer, who, with Ed Leeper, started modern EMF epidemiology with a 1979 paper on residential EMF and childhood cancer in Denver, Colorado.

Shortly before I was to finish the MPH degree and move on in the residency, I was visited by Dr. Leslie Knott. The exchange did not go well. He offered me a couple of residency positions, one in California and another somewhere I can no longer recall. I told him that I'd be happy in any position if he could guarantee me at least two years in one place. This annual moving was taking its toll on me and the family. He blew up and said that being a member of the PHS was like being in the Army, and that he could make no such guarantee. He then asked me to evaluate my year at the school of public health for him. I assumed that he wanted the truth, so I detailed the strong and the weak points of the year. He erupted again and accused me of being a malcontent. "Hopkins is a great school. You don't deserve to go to a school like Hopkins!"

I thought his tirade was the end of it, but a week later I got a late night phone call from Dr. Knott's secretary. "Dr. Milham, he is going to have you drafted," she said. "You need to spend two more weeks at Hopkins to fulfill your draft requirement." The school allowed me put in two more weeks (at that time, public health service counted toward military service), after which I signed up for a third residency year at the New York State Department of Health in Albany.

It was good to be back in my hometown with family support and lots of friends both in and out of the field. I was close to my old school, Albany Medical, and its library, plus I acquired a faculty position in pediatrics there.

My residency was directed by William Haddon, who later went on

to head the Federal Traffic Safety Commission. By mutual agreement, Haddon and I decided that my residency would be better served working with the head of vital statistics, a tall, bright, slightly rumped Ph.D. statistician named Alan Gittlesohn, who was glad to have me. Alan had room for my desk and even helped me push it down the hall from Dr. Haddon's office to his. We began a four-year friendship and research relationship from which we would both learn a lot.

After this third year of public health residency, I signed on with the New York State Department of Health. The move was just down the hall to a new office, working for Robert Korn. Alan Gittlesohn and I continued our work together on special projects. I finally felt somewhat settled.

We wanted to study the incidence of these devastating birth defects over time to search for etiologic clues. In epidemiology, incidence is the number of new cases per year per unit of population at risk. In mathematical parlance, incidence is just a fraction with the case count in the numerator and the population at risk in the denominator. In this case, the population at risk was the population of births. Fortunately, New York State has a large population. We were able to study more than 8,000 births with central nervous system defects in a population of more than 2.5 million births. The major finding of the study confirmed that more female than male newborns suffer from these defects, and we also observed a 50 percent decline in incidence over the years 1945–1959. Since we did this study (Gittlesohn & Milham 1962), it has been learned that dietary supplementation with folic acid before and during pregnancy can prevent 70 percent of these defects. I think that in the United States, folic acid was being added to certain foods after World War II. This would account for the declining incidence of central nervous system defects that we found.

Although nearly all congenital defects have a familial component, very few studies had determined the repeat frequency of CNS defects in families. I collected data on 139 families with a child born with either anencephalus or spina bifida, and found that ten of their 308 brothers and sisters had a similar defect (Milham 1962). This is about sixteen times higher than what would be expected.

CHILDHOOD LEUKEMIA

My first foray into investigating leukemia incidence in populations began in the early 1960s when the British journal, *The Lancet*, published a query asking for information about leukemia clusters. It would turn out to be an area that would hook my interest for decades to come.

This was the pre-computer era. To do the study, I used a card-counting sorter to sort death record punch cards for all the children

NEW YORK STATE DEPARTMENT HEALTH

MY FIRST JOINT epidemiology project with Alan Gittlesohn was to study congenital defects reported in New York State birth and stillbirth records. The health department covered the upstate counties and included the Long Island counties of Nassau and Suffolk. New York City had its own government and vital records system.

Before jumping into the study, I tried to assess how well the congenital defects were reported in the state birth and stillbirth certificates. The state had a system that paid for the surgical repair of certain birth defects, so I obtained case rosters from them. I also visited the three upstate teaching hospitals at Albany, Rochester, and Buffalo and had them pull all their charts for certain diagnostic categories of defects. When I compared the records, it was apparent the central nervous system (CNS) defects called anencephalus (absence of a major part of the brain) and spina bifida (spinal column defect) were well reported in the birth and stillbirth records (more than 80 percent). Cleft lip and palate was also well recorded (75 percent). So we had some good data to work with.