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IMMUNITY FOR THE PEOPLE: THE CHALLENGE OF ACHIEVING HIGH VACCINE COVERAGE IN AMERICAN HISTORY

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On June 8, 2006, the U.S. Food and Drug Administration (FDA) licensed Merck's vaccine Gardasil, a product shown in trials to prevent infection with human papillomavirus (HPV), the most common sexually transmitted disease and a leading cause of cervical cancer.[1] Although the vaccine was heralded as a major breakthrough with the potential for significant public health benefits, it also raised difficult policy issues. Its expected price of approximately $360 for a full course of three injections called into question whether it would be accessible to the uninsured. It was recommended to be given to girls at 11 to 12 years of age, a time when many young people have no regular contact with a primary care provider. Some religious conservatives voiced opposition to the vaccine, arguing that offering protection against a sexually transmitted disease would undermine prevention messages that stress abstinence.[2]

The licensing of the HPV vaccine highlights both the successes and the challenges of the United States immunization system, which is widely regarded as one of the most important public health achievements of the past one hundred years. At the same time, however, critical questions have surrounded their use. How can the benefits of immunity be distributed equitably to everyone, especially people of low socioeconomic status who experience disparities in health care access and outcomes? Who should bear the costs of vaccination? How should responsibility for promotion and delivery be divided among federal, state, and local health agencies, medical professionals, charitable organizations, and insurers? How should resistance or opposition to vaccines be dealt with?

The urgency of these questions has heightened over the past two decades as a consequence of the success of vaccine research and development. The number of recommended pediatric vaccines doubled from seven to fourteen from 1990 to 2006. Although coverage rates for most recommended vaccines are high, there is wide agreement that the system remains vulnerable. As an analysis by three staff members of the Institute of Medicine, a nonprofit research organization that advises the government on health issues, observed: "The United States lacks a comprehensive scientific and policy approach to explore fully the ramifications of the increasing number of vaccines that will soon be available."[3]

At this critical juncture, with increasingly expensive new vaccines either licensed or set to join an already crowded schedule, it is valuable to understand the historic evolution of immunization in the United States. This article describes the successive introduction of new vaccines from the early nineteenth century to the present and the efforts of key stakeholders to achieve high levels of use. In particular, I focus on two broad policy areas that have been central to vaccination programs as well as repeated flashpoints for controversy.

First, what are the most effective and ethical ways of achieving high levels of acceptance among people who are indifferent, wary, or antagonistic toward vaccination? It is a widely accepted tenet of public health practice that persuasive approaches are preferable to coercive ones whenever possible. But because the failure to immunize oneself or one's children can contribute to the spread of infectious diseases, the United States has invoked compulsory measures, primarily laws requiring immunization before children may enter school. Whether such laws are appropriate and under what circumstances exemptions to them should be allowed has been the subject of extensive debate and litigation.

Second, what is the proper scope of government activity in paying for and delivering vaccines? The United States has traditionally relied on market mechanisms rather than public sector support for health care, with limited categorical programs providing some services for the poor. Yet vaccination has always fit awkwardly within this paradigm because, unlike other health interventions that benefit the individual, it also carries a societal benefit through the herd immunity it creates. Thus, some observers have analogized immunization to public health responsibilities such as providing clean water or sewage disposal that are not left to the free market.[4]

The current challenges facing the country's immunization system, this review will show, have deep roots in enduring features of American politics and society. Decisions about how to achieve immunity for the people through an increasingly sophisticated and extensive vaccine regimen should be informed by this history.

VACCINATION IN THE NINETEENTH CENTURY: KEEPING THE POX AT BAY

Smallpox was one of history's most feared diseases because of its gruesome symptoms, high fatality rate, and rapid spread. Its symptoms began with chills, aches, and fever, then progressed ominously to nausea, vomiting, and difficulty breathing. About a week after infection, bright red pustules developed on the victim's face and hands, and then spread to cover the entire body. Eventually the pustules dried and itched intensely, scabbed over, and fell off. About one out of four victims died; those who survived were usually scarred for life and often blinded. Children, who were generally more vulnerable to infectious disease, died from the condition more often than did adults, but it struck young and old alike, and without regard to social class.

The fortuitous observation by the British physician Edward Jenner that milkmaids who were infected with cowpox, a disease of cattle, rarely contracted smallpox led to the introduction of vaccination to the western world. In 1798, Jenner published his famous treatise describing how infection with cowpox, which produced only mild symptoms in humans, also provided protection against the related disease of smallpox. Within a few years, vaccination—the intentional introduction of cowpox material into the body of a healthy person to induce immunity—had been introduced in America, where its success at protecting communities from a feared killer led to its widespread adoption.

Vaccination was an improvement over inoculation, an older method of inducing immunity in which a small amount of smallpox pustular material was introduced into the bloodstream—a technique that could inadvertently induce a full-blown case of the disease and even trigger an epidemic. The new technique joined other long-standing control measures such as quarantine, removal of the sick to a local "pest house" or infectious disease hospital, and disinfection of living quarters with sulphur and steam.[5]

An outbreak of smallpox in a town provoked a severe crisis, disrupting virtually all civic and commercial activity. As a result, many localities not only provided vaccination to all residents, but compelled it by law in order to assure the common welfare. Massachusetts, an early leader in the development of public health activities, enacted the country's first mandatory vaccination law in 1809, and in subsequent decades many other states and cities followed suit. Most of these laws required vaccination for people of all ages, though some were in effect only when an outbreak of the disease had occurred nearby. As public education became common around the middle of the century, laws specifically aimed at children attending school became widespread.[6]

The severity of the threat of smallpox led to one of the few instances of federal involvement in health in the early republic. In 1813, the U.S. Congress passed "An Act to Encourage Vaccination," which, among other provisions, appointed an agent to furnish certified vaccine matter to anyone who requested it and required the postal service to ship vaccine free of charge. The act was repealed nine years later, however, after an incident in which smallpox rather than cowpox was mistakenly shipped, resulting in several deaths.[7]

Although securing the vaccination of all citizens was clearly recognized as a public duty, it became a focal point for debate about the authority of local governments to levy taxes. In 1820, the residents of North Hero, Vermont, voted to institute a tax to pay for the vaccination of all the town's residents after cases of smallpox were diagnosed in the area. Dan Hazen, though he was present at the town meeting where the tax was approved, did not vote for it and refused to pay it. In response, the town constable seized Hazen's cow and sold it to raise the payment. Hazen sued, leading to a ten-year legal battle than ended when the state Supreme Court upheld the confiscation.[8]

By far the most controversial aspect of vaccination programs in the nineteenth century was not how they should be paid for—Dan Hazen's challenge notwithstanding, there was general agreement that providing it free with public funds was appropriate—but whether it should be forced upon those who were reluctant to undergo it. As vaccination led to the decline of smallpox over the course of the century, success bred complacency. Many people who had never experienced an epidemic became reluctant to undergo a procedure they viewed as unpleasant and of questionable necessity. And the procedure was not without its own risks. The arm was scraped multiple times with a lancet, usually made of ivory, until the skin was broken. The vaccine matter—lymph drawn from a cow infected with cowpox, mixed with glycerin—was then applied to the wound. The procedure was uncomfortable and caused the arm to remain sore for several days, often preventing people from working. It left a small scar. There was little oversight of medical practice, and many physicians failed to exercise proper care in performing vaccination; antiseptic procedures did not become the norm until late in the century, and instances of vaccination sores becoming contaminated, leading to serious illness and even death, were not uncommon. Thus, reluctance to undergo vaccination was not entirely unreasonable.[5]

Further, many people believed that smallpox was

not a contagion but was caused by miasmas or filth, and that clean living rather than vaccination was the best preventive. Others simply gambled that they would escape harm when an epidemic struck. Viewing with dismay his fellow citizens' reluctance to be vaccinated in the 1880s, New York City Health Commissioner Cyrus Edson declared, "It is easy to be bold against an absent danger, to despise the antidote when one has no experience with the bane!"[9]

Numerous anti-vaccination societies were established in the second half of the century, whose members distributed pamphlets and broadsides, lobbied legislatures for the repeal of compulsory laws, filed lawsuits, and sought to discourage the use of vaccination. Their rhetoric rested on two linked claims: that vaccination was a dangerous and unnecessary procedure, and that to compel it through law was a violation of the country's foundational belief in individual liberty.[10]

Opinions on whether compulsory vaccination was effective or ethical varied widely among public health officials and doctors. The secretary to the state board of health of Connecticut, which declined to make vaccination mandatory, explained the decision this way: "The people of this country are too thoroughly imbued with a sense of personal independence to submit patiently to personal compulsion. The attempt would excite hostility to vaccination that does not exist at present, and would hinder rather than promote the cause of vaccination."[11] In Louisiana, which also eschewed compulsion, a health official said that such a law "would probably meet the passive resistance of one-third of our people, the violent opposition of another third, the unwilling compliance of most of the remaining third, and cheerful compliance by the small fraction comprising the intelligent and law-abiding class."[12] Very different, however, was the view of Kentucky's health commissioner, who declared that compulsory vaccination "has never yet failed to bring an outbreak under quick control."[13]

Such conflicting views about compulsion among medical professionals, lawmakers, and the public resulted in dozens of challenges to vaccination laws in state courts around the country, which produced varied decisions. Most rulings upheld the laws, especially those requiring the procedure as a condition of school entry, but others limited the scope of compulsion. An Illinois court, for example, held that vaccination for the general population could be mandated only after an outbreak of smallpox had occurred.[14] The question of whether compulsory vaccination contravened the U.S. Constitution finally reached the Supreme Court in 1905 in the case of Jacobson v. Massachusetts, in which a Lutheran minister from Cambridge challenged that state's law. In a seven-two ruling, the justices declared that compulsory vaccination was a legitimate exercise of state governments' "police powers" to guard the health, welfare, safety, and morals of citizens. If duly elected legislatures had determined that smallpox was a threat and that vaccination was an effective way to prevent it, then laws requiring all citizens to comply were not unreasonable. "Society based on the rule that each one is a law unto himself," the decision stated, "would soon be confronted with disorder and anarchy."[15]

During the nineteenth century, the contours of vaccination policy became clear, as medical professionals, lawmakers, and the citizenry all sought to define the rights and responsibilities of government in guarding the communal well-being and the scope of individual autonomy.

IMMUNIZATION IN THE EARLY TWENTIETH CENTURY: "SELLING" GOOD HEALTH

"Will Vaccine Be the Greatest Cure in Medical Science?" asked a headline in the *New York Times* in 1914.[16] The article reflected the excitement and uncertainty in the wake of the Bacteriological Revolution of the late nineteenth century and the expansion of the pharmaceutical industry in the early twentieth, when many new products were developed and the modern vaccine era began.

The identification of many disease-causing microbes sparked attempts to create vaccines against various contagions, including tuberculosis, cholera, plague, and typhoid. Most of these vaccines remained experimental and were never widely deployed; their efficacy remained a matter of dispute, and most of the diseases they protected against were no longer significant threats in this country. Plague, for example, was a rare occurrence, but when it struck San Francisco and Honolulu at the turn of the century, vaccine was rushed to the scene.[17,18] The typhoid vaccine proved valuable in the military, where it reduced troop mortality, but advances in sanitation made its use among civilians unnecessary except in rural areas with poor sewage disposal.[19] Nevertheless, the idea that it was possible to stimulate artificial immunity to many diseases, not just smallpox, gained currency.

The most successful of the new products was a preparation against diphtheria called toxin-antitoxin, which became the second immunizing procedure to become commonplace. The vaccine was developed in the Bureau of Laboratories of the New York City Department of Health, whose director, William Hallock Park, conducted a pioneering series of trials beginning in 1913, first on children in the city's orphanages and

institutions, and then in the public school system. Park and his colleagues published favorable results in a series of important medical journal articles in the early 1920s, and the increasing awareness among physicians set the stage for broad campaigns to bring this breakthrough to children across the country.[20]

The first challenge was convincing the public that diphtheria immunization was safe, efficacious, and worth taking the time and effort of bringing children in for a series of three shots, two weeks apart. Efforts to stimulate interest in the new procedure were needed in part because the incidence of diphtheria, like that of most of the contagions that had been feared killers in the nineteenth century, had dwindled considerably. By the 1920s, heart disease and cancer had already surpassed infectious diseases as the country's leading causes of death.[21] Thus, immunization was no longer a crisis-control measure designed to forestall an imminent threat to the common welfare. Not only was there less urgency that might spur the public to action; the argument that providing immunization for all was a public safety function that lay with the government was less compelling.

One policy aimed at achieving high levels of vaccine coverage that was generally rejected was to require it by law. As early as 1921, some public health and medical experts suggested that immunization against diphtheria be made compulsory for school entry,[22] and such proposals continued to be advanced over the following two decades as use of toxin-antitoxin gained popularity. But only a few states took such a step. Most public health officials were wary of triggering a political and legal backlash against the new vaccine similar to the one that had developed against the smallpox vaccine. In addition, diphtheria immunization was recommended for the first years of life, and many doctors feared that a requirement tied to school entry would lead parents to postpone the procedure until it was too late.

To "sell" the importance of immunizing children against diphtheria, public health officials turned instead to the new techniques of marketing and persuasion that were becoming widespread around that time to sell consumer goods such as cars, appliances, and cigarettes: advertisements in newspapers and mass-circulation magazines, billboards, posters, publicity stunts, and short films.[23] Businesses and charitable organizations also played key roles in popularizing diphtheria immunization and making it available to the public. The Metropolitan Life Insurance Company, for example, placed full-page ads in popular magazines such as the Saturday Evening Post heralding the new preventive, and its staff of visiting nurses advised policy holders to take advantage of this new development in health.[24] Charities such as the Milbank Memorial Fund and the American Child Health Association provided funding to set up health clinics and pay the salaries for nurses and doctors.[25]

Yet it was clear that advertising, by itself, was insufficient to move parents to action. High coverage was generally achieved only when parents had in-person contact with a physician or nurse and when the product was made available in a free clinic.[26] Although the price of each shot varied according to region and individual practitioner, it could cost as much as $5 (about $50 in 2006 dollars).[21]

Public health activities, like government functions more generally, were carried out almost exclusively at the local level and to a lesser extent by state health authorities. While some agencies (notably in northeastern cities such as Boston, New York, and Providence) had active public health programs, funding in most localities was paltry. Even basic functions such as the registration of births and death remained spotty in many parts of the U.S. There was no federal department of health, and the U.S. Public Health Service had evolved little from its origins in port control and quarantine enforcement.

City health departments that did have sufficient resources adopted contrasting strategies for making the new preventive available. Some set up free clinics for all children regardless of the financial circumstances of the parents, while others set strict limits on access by anyone who was able to afford the services of a private physician. Some cities, including Chicago, provided free toxin-antitoxin to physicians on the agreement that they would charge only for their labor in administering it.[21] Others sought to negotiate with their local medical practitioners to offer the shots at a discount rate. In New York City, the health commissioner worked out a voluntary agreement with medical societies through which members would offer the full series of three shots for $6.[27]

The political climate during the 1920s was not conducive to public provision of immunization. In the aftermath of the "Red Scare" of 1919, potential incursions of communism into American society were a source of great anxiety. Libertarian and anti-government civic organizations lobbied against a range of developments they viewed as socialistic, including bills to ban child labor and to create a federal department of education.[28] In this environment, public health professionals in local and state health departments found that efforts to provide diphtheria immunization for free were a hard sell to the tax-paying public. Efforts at public provision of immunization provoked especially sharp criticism from physicians in private practice, who

accused health departments of trying to steal their patients and encroach on their professional turf.

At the same time, however, the inability of many citizens to pay for medical services emerged as a prominent political issue.[29] In 1926, the Committee on the Costs of Medical Care was formed, consisting of physicians, economists, and public health experts who studied ways that advances in medicine might be made accessible to all Americans. Underlying their mission was the question of whether the provision of medical services should remain subject to the rules of the marketplace or if medical care was an entitlement. The committee's final report, issued in 1932, called for the promotion of group practice and group payment systems, recommendations that were profoundly threatening to many physicians who saw them as socialistic schemes. The American Medical Association denounced the recommendations in an editorial in its journal.[30]

During the Depression, as Franklin Roosevelt's New Deal rolled out a panoply of federal programs to alleviate the nation's economic distress, the notion that it was the appropriate role of the government to intervene in urgent matters of domestic policy became more accepted. But health care remained conspicuously absent from most of the federal relief programs. Although the Social Security Act of 1935 did include matching grants to states to support maternal and child health programs,[30] the provision of immunization remained firmly within the fee-for-service paradigm that dominated medical care. Some forms of relief during the Depression aided immunization efforts; for example, workers from the Works Progress Administration assisted with outreach efforts such as visiting the homes of poor families to urge them to seek immunization.[31] Such programs were curtailed, however, when funds were cut in the early 1940s.

In spite of the financial barriers, public acceptance of diphtheria immunization grew steadily, as did vaccination against pertussis (also known as whooping cough), which became available in the 1930s. Since there was no systematic surveillance of immunization coverage levels, it is impossible to determine vaccination rates with any certainty, but special surveys provide some indications of moderate to high acceptance. In the late 1930s, for example, a survey in New York City found that about two-thirds of parents had had their children immunized against diphtheria.[21] Parents increasingly followed the advice of pediatricians and other child-rearing experts on how best to care for children. The American Academy of Pediatrics, founded in 1930, published its first recommendations for the routine immunization of children (nicknamed the "Red Book") in 1934, and subsequently updated the volume every two years.[32] Articles by medical journalists in *Good Housekeeping* and *Reader's Digest* stimulated public demand for experimental pertussis vaccines in the 1930s and 1940s, even when scientific evidence for it was inconclusive and medical professionals were divided over its efficacy.[33]

Immunization in the first half of the twentieth century, when vaccines against diphtheria and pertussis joined smallpox vaccination as commonplace and widely used preventive measures, may be characterized as an era of limited government involvement, partnerships between the public and private sector, and a slow but steady increase in acceptance, accomplished through the increasingly influential mass media and the advice of medical and public health experts.

IMMUNIZATION AT MID-CENTURY: THE ASCENDANCE OF SCIENCE, THE FIGHT AGAINST POVERTY

"For the public," an opinion pollster wrote in 1959, "the caduceus of medicine sits proudly at the top of the totem pole of science."[34] The unprecedented level of support and respect for the nation's scientific experts—and above all for its physicians—provides the backdrop for vaccination policy in the middle decades of the century. Breakthroughs such as the antibiotic penicillin, the anti-tuberculosis drugs streptomycin and isoniazid, and the blood product gamma globulin elevated medical researchers and practitioners to the status of cultural heroes. The nationwide trials of Jonas Salk's polio vaccine in 1954 and 1955 both contributed to and drew upon the sense that scientific medicine was destined to banish infectious disease.[35]

Although polio imposed a relatively small burden of morbidity and mortality, it was the subject of extraordinary public fear, and its image as a crippler of children along with the excitement surrounding the trials shaped events when the vaccine was licensed in April 1955. Unlike the introduction of diphtheria and pertussis immunization, when interest had to be stimulated among an often wary and uncertain public, the demand for the Salk vaccine was instantaneous and overwhelming. The most urgent practical choices were related to getting the most vaccine into the most arms as quickly as possible.[21]

Confusion reigned over how this was to be accomplished, however. It would be impossible for the pharmaceutical companies making the vaccine to produce enough doses in time for the summer polio season. Some kind of rationing would be necessary, though how this would be carried out fairly or consistently was unclear. The Department of Health, Education

and Welfare had been created in 1953, and the agency became the subject of harsh public criticism for its failure to anticipate demand for the vaccine and its hands-off response to its distribution once it became available.[36] Reflecting the country's tradition of private sector initiatives, it was not the government but a charitable organization—the National Foundation for Infantile Paralysis, later known as the March of Dimes—that funded and coordinated the Salk trials. The Foundation played a leading role in distribution, having arranged bulk purchase of vaccine from the manufacturers to distribute free to states once it was licensed.[34]

Rationing was carried out through voluntary agreements in each state among public health entities and medical associations. In New York State, for example, 80% of the vaccine was reserved for official health agencies, while 20% was made available through commercial distribution channels. The state and local medical societies pledged that private physicians would give the vaccine only to children in the priority age groups.[37] During the early period of temporary shortage, children 5 through 9 years of age were given first priority, with any vaccine left over going to children from the ages of 1 to 19. Priorities within this group were to be determined locally.[37]

Although members of the U.S. Congress went to great lengths to declare that public health decision-making transcended politics, hearings on proposed legislation to provide financial assistance to states made it clear that programs for polio vaccination reflected an ideology about the proper role of the government in caring for the health of citizens.[38] As had been the case in the 1920s, antipathy toward "socialized medicine" loomed large over discussions of government responsibility for providing the polio vaccine. Fear of communism, which was at a high-water mark during the Cold War, had been a key factor in the defeat of Harry Truman's plan for a universal health care system in 1949. President Dwight Eisenhower's Secretary of Health, Education and Welfare adamantly opposed suggestions to bring distribution of the vaccine under federal control.[39]

Nevertheless, Congress did pass a bill with bipartisan support that allocated federal funds to states to provide for free immunization of people younger than 20 years of age and pregnant women of all ages. Grants were awarded based on the number of children in the state and its per capita income. The act explicitly forbade use of means testing to limit eligibility of those receiving the vaccine.[40] Over the next two years, Congress appropriated almost $54 million through the act.[41]

In spite of this assistance, surveys showed that rates of vaccination among the poor lagged far behind those of the middle and upper socioeconomic classes. Polio outbreaks in the late 1950s struck urban ghettoes in Chicago, Newark, Baltimore, and Providence, and rural poverty areas in Appalachia.[42] This trend prompted heightened efforts to reach out to the poor. Doctors typically paid about $2 for a dose of the Salk vaccine and in turn offered it to their patients for about $3 to $5 per shot. Many doctors charged more, however. In 1958, the March of Dimes and the American Medical Association worked out a plan through which the doctors' organization would sponsor "dollar clinics" where people could receive their shots for $1 each (about $7 in 2006 dollars).[43]

The licensing of a second polio vaccine in 1961, a live attenuated vaccine developed by Albert Sabin, further raised the visibility of vaccination and opened a window of opportunity in which immunization proponents could argue that the federal government should play an increased role. The new presidential administration of John Kennedy was more receptive to the idea of federal involvement in health than Eisenhower had been, and in 1962 Congress passed the Vaccination Assistance Act, which created a permanent home for immunization programs within the U.S. Public Health Service.[40] The Act provided grants-in-aid to states to support delivery of the diphtheria, pertussis, tetanus, and polio vaccines (smallpox had been virtually eliminated from the U.S. and vaccination against it would soon be discontinued).

The passage of the Vaccination Assistance Act exposed long-standing fissures between public health entities and private practitioners over whether it was appropriate for the government to intervene in the "marketplace" of medical care. Although doctors' groups such as the American Academy of Pediatrics provided the authoritative voice that the public trusted, their vision for how vaccines should be administered was often in conflict with that of their counterparts in public health. As an example of the ways that the issue of medical care for the poor could provoke controversy, a letter from a private pediatrician to the editor of the *American Journal of Diseases of Children* called the Vaccination Assistance Act "a waste of money" that might, "in any state with a politically inclined director of health, be the beginning of removing all immunizations from the physicians' offices, into the public health clinics and health departments of that state."[44]

The licensing in quick succession of vaccines against measles (1963), mumps (1967), and rubella (1969) further reinforced the belief that immunization was a cornerstone of medical science's triumph over disease, while at the same time it stimulated political debate

about the costs of medical care and concern about how the benefits of immunization would be available to all members of society. A dose of one of the two measles vaccines licensed in 1963 cost about $3; the cost to parents to have one child immunized against measles, including the doctor's fee, a possible shot of gamma globulin that was given with the live vaccine, or three doses of the killed vaccine, averaged around $10 ($60 in 2006 dollars).[45] As a result, few public clinics for the poor made the new vaccines available; middle- and upper-class families who could afford the services of a private pediatrician were the main beneficiaries of the new products. Only after federal funding to states became available through the Vaccination Assistance Act in 1965 did use of the measles vaccine become more routine and coverage rates increase.

Against the backdrop of the activist social programs of Lyndon Johnson's War on Poverty, immunization activities became more explicitly focused on efforts to bring vaccination to the poor. The enactment of Medicaid in 1965 and the creation two years later of the Early and Periodic Screening, Diagnosis and Treatment (EPSDT) program, a Medicaid benefit intended to ensure that poor children would receive preventive care, illustrated the extent to which the federal government was seen as having a key role to play in financing health care for those who could not afford it. An ambitious (though ultimately unsuccessful) campaign to eradicate measles launched in 1966 was of a piece with this broad political environment.[21]

The belief that government intervention was needed to achieve high vaccination coverage lay behind the other major policy initiative of the 1960s: the enactment of laws requiring immunization for school attendance. A hodgepodge of state and local laws, many dating from the era of smallpox in the nineteenth century, existed in about half the states. In 1967, in concert with its national eradication campaign, the U.S Centers for Disease Control and Prevention (CDC) launched a push to make the laws more extensive and uniform. From 1968 to 1974, the number of states with laws requiring all or most recommended vaccinations prior to school entry increased from twenty-five to forty.[46] States without laws gradually fell in line with the national trend, and by 1981, Idaho, Iowa, and Wyoming had become the last states to enact such laws.[47]

Charitable organizations continued to play a role in vaccine promotion. The Joseph P. Kennedy Foundation, which was concerned with mental retardation, sought to promote use of the measles vaccine, since complications of measles were a leading cause of retardation. The Foundation had joined the CDC in urging lawmakers around the country to enact laws requiring children to be vaccinated before they could enter school.[21] In 1971, the foundation sent a letter to the wives of governors and congressional representatives around the country, urging them to coordinate efforts by "women's groups" in the state, such as the PTA or the Junior League.[48] The foundation's proposed programs emphasized education aimed at mothers, since "many mothers simply have not been educated about the benefits of and need for immunization. If they knew, they would make sure their children were protected."[49] In addition to a strong gender bias, the wording of the foundation's letter gave voice to the view that, no matter how expansive the governmental role in providing vaccines grew, getting children immunized ultimately depended upon parental action.

As school laws were enacted, immunization levels among school-age children climbed, but the laws did little to improve coverage among infants and preschoolers. In the early 1970s, the nation saw repeated outbreaks of vaccine-preventable diseases. In response, the U.S. Congress created a new program (the Vaccination Assistance Act had expired in 1968) that authorized the Public Health Service to provide grants-in-aid to help states and localities deliver vaccines.[40] This assistance, so-called "317" grants for the enabling section of the Public Health Service Act, would provide an important source of funds in subsequent years. Nevertheless, support for vaccines remained highly variable and, according to most experts, inadequate to the need. Immunization programs lacked a natural constituency of political support that might have lobbied for expanded funding. Samuel Katz, chair of the American Association of Pediatrics' Committee on Infectious Diseases, chided his colleagues for "their exquisite attention to detail but detachment from concern with some basics such as immunization status."[50]

Vaccination policy during the middle of the twentieth century was characterized by dramatic strides in the science of vaccine development that brought new acclaim to the power of scientific medicine to banish disease. Ironically, however, this recognition did not translate into a steady and reliable source of financial support to assure that needed vaccines would get into the bodies of the vulnerable children who needed them most.

IMMUNIZATION IN THE CONTEMPORARY ERA: NEW PRODUCTS, OLD CHALLENGES

"Public Health Needs a Shot in the Arm," declared a *USA Today* headline in 1991, in the wake of a measles epidemic that had spread across the country.[51] In spite of the enactment of laws, many years of educa-

tion and promotion, and a patchwork of public sector programs for free or low-cost immunization, the promise of vaccines remained partially unfulfilled. This point was driven home by an outbreak of measles beginning in 1989 that struck primarily among poor African American and Latino pre-school children in large cities including Los Angeles, Chicago, Houston, Milwaukee, and Washington, DC.[52] The epidemic threw into stark relief the disparities in health coverage for poor children.

As a subsequent analysis in the *American Journal of Preventive Medicine* noted, everyone agreed that immunization rates lagged far below what they should have been and that more efforts were needed to boost coverage rates, but there was no consensus on what exactly was the source of the problem. According to some observers, parental apathy or ignorance was to blame, and intensified education programs were needed. According to others, the high cost of vaccines was the problem. Since many private insurers did not cover routine immunization, even children with health insurance sometimes had to be taken to a public clinic when it was time for shots. In still other accounts, the fragmented nature of the U.S. health care system, with children's records scattered among many providers they might see during the time they were supposed to receive their shots, led to missed opportunities to vaccinate.[40]

Dissatisfaction with vaccine costs and the system through which children received their shots was part of a larger debate about whether the United States should join the world's other industrialized democracies in establishing national health care for its citizens. A window of political opportunity for proponents of universal insurance opened with the election of Bill Clinton to the presidency in 1992.[53] One of the administration's first legislative priorities was the Children's Immunization Initiative. Although the proposal was originally intended to provide free vaccines for all children regardless of family income level, it was eventually scaled back and passed as an entitlement program, called "Vaccines for Children," designed to reach young people who were eligible for Medicaid, those who lacked insurance, and Native American children. Created as an amendment to Title XIX of the Social Security Act (Medicaid), the program provided federal dollars to states to purchase vaccines from manufacturers and distribute them free to health care providers in the public and private sectors who served poor children.[54] For the first time, federal funds could also be used to support costs directly related to administering vaccines, such as the salaries of doctors and nurses.

The new funding stream coincided with a dramatic growth in the schedule of recommended vaccinates. During the 1990s, vaccines against *haemophilus influenza* type B, hepatitis B, chickenpox, and invasive pneumococcal disease joined the CDC's schedule of recommended pediatric vaccines. The number of injections children received climbed steeply, making it even more difficult to assure that they would get all recommended vaccines in a timely manner and at an affordable cost.

Another consequence of the rising number of shots that children received was increasing anxiety about the safety of vaccines. Attention to the potential for adverse events had achieved high visibility during the 1980s, when it was alleged that the whole-cell pertussis vaccine, typically given as one component of the trivalent diphtheria-pertussis-tetanus (DPT) shot, might in rare instances cause brain damage. This controversy led to the passage in 1986 of the National Childhood Vaccine Injury Act, which created a system of compensation for those harmed by vaccine-related adverse events.[55] During the 1990s, these concerns increased and there emerged the most vocal and politically active anti-vaccination movement since the nineteenth century.

This development grew in part out of broad social trends. The general decline in trust and respect for institutions and authority that had occurred in the 1970s afflicted doctors, while widely publicized scandals such as the U.S. Public Health Service's Tuskegee syphilis study had also damaged health professionals' credibility.[56] This transformation set the stage for open challenges to the expert judgment of immunization proponents. The growth of the internet facilitated the spread of rumors and unproven hypotheses. Connections were alleged between vaccination and conditions as diverse as sudden infant death syndrome, multiple sclerosis, attention-deficit-hyperactivity disorder, and diabetes.[57] Most inflammatory of all were charges of a connection between vaccines and an apparent rise in rates of autism in children. A 1998 paper in the *Lancet*[58] alleged that the measles component of the measles-mumps-rubella vaccine might be causally linked to autism (the conclusion was subsequently disavowed by the majority of the paper's authors after charges of conflict of interest were brought against the lead researcher).[59] A connection was also alleged between autism and thimerosal, a mercury-based preservative used in some multi-dose vaccine vials to prevent contamination after the vial was opened.

One consequence of the growing sense of public unease about vaccine safety was efforts on the part of vaccine skeptics to liberalize exemptions to school entry requirements. Most public health experts agreed that

exemptions served as a "safety valve" that prevented backlash against the use of law to achieve compliance with vaccine recommendations. But many expressed concern that too liberal exemption policies might lead more parents to opt out, thus putting communities at heightened risk for outbreaks of vaccine-preventable illnesses. Empirical research had demonstrated that unvaccinated clusters of children could pose serious risks to the health of the community.[60,61]

The roots of exemptions lay in religious objections to vaccination. When school entry laws were enacted during the late 1960s, members of the Christian Science church successfully lobbied legislatures in many states to include exemptions for individuals whose religious tenets specifically proscribed vaccination. During the 1990s, many states expanded their exemptions to include people with secular philosophical objections as well. As of 2006, forty-eight states allowed religious exemptions to vaccination, and in twenty of those states parents could opt out for philosophical beliefs as well. In two states, only exemptions for medical contraindications were allowed.[62]

What is perhaps most remarkable is that given many obstacles, the United States has achieved levels of vaccine coverage equal to or greater than most other industrialized democracies. Coverage rates for recommended childhood vaccines reached record high levels in 2004. But there are several caveats to this success. Reflecting the country's highly decentralized public health system, rates varied substantially among states.[63] Vaccine production remains concentrated in just a handful of pharmaceutical companies, a situation that led to repeated shortages of pediatric vaccines from 2000 to 2002 and rationing of the flu vaccine in 2004. A report of the Institute of Medicine in 2000 on vaccine financing noted that the country's system was "fragile and unstable" and called for a major federal commitment to ensure that the achievement was sustained.[64]

It is also clear that a substrate of anxiety remains among the public about the alleged harmful effects of vaccines. These fears continue to find voice in articles in the popular media charging that public health officials at the CDC and FDA have engaged in a conspiracy to conceal the evidence of a causal connection between thimerosal and autism.[65] At least seven states have passed legislation barring mercury in childhood vaccines, and another 20 are considering such bills, moves that critics claim would increase the costs of vaccines without a clear public health benefit.[66]

As immunization pioneer Samuel Katz argued in the early 1970s, "There are many complex, interacting reasons for the persistent failure to achieve optimal immunization of all children. Sociologic, economic, educational, political, and logistical factors are all involved. They do not permit any simple, immediate solutions."[67] Katz's observation remains true today. Fundamental characteristics of American political and civic culture continue to shape and often constrain efforts to achieve immunity for the people: the absence of a universal health care system; a more general preference for addressing social problems through voluntaristic, private sector solutions; devolution of responsibility for public health activities to state and local units rather than federally coordinated efforts, resulting in great regional and local variation in health outcomes; and a strongly libertarian orientation, especially toward matters of healing and bodily integrity.

The central issues that have dominated vaccination policy for the past two centuries—how to convince the unwilling or uncertain and how to meet the demand among the ready and enthusiastic—will take on new salience in the coming years as vaccines increase in price and target diseases that afflict fewer people. Among health interventions, vaccines have always had one of the most favorable cost-benefit ratios. For a relatively low price, they have not only prevented huge expenditures in health care, but also reduced burdens of human suffering. While such calculations were straightforward in the past, they are becoming more complex in proportion to the growth of the schedule of recommended vaccines. Each newly licensed product will have to be carefully weighed, not only in terms of its financial costs, but also in terms of the number of additional shots it will require children to undergo and the severity and prevalence of the disease that is prevented.[68] These calculations will also need to take into account less readily quantifiable but equally critical considerations related to the social and political climate in which efforts to create population-level immunity will be implemented.

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