

Dr. Herman Kabat: Neuroscience in Translation . . . From Bench to Bedside

M. Elizabeth Sandel, MD

INTRODUCTION

Herman Kabat, MD, PhD, initially trained as a basic science researcher and then as a clinical neurologist during the 1930s. He is best known for a physical therapeutic method, “proprioceptive facilitation,” now referred to as “proprioceptive neuromuscular facilitation” (PNF) [1-3], that he developed with physical therapist Margaret (“Maggie”) Knott to treat patients with neurologic disorders. However, Kabat must be remembered for much more than the development of this one method. Rigorous neuroscience training and research in a neurophysiology laboratory established a strong foundation for his understanding of the neuromuscular system. Medical training enabled him to apply this knowledge and to conduct what is now called translational research in the developing fields of physical medicine and rehabilitation (PM&R) and physical therapy [4]. Kabat insisted that scientific knowledge, revealed through basic science research, could and should be translated into clinical practice. In particular, he directed his mission toward clinical research and practice, aiming to help those who the medical profession had for the most part abandoned. The key word in this story of an early pioneer who was a neurologist by training but essentially practiced as a PM&R physician is the word “facilitation.”

THE EARLY YEARS

Herman Kabat was born on January 8, 1913, in Brooklyn, New York, the son of Samuel and Mary (Kronick) Kabat. He received a bachelor's degree from New York University in 1932, at the age of 19. Three years later, he earned a PhD from Northwestern University's Institute of Neurology and remained on the faculty in the Department of Physiology and Neuropsychiatry at Northwestern until 1943 [5]. Kabat's early publications are evidence of his intense interest in neuroanatomy and neurophysiology. For example, he used stereotactic instrumentation and electrical stimulation to localize and investigate central nervous system circuits involved in autonomic responses, blood pressure regulation, and the gastrointestinal, urinary, and respiratory systems [6-10]. During this period of study and the teaching of neuroanatomy and neurophysiology at Northwestern University, Kabat decided to pursue a career in medicine, perhaps in part because of the polio epidemic that was reaching a crisis point in the United States. In 1939, 7300 cases of polio had already occurred. This number reached 19,000 by 1944 and nearly 58,000 by 1952 [11].

A CLINICAL RESEARCH CAREER LAUNCHED

Kabat received his medical doctorate in 1942 from the University of Minnesota, and it was there that he met Miland Knapp, MD, a physiatrist who worked with Sister Elizabeth Kenny. Sister Kenny had arrived from Australia in 1940 and was developing methods of treating patients with poliomyelitis [12]. Kabat's introduction to these 2 important figures launched his clinical rehabilitation research career. However, these collaborations also showcase his strong commitment to science and his unwillingness to compromise scientific principles. In fact, his dissatisfaction with the Kenny approach reflected one of several disagreements with other rehabilitation professionals who he

M.E.S. Physical Medicine and Rehabilitation,
University of California, Davis, Sacramento, CA.
Address correspondence to: M.E.S.; e-mail:
bsandel2@gmail.com.
Disclosure: former chief and medical director,
Kaiser Foundation Rehabilitation Center.

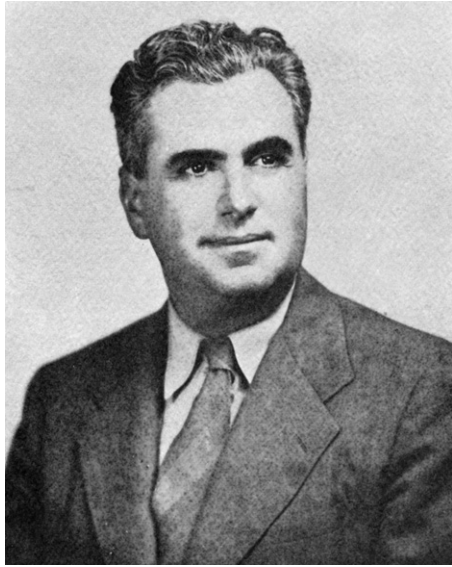


Figure 1. Herman Kabat, MD, PhD, ca 1947.

believed did not fully understand neurophysiology [13]. Kabat and Knapp joined forces to study the mechanisms of muscle spasm in poliomyelitis; they presented evidence that infection with the polio virus damages internuncial neurons in the gray matter of the spinal cord and, at the same time, decreases the inhibition of proprioceptive reflexes. Their study involved measuring the chronaxie of muscles in 14 patients and the effective use of neostigmine, a medication that acts on the spinal cord to inhibit proprioceptive reflexes [14]. Kabat was now studying the use of pharmacologic interventions that facilitated human functioning, with significant results.

In 1943, Kabat left for Washington, DC, and spent the next few years at the National Institutes of Health, the Public Health Service in Bethesda, Maryland, and the District of Columbia's Crippled Children's Program. At the National Institutes of Health, he continued research he had begun in Minnesota at the Anderson Institute for Biologic Research using the Kabat-Rossen-Anderson apparatus, a device that used a cervical pressure cuff to produce transient cerebral anoxia in human subjects [15]. During this period, from 1943 to 1946, Kabat continued to transition from animal to human research [16,17], and he met Margaret Knott, a Walter Reed physical therapist, who shared his vision for finding interventions for people with disabling neurologic diseases and conditions. They began a collaboration and exploration of various techniques for the facilitation of functioning through physical and pharmacologic interventions. Kabat (Figure 1) would soon meet another key person who supported his research and clinical career for a relatively brief but very significant period: Henry J. Kaiser.

TWO HENRY J. KAISERS MEET HERMAN KABAT

During the 1930s through the 1950s, Henry J. Kaiser, Sr, the industrialist and founder of the health care system known as Kaiser Permanente, built aqueducts, dams, bridges, warships, cars, and hospitals, mostly on the West Coast. Edgar and Henry J. Kaiser, Jr, his 2 sons, were working for the company in the 1940s. In 1945, at the age of 26, Henry Jr was exhausted from work and suspected something else was wrong. Cecil Cutting, MD, one of the founders of the Permanente Medical Group, diagnosed multiple sclerosis [18]. His father turned to his friend, the microbiologist and writer Paul De Kruif, author of *Microbe Hunters* and other popular science books. De Kruif was preparing an article for *Reader's Digest*, "Many Will Rise and Walk Again," about the use of neostigmine for patients with neurologic conditions [19]. Kabat had told him about a woman with multiple sclerosis who was treated with neostigmine and physical therapy with dramatic results, prompting Henry Kaiser to investigate further. He sent his colleague Sidney Garfield, MD, to meet Kabat. Garfield was the first physician hired by Henry Kaiser and the one who had established a hospital for workers in the Mojave Desert during the building of the Colorado River Aqueduct in the early 1940s [20]. De Kruif would later publish more of the Kabat-Knott story in his book, *Life Among the Doctors*, which included the story of Kabat's work in his home-based office in Washington, DC [21].

Henry, Jr, received treatment from Kabat and Knott, including neostigmine and physical therapy, and he improved dramatically. Garfield sent orthopedist Richard Moore, MD,



Figure 2. From left to right (foreground): Henry J. Kaiser, Sr, Margaret Knott, Herman Kabat, and Mildred Ackerman (Mills College professor and dancer, identified by Julie Kabat), at Kabat-Kaiser Institute, ca 1950. Courtesy of Kaiser Permanente Heritage Resources.

and internist René Cailliet, MD, to train with Kabat at the Kabat-Kaiser Institute (KKI) in Washington, DC, which opened with funding from Henry J. Kaiser. Moore had helped provide medical care to workers and their families at the Kaiser Permanente Grand Coulee Dam work site in the 1930s. Cailliet was a young internist Garfield knew from Southern California. The plan was to open several rehabilitation centers across the country. Three California KKI facilities were opened in Oakland, Santa Monica, and Vallejo between 1947 and 1948 [18]. The first facility briefly continued under Kabat's medical leadership in Washington, DC, but was closed when Kabat moved to head the Vallejo facility in 1947. Only the Vallejo facility, now known as the Kaiser Foundation Rehabilitation Center and Hospital (KFRC), remains today [22].

Physiatrists Ora Leonard Huddleston, MD, PhD, and René Cailliet, MD, both served as medical directors of the Santa Monica KKI facility. Huddleston also served as the first medical director of the Permanente physical therapy school, established in 1948 in Vallejo. Both physiatrists were active in academic medicine in Southern California and in national organizations. Both served as presidents of the American Congress of Physical Medicine, now the American Congress of Rehabilitation Medicine. Huddleston was also a founding member of the American Board of Physical Medicine, now

the American Board of Physical Medicine and Rehabilitation [23]. Cailliet is best known for his textbooks on musculoskeletal medicine [24]. Both Huddleston and Cailliet conducted research with Kabat, who was also a member of the American Congress of Rehabilitation Medicine.

THE KKI IN VALLEJO

Kabat arrived in Vallejo in August 1947 and Maggie Knott arrived shortly thereafter, following Henry Kaiser's purchase of the Vallejo Community Hospital, which had been government-sponsored during the war, to establish Vallejo's KKI facility to treat patients with polio, multiple sclerosis, strokes, spinal cord injuries, and other disabling conditions (Figure 2).

In the same year, the United Mine Workers of America established the Welfare and Retirement Fund, and a number of rehabilitation centers, including the Kessler Institute in New Jersey, the Rusk Institute in New York, the Woodrow Wilson Rehabilitation Center in Fishersville, Virginia, George Washington University Hospital in Washington, DC, and the KKI centers in Washington, DC, Oakland, and Vallejo, had contracts to provide medical and rehabilitation services to patients with acute and chronic injuries [25,26]. Physiatrists George Deaver, MD, and Howard Rusk, MD, both of Rusk



Figure 3. A United Mine Worker from West Virginia carried by stretcher from a Pullman train car for transport to Kabat-Kaiser Institute in Vallejo, California, ca 1948. Courtesy of Kaiser Permanente Heritage Resources.

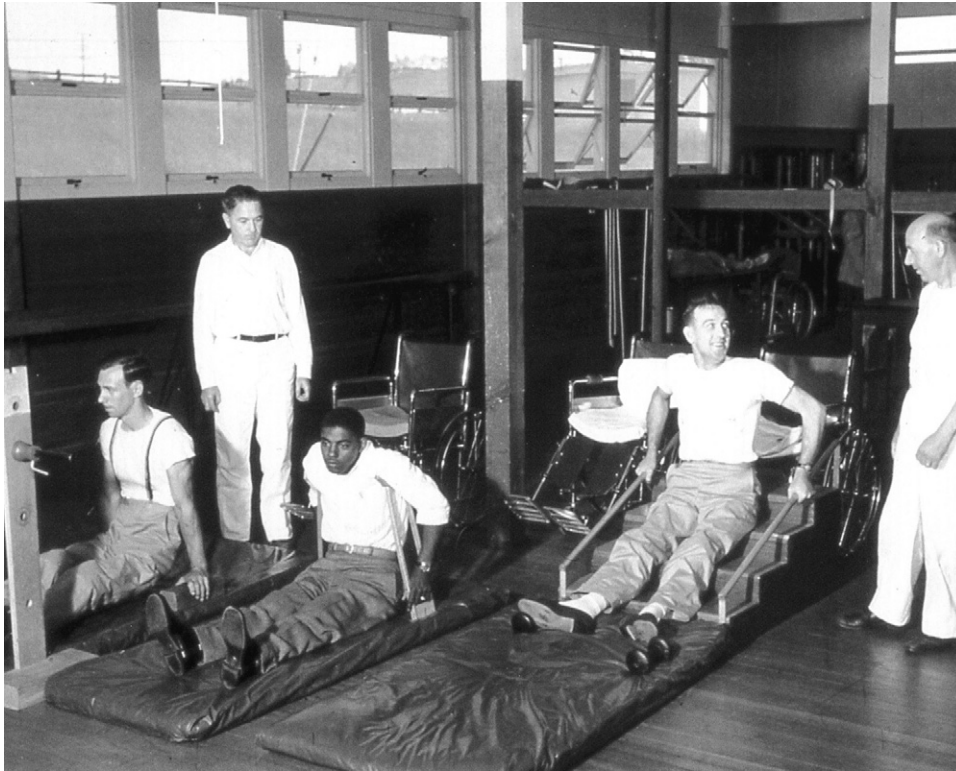


Figure 4. Caption: Miners with paraplegia exercising on mats at Kabat-Kaiser Institute in Vallejo, California, ca 1948. Courtesy of Kaiser Permanente Heritage Resources.

Institute, and Henry Kessler, MD, founder of Kessler Institute in New Jersey, were other prominent physicians who accepted injured miners as patients in their hospitals during this era [27].

One of Kabat's patients at the Vallejo KKI facility who made California history was Harold Willson, a young man with a spinal cord injury sustained during a mining accident in West Virginia in 1948. After his rehabilitation, Willson served as an economic analyst for Kaiser Permanente, and in the early 1960s he launched a campaign to make the Bay Area Rapid Transport (ie, BART) system wheelchair accessible. The campaign included an initiative to raise \$10 million to implement the system when the State of California did not have the funds to do so [28]. Kabat published a case series of 3 United Mine Workers patients, one of whom was acutely injured, 5 and 8 years after they sustained their injuries; these patients made remarkable improvements after they used the techniques Kabat and Knott were continuing to develop (Figures 3-5) [29].

FACILITATING FUNCTION IN THE NEUROMUSCULAR SYSTEM

Kabat's research and writing peaked during the Kaiser Permanente years, from 1947 to 1954, when his understanding

of the neuromuscular system provided a solid foundation for developing the physical therapy approach he initially called proprioceptive facilitation. During that 7-year period, Kabat published more than 20 articles, including 2 in *Science* [30-40]. Kabat based this work on the work of Charles Scott Sherrington, a neurophysiologist and Nobel Laureate. (Sherrington shared the 1932 Nobel Prize with Edgar Adrian.) Sherrington's research established that components of the neuromuscular system did not operate in isolation. He emphasized concepts such as temporal and spatial summation, after-discharge, irradiation, successive induction, and reciprocal innervation and inhibition (the relationships of muscular antagonists and agonists) [41].

Kabat was convinced that these concepts could be useful in developing interventions for people with neuromuscular disorders. He outlined 4 essential mechanisms: (1) maximal resistance; (2) reflexes (eg, the stretch reflex tonic neck reflex, or righting reflexes, and reduction of spasticity with cold packs—ie, external stimuli for facilitation); (3) irradiation (use of muscle stretch, a proprioceptive and therefore internally generated phenomenon, and applications of therapy using diagonal spiral patterns that are physiologically based); and (4) successive induction (techniques based on reversal of antagonists). Kabat argued that these techniques could be applied



Figure 5. Patients at Kabat-Kaiser Institute using therapeutic exercise equipment, ca 1948. Courtesy of Kaiser Permanente Heritage Resources.

singly or in combination for greater effect through Sherrington's concept of temporal and spatial summation [42].

Sidney Licht, a physiatrist and author of a series of PM&R textbooks, wrote about the history of therapeutic exercise and included this commentary about Sherrington, other neurophysiologists, and Kabat:

... Sherrington ... developed the concepts of reciprocal innervation and inhibition. Several physicians were instrumental in introducing normal and pathological reflexes into exercise therapy, but chief among these was another neurophysiologist, Herman Kabat, who left the laboratory in search of a medical degree to put his ideas into clinical practice. He used the stretch reflex of Sherrington, the flexion reflex of von Bechterew and the tonic neck reflex of Magnus (among others) and called his method facilitation. Facilitation is especially recommended in patients with paralysis because of the high synaptic resistance produced by disease and disuse. Pavlov had shown that repeated transmission of impulse across synapses decreased synaptic resistance and resulted in new functional pathways in the central nervous system. By empirically

trying different approaches, Kabat arrived at more effective techniques [43].

Kabat received national publicity in the early 1950s for his work at the Vallejo facility, including a major spread in *Collier's Weekly* (Figure 6) [44]. His scientific publications were greeted for the most part positively, although sometimes colleagues damned his ideas with faint praise. Pediatrician Harriett Gillette, MD, of Warm Springs, Georgia, commented in one publication, "The techniques of central facilitation as outlined by Dr. Kabat are successful and useful ones. I personally have experienced gratifying results with the use of some of them. However, I am constantly reminded that the art of medicine lies in a knowledge of the application and the judicious use of its many tools" [37].

Kabat published a collaborative study with Huddleston, Moore, and Cailliet on respiratory paralysis in patients with poliomyelitis, reporting the successful treatment of 12 patients through use of a combination of resistive exercises, manual mobilization, reinforcement techniques, positive and negative respiratory pressures, and abdominal binders. Hart E. Van Riper, MD, a pediatrician and director of the National Foundation for Infantile Paralysis, greeted the study critically: "I do not believe that the number of cases presented, or the demonstration which we have witnessed gives us sufficient clinical material upon which to make a definitive evaluation of this technique." He also remarked on the lack of funding for research and criticized the authors because they did not credit his foundation for funding 5 other institutions and did not comment on the clinical activities in these institutions [45].

At the same time that some physicians criticized his work, Kabat was critical of others, just as he was with the Kenny approaches that he believed were not scientifically sound. In 1950, *Science* published his commentary on the relationships of muscular antagonists and agonists [38]. In discussing Sherrington's point that inhibition is not only a suppressor of reflexes but also a "delicate adjuster of the intensity of reflex contraction," Kabat went on to make this observation: "Here again the emphasis is on reflex rather than voluntary contraction, and Sherrington himself would probably decry the oversimplification of the phenomenon as stated in a current text on physical medicine: 'Reciprocal innervation means that when a voluntary or reflex contraction occurs, as in the biceps muscle, it is accompanied by relaxation of its antagonist, the triceps muscle'" [38,46].

TURMOIL AND TROUBLE

Unfortunately for both Kabat and the Permanente Medical Group, the confluence of anticommunist and antisocialist politics in the United States meant trouble for Kaiser Permanente for decades. The situation came to a head during the McCarthy era in the early 1950s. Organized medicine fiercely opposed a prepaid, non-fee-for-service health care system, and for many

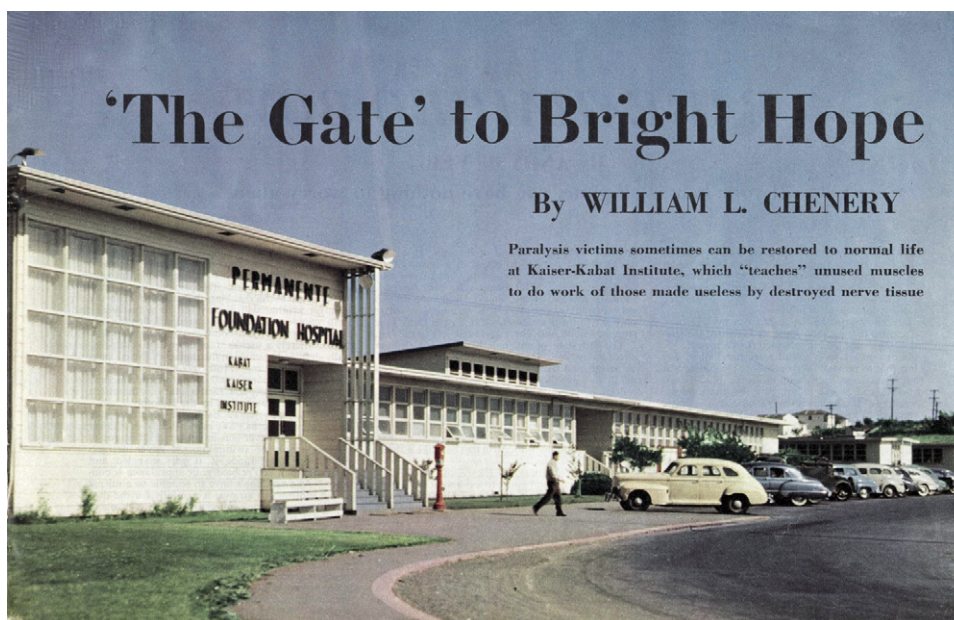


Figure 6. Kabat-Kaiser Institute, Vallejo, California. *Collier's Weekly* story, July 8, 1950. Courtesy of Kaiser Permanente Heritage Resources.

years Kaiser Permanente physicians were excluded from practice in non-Kaiser hospitals and from medical associations, including the American Medical Association and the California Medical Association. Physicians and other employees were accused of having ties to socialist and communist organizations. Paul De Kruif, for one, had strongly defended the system and its physicians for many years [47,48]. According to several oral history sources, Kabat was asked to leave the organization in 1954 because of Henry J. Kaiser's anticommunist sentiments and rumors about Kabat's political views and activities, or those of his colleagues [49,50].

After a few more years of medical practice in the San Francisco Bay Area, Kabat, his wife Sarah, and their 4 children moved back to the East Coast, settling in Rhode Island, where Kabat was on the staff at Miriam Hospital in Providence. Governor Dennis Roberts hired him to establish rehabilitation centers, including one at Newport Hospital. During this later period, Kabat identified himself as a PM&R physician (Julie Kabat, personal communication, 2013.)

Clifford Keene, MD, who was director, vice president, and general manager of Kaiser Foundation Health Plan and Hospitals, appointed Sedgwick Mead, MD, from Harvard University, who had completed his training with a Baruch fellowship, to take over the medical directorship of the Vallejo KKI facility, renamed the California Rehabilitation Center in 1954 [11].

THE WORK CONTINUES IN VALLEJO

Physical therapists Maggie Knott and Dorothy Voss published the first textbook on PNF in 1956 [51]. Knott contin-

ued to train physical therapists from around the world at the facility (renamed the Kaiser Foundation Rehabilitation Center and Hospital, ie, KFRC, in 1964) until her death in 1978. KFRC postgraduate training programs continue the Kabat-Knott legacy. Hundreds of physical therapists from the United States and abroad have been trained during the last 65 years. PNF theory and practice has been used in musculoskeletal and sports medicine, in addition to neurologic disorders [52-54]. Since the 1940s, physical therapy approaches for neurologic disorders other than PNF, such as Bobath (known in the United States as neurodevelopmental training) and more recently constraint-induced movement therapy, have been favored, although the reasons for this favoritism are not entirely clear. The benefit of one physical therapeutic approach over another is still not clearly established for stroke, the most prevalent disabling neurologic condition, or for other neurologic conditions [55-58].

The Kabat-Knott Center for Rehabilitation Research at KFRC is dedicated to the study of rehabilitation outcomes research, primarily observational studies. One of the Research Center's recent prospective studies of patients who have had a stroke in the Kaiser Permanente Northern California Health System found superior functional outcomes for patients receiving care at KFRC compared with other post-acute care sites, although the study was not a comparative study of physical therapy approaches or treatment intensity [59].

In his later years of practice, Kabat continued to design physical and rehabilitation interventions for patients with

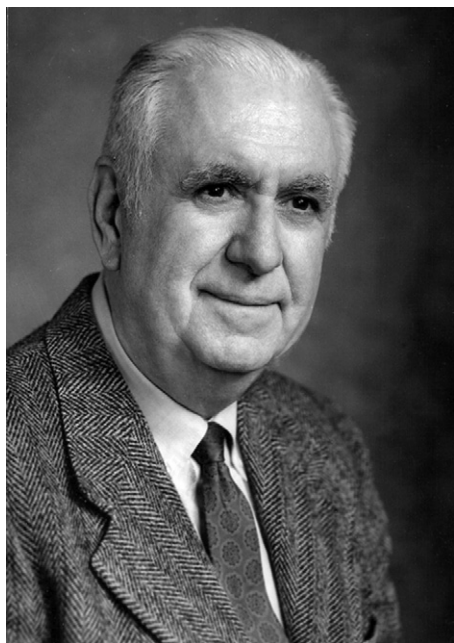


Figure 7. Herman Kabat, ca 1980. Courtesy of Julie Kabat.

neurologic disorders, including movement disorders (athetosis and ataxia [60,61]) and for painful conditions caused by disk herniation [62,63]. As in previous decades, he designed therapeutic approaches based on pathophysiological concepts that he had learned as a physiology graduate student.

His publications in these later years also document his physical diagnostic skills. Herman Kabat retired in the mid 1980s and died in 1995 at the age of 82, leaving a legacy not to be forgotten (Figure 7).

CONCLUSION

The best tribute that the fields of PM&R and physical therapy could offer to this early pioneer, physician scientist, and humanist is research focused on physical therapy that produces greater levels of evidence-based treatment for patients with neurologic disorders such as stroke, to facilitate functioning. Kabat's contributions provide a path forward until more evidence is available. According to his daughter Julie, "he never intended his research on PNF methods to be accepted without further questioning, or to be codified and remain unchanged. He thought clinical practice should be based on sound scientific principles and ongoing research, since scientific inquiry is a dynamic process always open to improvement" (Julie Kabat, personal communication, 2013). Kabat also steadfastly believed in medicine's responsibility to patients abandoned as "incurable" but whose inner resources could be engaged through a therapeutic relationship, along with the use of interventions based on scientific principles to improve or facilitate functioning. His message from more than 6 decades ago captures the principles of PM&R:

It is a common thought that when a person is in trouble he has to call on inner resources or untapped sources of strength within himself to face the crisis. A person



Figure 8. Maggie Knott and Herman Kabat treating a polio patient at Kabat-Kaiser Institute, Vallejo, California. From *Collier's Weekly*, July 8, 1950. Courtesy of Kaiser Permanente Heritage Resources.

suffering from paralysis must mobilize inner resources not only to make the necessary psychological adjustment to a handicap, but even more, to fight against the paralysis and get back on his feet again. We have learned that dormant powers within the central nervous system can be stimulated to make paralyzed muscles work again and make useless limbs function once more. So to us, the hidden powers within the brain are not only real but also essential for recovery and rehabilitation. There is no question that it is the patient himself who restores muscular function and skill in doing things. All the skill and knowledge of the doctors, therapists, and other members of the staff cannot be effective in helping the patient unless he himself puts out his best effort. It is his own push and pull that is therapeutic and beneficial. The rest of us can guide and direct these heroic efforts to ensure achievement of the goal in the shortest possible time. All of us stand in continual awe of the courage and zeal that makes it possible for the most important member of the team to pull himself up by his boot straps and do the impossible—the patient! [64]

One patient, diagnosed with poliomyelitis at the age of 31 years and treated by Kabat and Knott at the Vallejo KKI for contractures and other late effects of polio, sums up her experience of the care provided: “Finally, it was over. I saw that Maggie and Dr. Kabat had been crying . . . I was very moved” (Figure 8) [65].

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