Arnold Max Meirowsky: champion of the American mobile neurosurgical unit during the Korean War

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Dr. Arnold Max Meirowsky (1910–1984) developed the mobile neurosurgical unit for the US army during the Korean War, introducing to the American military the concept of the mobile neurosurgical unit. After implementation of the neurosurgical detachment, meningocerebral infections saw a decrease from 41% to less than 1%, with similar improvements in mortality and complication rates. Additionally, Meirowsky developed many techniques and improvements in neurosurgery, specifically in the field of neurosurgical trauma, which he dedicated himself to even after reentering civilian practice. Furthermore, his mentorship of Korean surgeons and the influence of his mobile neurosurgical unit were major influences cited to be pivotal to the founding of neurosurgery as a specialty in South Korea. As he is underrecognized for these accomplishments in the neurosurgical literature, the authors seek to review his wartime and career contributions. They also specifically present details of his standardization of the mobile neurosurgical unit and showcase several of his other advancements in the treatment of neurosurgical trauma.

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At 11 o’clock one morning last week, the heavy tread of a Chinese artillery barrage marched across a Korean hillside near the 38th parallel. Sitting in a slit trench, a U.S. private caught the blast of a shell exploding in front of him. A tiny, singing splinter drove through his skull and lodged in his brain. In the foggy depths of consciousness, the private heard his buddy screaming, “Medics, damn it! Medics!” Eleven hours later, the private was resting comfortably between the clean sheets of a U.S. Army evacuation hospital near Seoul. The faithful medics had brought him down from his bloody hill by litter jeep, taken him to a mobile field hospital where a helicopter whirled him off for neurosurgery at the evacuation hospital. The surgeons deftly chipped away some of the skull, carefully picked and washed the dirt, bone splinters and hair from the missile track in his brain, and sewed him up again. The splinter itself, about five millimeters square, was left untouched; to remove it would have meant damaging unharmed tissue, and experience has shown that it will soon be covered with scar tissue and cause no trouble. At week’s end, the private was completely lucid and feeling fine…. The men he owes his life to are the medics and surgeons of the Army’s ist [sic] Provisional Neurosurgical Detachment and its trim, brown-haired commander, Lieut. Colonel Arnold M. Meirowsky.¹

Dr. Arnold Meirowsky (1910–1984) was enormously influential to military neurosurgery during the Korean War, introducing to the American military the concept of the mobile neurosurgical unit. After implementation of the neurosurgical detachment, meningocerebral infections saw a decrease from 41% to less than 1%, with similar improvements in mortality and complication rates. Additionally, Meirowsky developed many techniques and improvements in neurosurgery, specifically in the field of neurosurgical trauma, which he dedicated himself to even after reentering civilian practice. Furthermore, his mentorship of Korean surgeons and the influence of his mobile neurosurgical unit were major influences cited to be pivotal to the founding of neurosurgery as a specialty in South Korea. As he is underrecognized for these accomplishments in the neurosurgical literature, the authors seek to review his wartime and career contributions. They also specifically present details of his standardization of the mobile neurosurgical unit and showcase several of his other advancements in the treatment of neurosurgical trauma.

Early Life and Family

Born in Cologne, Germany, on April 7, 1910, Arnold Max Meirowsky was the youngest of three of Emil Meirowsky and Clara (Wedel) Meirowsky (Figs. 1 and 2). Arnold’s father was a world-renowned professor of dermatology at the University of Cologne, and their family lived affluently in a large house with maids and cooks. Arnold’s uncle, Max Meirowsky, was an industrialist and art collector. Following in the footsteps of his father and older sister, Arnold enrolled in medical school at the University of Cologne, graduating in 1934. Between 1935 and 1936, Arnold completed postgraduate training in general surgery in Berlin before leaving for the US in December 1937 in pursuit

ABBREVIATIONS MASH = Mobile Army Surgical Hospital; WWII = World War II.
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of opportunity, much to his father’s chagrin (Jane Merrow, interview, 2021).

Shortly after Arnold left home, his family felt the effects of the Nazi regime and the looming World War II (WWII). Although the family was atheist and socially Catholic, they were deemed Jewish and persecuted. Despite Emil’s insistence to continue practicing dermatology, his university stripped him of his titles and licenses. The family stayed in Germany too long to extract their wealth and narrowly escaped to England in 1939 with the help of their elder son, Werner Leopold Meirowsky (later William Merrow). Their eldest child, Lisamaria, a pediatrician who converted to Catholicism and became a nun, helped Jewish refugees escape across the Dutch/German border until she was arrested by the Gestapo in 1942 and deported to the Westerbork transit camp. Lisamaria was subsequently transported to Auschwitz and murdered (Fig. 2). In 1947, Arnold helped his parents immigrate to the United States (Jane Merrow, interview, 2021).

Involvement in WWII

Upon arriving to the US in 1937, Meirowsky immediately loved and embraced America. He underwent a rotating internship at St. Francis Hospital in Santa Barbara, California, between 1938 and 1939 (A. M. Meirowsky, unpublished correspondence, from archives at Indiana University–Purdue University Indianapolis). He then did his neurosurgical residency at Albany Hospital in Albany, New York, between 1939 and 1942, training with Eldridge Campbell. After residency, Meirowsky completed a fellowship at Barnes Hospital and St. Louis Children’s Hospital at Washington University School of Medicine in St. Louis, Missouri, with Ernest Sachs.

Following the attack on Pearl Harbor in 1941, the US became embroiled in WWII. On August 26, 1942, shortly after finishing his fellowship, Meirowsky enlisted in the US Army to treat wounded soldiers. As a captain in Okinawa during April 1945, Meirowsky stated:

FIG. 1. Timeline of events from 1910 to the present. Upper: Events from Meirowsky’s life. Lower: Details related to military neurosurgery.

FIG. 2. Stumbling blocks (“stolperstein”) in the Cologne district Lindenthal commemorating Arnold Meirowsky’s family at Fürst-Pückler-Str. 42. A: Clara Meirowsky’s stolperstein, laid in October 2016. The inscription translates to, “Here lived Clara Meirowsky, born Wedel in 1873, escape in 1939 to England then the USA.” B: Lisamaria Meirowsky’s stolperstein, laid in May 2014. The inscription translates to, “Here lived Dr. Lisamaria Meirowsky, born 1904, escape to Holland in 1938, internment at Westerbork, deported in 1942, Auschwitz, murdered August 9, 1942.” C: Emil Meirowsky’s stolperstein, laid in March 2015. The inscription translates to, “Here lived Dr. Emil Meirowsky, born 1876, prohibited from working in 1933, escape in 1939 to England, then USA.”
I am working almost day and night; for the first time tonight things are quiet, but I’ll need that time to sleep, I’ll write long letters when this campaign has been completed…. Our soldiers are doing a superb job, but the going is rough for them and for all of us. My experiences here are beyond anything that I have ever known. I am spending all my time taking care of the brain injuries; there is practically no time for me to take care of the many peripheral nerve injuries; I have to leave that to the orthopedic people and to the general surgeons…. Some can’t be saved but there are many whom we can help…. If I’d get killed tonight, I’d feel my life has been worthwhile, if for nothing else than these days on Okinawa.4

The Korean War and the Introduction of the Mobile Neurosurgical Unit

After returning from WWII, Meirowsky became director of neurosurgery at Kennedy Veterans Administration Hospital in Memphis, Tennessee. Only a few years later, in 1950, the US became involved in the Korean War. Meirowsky again returned to active duty in 1951, joined by Campbell, who was key to supporting his pioneering efforts in military neurosurgery. Meirowsky worked in the Eighth Army Surgical Hospital from October 1950 to July 1952, surviving shelling while aiding wounded soldiers.2 Meirowsky noted that during war, many head wounds were secondary to shrapnel fragments, and to a lesser extent, bullets and other missiles.2 He criticized the shape of the US Army helmet for not providing enough protection to the frontal and temporal regions and provided suggestions for improvement.5 Furthermore, he lamented that wearing the helmet was not always mandatory and that many deaths from low-velocity missiles could have been prevented.

At the beginning of the Korean War, specialized neurosurgical care was not available to soldiers on the battlefield; the closest available center was in another country at Tokyo Army Hospital.6 Soldiers who sustained craniocebral injuries were first treated at battalion aid stations. After delays ranging from 1 to 23 days, they would finally be transferred to Tokyo. This lengthy journey was associated with a 41% meningocerebral infection rate by the time these patients received definitive care.6,7 A further vexing problem was decubitus ulcers in patients with spinal cord injuries, considered to be an unavoidable consequence of spinal cord injury.8 Meirowsky felt “bitter disappointment” in these early months of the war and that he was “in the wrong spot” rather than closer to the battlefield where his patients needed care most (A. M. Meirowsky, unpublished correspondence, from archives at Indiana University–Purdue University Indianapolis). Yet despite these setbacks, he stated:

“…”

During World War I, Harvey Cushing advocated for early operative treatment of head injuries; this notion was promulgated in WWII with the first forward mobile neurological units that would set up near the battlefield, developed by Sir Hugh Cairns.9 By the Korean War, Meirowsky had fully embraced the importance of the earliest possible treatment of neurosurgical trauma and wished to build on Cairns’ approach, disappointed with delays in early definitive treatment. Meirowsky proposed the idea of implementing the first American neurosurgical team on the battlefield to achieve this rapid response, which was initially rejected by higher command.9 Leaders worried about the risk of losing skilled and valuable neurosurgeons and argued that such intricate operations were not possible on the field. Meirowsky persisted until the Army agreed to let him “study” the possibilities. During a retreat from the Chosin Reservoir at Hamhung in the winter of 1950, Meirowsky arrived with a duffel bag of instruments and “elbowed” some space in a field hospital.1,17 He convinced other physicians to assist him, and by the end of the evacuation, proved that neurosurgery could be performed under combat conditions.1 Following that trial, the Army let him set up a provisional three-man team in Taegu, in which he performed a prolific 108 operations during the first weeks of the Spring Offensive.

In April 1951, under the leadership of Meirowsky, the Eighth Army organized the 1st Provisional Neurosurgical Detachment, assigned to the 52nd Medical Battalion and attached to the 121st Evacuation Hospital.10 This was the only neurosurgical care available to United Nation forces within Korea at the time. In just 26 days, 126 craniotomies and laminectomies were performed. The “able but abrasive” neurosurgical consultant of the Far East Command, Lieutenant Colonel Meirowsky, worked half of each month at the new unit, spending the other half back in Japan. By mid-October 1951, he convinced leadership to let him set up a second detachment at the 8209th Mobile Army Surgical Hospital (MASH) unit.10 Between September 1950 and August 1952, the overall mortality for the 1105 casualties with penetrating head injury was 7.8%, and the mortality for those with penetrating wounds of the spinal canal was 3.6%. What set Meirowsky’s approach apart from prior neurological units was his novel use of a two-tiered triage and evacuation system that implemented the use of helicopters and airplanes for speedy transport. The incidence of meningocerebral infection decreased from 41% to less than 1%. Decubitus ulcers did not develop in a single American or United Nations casualty within the Far East Command between October 1951 and September 1952. When interviewed by TIME, Meirowsky humbly stated, “There’s nothing spectacular in any of this. It’s just plain hard work.11

Organization of the Mobile Neurosurgical Unit

In designing the first American mobile neurological unit, Meirowsky had three goals: 1) minimizing time to neurological management, 2) mobilizing for deployment in ever-changing situations, and 3) economizing to reduce the costs of veteran care.6 These neurological detachments were added to parent MASH units to share supplies and materials. Meirowsky detailed technical notes
on these neurosurgical units in hope that standardization would allow for widespread adoption.

**Staff**

With an anticipated 25–35 patients per neurosurgical unit, minimums included one experienced neurosurgeon, one assistant neurosurgeon with at least 2 years of residency training, and an optional but helpful assistant surgeon. Additional requirements included one experienced anesthesiologist, four nurses with neurosurgical training, and 10 enlisted surgical technicians. Of the surgical technicians, four were employed in the operating room, each working a 12-hour shift. The two most skilled became scrub nurses and the other two circulating nurses or operative assistants. Six other technicians took care of the preoperative and postoperative work. Preoperatively, technicians shaved and prepped patients, inserted catheters, and recorded vital signs. Postoperatively, they managed comatose and paraplegic patients.

**Equipment and Facilities**

As the neurosurgical units were attached to a parent MASH unit, surgical linen, cots, litters, blankets, and various housekeeping items were shared. A 2.5-ton cargo truck was assigned to each neurosurgical team for transport should there be any unexpected moves on the field. As for specifics of the setup of the tents, there were three sections of tents, the center section being the operating room, which was sandwiched between tents for the preoperative and postoperative areas (Fig. 3A). To construct the operating room, two hospital tent end sections were combined, allowing enough space for 1–2 operating tables and operating equipment. Surgical instruments included the US Army’s surgical instrument set and a supplemental...
set for brain and nerve injuries (Fig. 3B). Three combined sets were needed to operate on a 24-hour basis. For the operating table, a sturdy metal litter stand was made of scrap iron, rather than using costly and impractical commercial operating tables (Fig. 3C). The patient’s head was positioned with blankets and tape. For suboccipital operations and laminectomies in the prone position, a circular hole was made in the litter for the face, which enabled the anesthesia team to access and manage the patient’s airway. For lighting, a surface light was made to move on a cross beam (Fig. 3D). This was supplemented by head lights as well as Frazier lighted retractors for illuminating deep structures.6

Meirowsky also recommended installation of a record room in the postoperative tent to maintain important medical records for clinical care and future research purposes (Fig. 3G).6

Meirowsky placed special importance on the care of paraplegic and quadriplegic patients and invented a “litter-turning method” to prevent decubital ulcers (Fig. 4). This system involved placing a new second litter on top of the patient and strapping them between the padded litters on sawhorses, turning their position safely with a single quick flip, and then removing the top litter for cleaning. The litter for the prone position was prepared with openings for the face and catheter. Litter turning was performed every 2 hours, which—in addition to his many other well-documented techniques to care for these patients—prevented the development of decubitus ulcers in any American or United Nations patient during the Korean War.6

Transportation of Patients

Meirowsky insisted that direct helicopter evacuation from the battalion aid station on the field to the mobile neurosurgical unit provided the fastest and safest transportation (Fig. 5 left). Previously, ambulance rides on rough roads were poorly tolerated by neurosurgical patients, for whom every pothole could potentially incite disaster. Three to 7 days after surgery at the mobile neurosurgical units, patients could be evacuated directly to the major neurosurgical center at Tokyo Army Hospital, omitting interim hospitalizations at installations not specially equipped for neurosurgical care. Patients with uncomplicated penetrating brain wounds tolerated the trip

without issue, while patients with transventricular injuries fared better with a longer initial postoperative stay prior to transportation. Soldiers with spinal cord trauma who did not have wounds to the abdomen or chest were transported 3–4 days after laminectomy. As for the specific form of transport, patients were first carried by helicopter to an airport, where a C-54–type aircraft would then carry them to Tokyo. During winter months, the Army Quartermaster’s winter evacuation bag kept patients warm even at sub-zero temperatures (Fig. 5 right).6

Techniques Developed for Neurosurgical Trauma

Over the course of war and through the treatment of numerous injured soldiers, Meirowsky advanced the management of neurosurgical trauma significantly. He regularly published scientific articles during and after serving in the military, detailing his experiences and research findings. Perhaps his magnum opus is his text, *Neurological Surgery of Trauma,*7 with another significant work being *Penetrating Cranioencebral Trauma.*11

Meirowsky emphasized several key principles in the management of penetrating head injury, although some have fallen out of favor in contemporary management.7 Chief among these principles was that the earliest possible neurosurgical intervention was necessary to successful treatment of penetrating cranioencebral trauma. Meirowsky espoused the notion that maintenance of an open airway was the most important emergency measure in an unresponsive patient with penetrating cranioencebral trauma. If the patient was in a coma, positioning them on their side was important to facilitate drainage and prevent aspiration of mucus and vomit. In the Korean War, Meirowsky argued against the prevailing stance of the time and felt that tracheostomy was often not necessary as long as lateral positioning and frequent suctioning were carried out.

Obtaining radiographs at forward battalion aid stations was unnecessary and likely to result in delays in care, Meirowsky contended, but preoperative radiographs at the neurosurgical units were essential.7 This was especially important when scalp wounds that appeared uncomplicated obscured intracranial trauma. In scalp lacerations and compound fractures, he emphasized that debridement should be carried through all layers including the peristemeum, with en bloc resection of infected and some healthy tissue. He highlighted this point with a drawing in his article (Fig. 6), an example of the many detailed drawings, case vignettes, and pictures that Meirowsky employed throughout his publications and articles.

Influence on South Korean Neurosurgery

In addition to providing better care for injured soldiers, Meirowsky was pivotal to the development of neurosurgery in South Korea.12,13 Prior to the Korean War, neurosurgery was not a distinct specialty but rather part of general surgery.14 During the Korean War, Korean surgeons had an opportunity to learn from Western neurosurgical practices and gain invaluable training experiences.12 In particular, Meirowsky’s mobile neurosurgical units are widely cited as one of the main sources of influence by South Korean neurosurgeons.12–19 Meirowsky was specifically recognized as one of the main mentors that strongly influenced the Korean surgeons, with other American neurosurgeon mentors being Lieutenant Colonel George Hayes and Captain Farley.12,16,19 A familial and courteous bond between the American and Korean neurosurgeons developed in these mobile neurosurgical units.14 The influence of Meirowsky and his neurosurgical units on Korean neurosurgery is best stated by Dr. Joon-Ki Kang in his presidential address to the International Society of Pediatric Neurosurgery: “I have no hesitation in emphasizing that Korean neurosurgical activities began with scientifically advanced neurosurgical concepts and techniques received from the U.S. MASH. The progress made in our activities was also much influenced and developed by this...
contact with Dr. Meirowsky and Dr. Hayes, who worked closely with Korean Army surgeons.”

After the Korean War ended, some army surgeons stayed in Korea to practice neurosurgery while others went abroad to study in Western countries and returned with additional training. This included pioneers such as Hun Jae Lee and Bo Sung Sim. These Korean surgeons ended up establishing neurosurgery in Korea, founding the Korean Neurosurgical Society in 1961. In a letter to his friend L. W. Freeman during the war, Meirowsky stated, “It has been a real pleasure and a joy to teach these men” (A. M. Meirowsky, unpublished correspondence, from archives at Indiana University–Purdue University Indianapolis).

Postwar Civilian Life and Career

After the war, Arnold Meirowsky worked at the Veterans Administration Medical Teaching Center and Kennedy Veterans Hospital in Memphis, followed by work at the University of Cincinnati College of Medicine. He made his way to Vanderbilt University in August 1953, where he became associate professor of clinical neurosurgery (1953–1984). He was attending staff at Vanderbilt Hospital (Fig. 7A), with appointments at St. Thomas Hospital, Nashville General Hospital, Baptist Hospital, and Williamson County Hospital (where he served as chief of surgery in 1982).

Infection control and cleanliness in his operating room continued to be enduring themes even after the wars. It was said that Meirowsky once mandated that a nurse leave the operating room for having a single hair protruding from under her surgical cap (Jane Merrow, interview, 2021). He held various leadership positions, such as serving as president of the Middle Tennessee Medical Association in 1966 and the Southern Neurosurgical Society in 1972.

Arnold Meirowsky remained intensely focused and dedicated to his profession as a neurosurgeon. He had great compassion for his patients and took his work seriously, working constantly with few holidays. He never married, although he had many friends and enjoyed a vibrant and well-publicized social life. Outside of his clinical work, Meirowsky took up a hobby of breeding dogs; he was particularly proud of his prized Miniature Schnauzers and briefly served as the President of the Standard Schnauzer Club of America. He liked fine wine and dining. He was also part of the First Lutheran Church in Nashville, Tennessee. Although he did not converse about his war experiences in everyday conversation, he was said to take offense at the lightheartedness of the television show M*A*S*H in reflection of such a serious time (Jane Merrow, interview, 2021).
Death and Legacy

Dr. Meirowsky died on April 2, 1984, after an apparent heart attack at home.2 He is buried in Woodlawn Memorial Park and Mausoleum Nashville, Davidson County, Tennessee (Fig. 7B). Meirowsky was awarded the Legion of Merit for his service in WWII. For his work in creating the first mobile neurosurgical team in Korea, the US Army awarded him the Oak Leaf Cluster and the Outstanding Civilian Services Medal. He also received the Chungmu Distinguished Military Service Medal with the gold star from the Republic of Korea government.2 Modern manifestations of the mobile neurological unit permeate contemporary healthcare, such as with mobile stroke units that enable prehospital treatment.22 His actions during the war and introduction of the mobile neurological unit saved countless lives, as did his continued dedication to his work in civilian life. Arnold Meirowsky’s enduring contributions to neurosurgery in warfare and in neurological trauma reflect an ethos of innovation, commitment to improving the lives of mankind, and bravery under duress—virtues worthy of celebration for current and future generations of neurosurgeons.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Riesenburger, Wang, Bi. Acquisition of data: Riesenburger, Wang, Kelly. Analysis and interpretation of data: Wang. Drafting the article: Riesenburger, Wang, Bi, Kelly. Critically revising the article: all authors. Reviewed the final version of the manuscript on behalf of all authors: Riesenburger. Administrative/technical/material support: Riesenburger, Bi, Kelly. Klimo. Study supervision: Riesenburger.

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