Neurosurgery at Pearl Harbor: Ralph Cloward’s legacy

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Ralph B. Cloward (1908–2000) was the sole neurosurgeon present during the Japanese attack on Pearl Harbor on December 7, 1941. Cloward operated on 42 patients in a span of 4 days during the attacks and was awarded a commendation signed by President Franklin D. Roosevelt in 1945 for his wartime efforts. During the attacks, he primarily treated depressed skull fractures and penetrating shrapnel wounds, but he also treated peripheral nerve and spine injuries in the aftermath. His techniques included innovative advancements such as tantalum cranioplasty plates, electromagnets for intracranial metallic fragment removal, and the application of sulfonamide antibiotic powder within cranial wounds, which had been introduced by military medics for gangrene prevention in 1939 and described for penetrating cranial wounds in 1940. Despite the severity of injuries encountered, only 2 soldiers died in the course of Cloward’s interventions. As the sole neurosurgeon in the Pacific Theater until 1944, he remained in Honolulu through World War II’s duration and gained immense operative experience through his wartime service. Here, the authors review the history of Cloward’s remarkable efforts, techniques, injury patterns treated, and legacy.

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initially practiced at “The Clinic,” where his father had practiced as an otolaryngologist and ophthalmologist, however, by 1939, he had opened his own independent practice. He was the only physician practicing neurology and neurosurgery in Hawaii at that time. When Cloward began practicing in Hawaii, neurosurgery was a young specialty—membership in the Harvey Cushing Society totaled just 42 members at the time. In 1938, at the beginning of Cloward’s practice, the population of Honolulu was approximately 150,000; however, by 1980, approximately 40 years into Cloward’s practice, the population in Honolulu County had swelled to over 630,000. Therefore, Cloward was strategically placed to care for a growing population as the sole provider of neurosurgical services in the Hawaiian Islands for many years.

In 1940, the Honolulu County Medical Society was advised by the American Medical Association’s committee on medical preparedness to prepare for a possible mass casualty event. Fortunately, Cloward participated in preparedness training: “It was general belief that war was not likely to come to Hawaii, but in case it did, we made preparations for the first aid care of casualties. When the attack finally did come the civilian population was ready but the military was not.”

On December 7, 1941, Cloward was at his Manoa Valley home when he saw smoke over Waikiki from the Pearl Harbor attacks (Fig. 1). He recalled: “I heard a radio broadcast: ‘will the following doctors report to Tripler Hospital immediately.’ My name was the third on the list.” At the time of the Pearl Harbor attacks, Tripler General Hospital (Fig. 2) was a 250-bed military hospital with only 3 operating rooms. Within 2 hours of the attacks, the hospital had 1500 patients arrive with serious injuries. Cloward was rushed to a makeshift operating suite: “The small 14 x 18 ft. O.B. delivery room was to be my operating room.”

From December 7 until late on the night of December 10, Cloward operated on 42 patients with severe head injuries, a “3 day round-the-clock surgical marathon.” For triage, patients with large sections of skull missing and brain herniating out with catastrophic bleeding were not operated on because of the extraordinary number of cases requiring treatment and the likely poor outcome for these patients. Cloward had to make use of the tools available in the dire conditions: “My suction apparatus was a portable machine run by a small motor used to aspirate the trachea of newborn babies…we had no gelfoam or thrombin but made ample use of large wads of cotton soaked in hydrogen peroxide.” The majority of the patients Cloward operated on had wounds from metallic bomb fragments with compound depressed skull fractures. Shrapnel injuries were among the most common sustained by US soldiers during the Pearl Harbor attacks, with surgeons working constantly to remove foreign shrapnel from soldiers’ limbs (Fig. 3). Cloward published a detailed description of his operating experience in “War injuries to the head: treatment of penetrating wounds,” published in the Journal of the American Medical Association in 1942. In this report, he made several interesting observations about patients at presentation and during the initial operative exposures: 1) the penetrating cranial shrapnel injuries produced “uniformly circumscribed holes” in the skull, and “no long linear fracture lines radiating from the point of entry of the foreign body were seen in any of the fractures”; 2) the defect in the inner table of the skull was often larger than the missile itself, whereas the defect in the outer table was usually a smaller hole; 3) few soldiers with penetrating cranial shrapnel wounds were unconscious at presentation: “The majority of them had not even been unconscious but were able to recall everything that had transpired from the time they were hit”; and 4) large dural defects were commonly seen: “Large gaping defects were always found in the dura mater, having been made not only by the penetrating object but also by the fractured pieces of bone carried in with it.” Later, in 1950, Cloward published his experience in treating head injuries and cited Cushing and Cushing’s World War I experience while describing his own methodology (Fig. 4)
ments within the brain: “The question arises as to whether or not the metallic foreign bodies should be removed from the brain or left in.” He would palpate the tract with a rubber catheter similar to methods described by Harvey Cushing to determine whether there were any larger metal fragments left at the deep portion of the missile tract. He was concerned about the delayed development of epilepsy in patients who had retained metal fragments, which prompted him to remove all accessible metal fragments when possible. To close larger dural defects, Cloward used a large periosteal graft, and he described using a 6.5-cm periosteal graft to close a large dural defect behind the right orbit of a soldier who had a complete orbital blowout injury with destruction of the frontal, ethmoid, and sphenoid sinuses. Occasionally, Cloward would use a large electromagnet provided by the army to remove retained steel fragments through a trephine hole.

Cloward applied newer techniques including the application of antibiotic powder within the cranial wounds (introduced by Army medics in 1939 for the prevention of

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**FIG. 3.** A US Marine holding a piece of shrapnel removed from his right arm at a medical tent at Pearl Harbor with the surgeon in the background. Photograph from December 8, 1941. United States Marine Corps.

gangrene), which may have contributed to his low infection rate: "no infection was encountered in any of these cases in which the preliminary treatment described of cleansing the wound and applying the sulfonamide powder was employed." This technique for intracranial application of sulfonamide powder had only been described in the literature in 1940. Cloward would place sulfanilamide powder in the missile tract and in the brain tissue as well. Although he noted that follow-up was insufficient at the time of writing, Cloward observed that no abscesses or meningitis cases were later encountered when the sulfanilamide powder was applied, whereas 1 patient without applied sulfanilamide powder died of meningitis 4 days after presentation. No cases of delayed cerebrospinal fluid leakage were noted. Of the dozens of patients Cloward operated on within 48 hours of injury, only 2 died; one death was attributed to extensive subdural hemorrhage and the other to meningitis that had developed 4 days after injury. Cloward was one of the first surgeons to use tantalum cranioplasty plates to repair skull defects from war wounds, although these plates were not available until 6 months after the Pearl Harbor attacks. Many of the techniques applied by Cloward, such as the use of thrombin, antibiotic powder, routine dural closure, and bone fragment removal, were described by R. Glen Spurling in 1960 as major advances in cranial war injury management in World War II. Interestingly, Spurling does not reference Cloward despite the overlapping techniques mentioned.

Cloward predominantly treated cranial injuries, but he also described one peripheral nerve injury that required surgical repair at Pearl Harbor. A Japanese American fisherman aboard his fishing vessel was struck by a bullet in his gluteal muscle, completely transecting his sciatic nerve. Cloward suture-repaired the injury, and after 22 months, the patient's foot drop had disappeared.

Cloward was finally able to return home after 3 straight days of operating. Interestingly, he crashed his vehicle during the late-night drive, an event that he attributed to the military blackout requirement that car headlights be painted black to avoid detection by the Japanese. Amazingly, he was unharmed, and 6 native Hawaiian men helped him lift his vehicle out of the ditch beside the road.

Neurosurgical Practice After Pearl Harbor

Cloward was in a unique position as the sole neurosurgical provider in the Pacific Theater from 1941 to 1944, only receiving relief when the US Navy sent Dr. Exum Walker of Atlanta to Pearl Harbor in 1944. During the war, Cloward served the US military but also continued practicing in the civilian population as needed. These dual roles offered him vast experience with various populations and many pathologies. Because of the large Japanese population in the Hawaiian Islands, he treated dozens of patients with hyperhidrosis and developed the thoracic sympathetic ganglionectomy technique (Fig. 5A). He was also uniquely positioned to care for soldiers with degenerative and traumatic spinal pathology. He went on to describe the posterior approach for lumbar interbody fusion (Fig. 5B) and independently described the anterior cervical discectomy and interbody fusion technique (Fig. 5C) in the 1950s. Although he did not describe any acute cases of spinal pathology treated at Pearl Harbor, in the aftermath Cloward treated many patients with sciatica via lumbar discectomy and his newly developed interbody fusion technique. He attributed such pathology to the manual labor required to rebuild wartime defenses: “I operated on many patients with sciatica and low back pain, especially after Pearl Harbor (December 7, 1941). The labor required to build our wartime defenses resulted in many low back injuries.” Figure 6 displays a timeline of Cloward’s career around the time of Pearl Harbor.
Accolades and Legacy

Numerous awards were bestowed on Cloward throughout his career, beginning with a commendation signed by President Franklin D. Roosevelt in 1945 for his wartime efforts. After the war, Cloward continued his practice in the Hawaiian Islands. For many years, he remained the sole neurosurgical practitioner there. His ability to learn from his patients and surgical experience and to reflect on his clinical observations enabled him to innovate and develop many of his surgical advances. His many academic contributions are notable in that the vast majority were written by a single author, which is likely reflective of the frontier nature of his practice. Likely also a result of the isolation of his practice was his clinical innovation. Cloward went on to design approximately 100 surgical instruments, many of which are used by spine surgeons today, and he obtained 2 patents (Fig. 7).3,20–23

FIG. 6. Timeline of Cloward’s neurosurgical career at the time of Pearl Harbor. AMA = American Medical Association; JAMA = Journal of the American Medical Association; JNS = Journal of Neurosurgery; WWII = World War II.

Conclusions

With the recent passing of the 80th anniversary of the Pearl Harbor attack, the contributions of Ralph Cloward to the war and the neurosurgical specialty are especially germane. Just as the Pearl Harbor attacks forever shaped America’s history and immediate involvement in World War II, so too did Cloward forever change the field of neurosurgery through his surgical techniques, surgical tools, and commitment to presenting and publishing his work.

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References


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Supplemental Information

Previous Presentations

The abstract was previously presented at the Rocky Mountain Neurosurgical Society Annual Meeting in June 2021.

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