Neurocrit Care
https://doi.org/10.1007/s12028-023-01913-z

NEUROCRITICAL CARE SOCIETY

NEUROCRITICAL CARE THROUGH HISTORY

Go or No-Go: The History of an Acute Neurosurgical Dilemma

Eelco F. M. Wijdicks*

The prolific neurologist M. Allan Starr of the College of Physicians and Surgeons of Columbia University, New York, wrote in his book *Brain Surgery* [1] (Fig. 1), possibly the first US book on neurosurgery patients he referred to surgeons, the following on when to proceed with emergent trephining:

> *Such symptoms are a condition of stupor which g radually deepens into coma with stertorous breathing, a slow and sometimes irregular pulse, a rise of temperature to 101° to 103°. Suppression of urine and polyuria have both been observed, and an appearance of albumen or sugar in the urine is frequent; vomiting occurs if the patients are not deeply comatose. Irregularity of the pupils with dilatation on the side of compression has been noticed [1].*

Also patients who developed worsening hemiplegia or aphasia in several days frequently underwent a burr hole procedure. He devoted a chapter in his book to tapping the lateral ventricle in patients with acute hydrocephalus, with few surviving. In his mind, surgery could be quite successful and he strongly argued against throwing in the towel—and that in 1893!

Many neurosurgeons believed that surgical evacuation of hematomas averted death by relieving cerebral compression, diminishing the severity of the hemiparesis, and speeding the rate of recovery. Neurosurgeons depended primarily on accurate clinical assessment supplemented by multiple exploratory burr holes and, if indicated, needling of the brain with a cannula.

Initially, neurosurgeons used cerebral angiography in acute situations to find compressing hematomas, which led to acute evacuation in a series of mostly successful cases [2]. Interestingly, the article also showed good outcome in a 10-year-old "schoolgirl" with acute carotid occlusion after the swollen, infarcted brain was discovered, resulting in craniectomy—this was way ahead of other publications on craniectomy [3], when a computed tomography scan could aid decision-making.

Looking back at milestones over the years, we must ask the following questions: when did neurosurgeons proceed, and when did they decide that the clinical examination in a rapidly deteriorating patient did not warrant emergency surgery? We would imagine that fixed and dilated pupils was a stopping point, but the appearance of extensor posturing also traditionally signaled that surgery would be futile. Not for Neurosurgeon Howard Freedman who started his article with the following statement:

> *It was recognized early that the exhibition of the decerebrate attitude was of grave prognostic import, especially when it came in the course of supratentorial space-taking lesions—hemorrhage, abscess, or tumor. In fact, it has been and unfortunately continues to be, the opinion of many neurologists and some neurosurgeons in particular that the supervention of the decerebrate attitude mitigates against if not actually precludes the possibility of recovery regardless of therapy* [4].

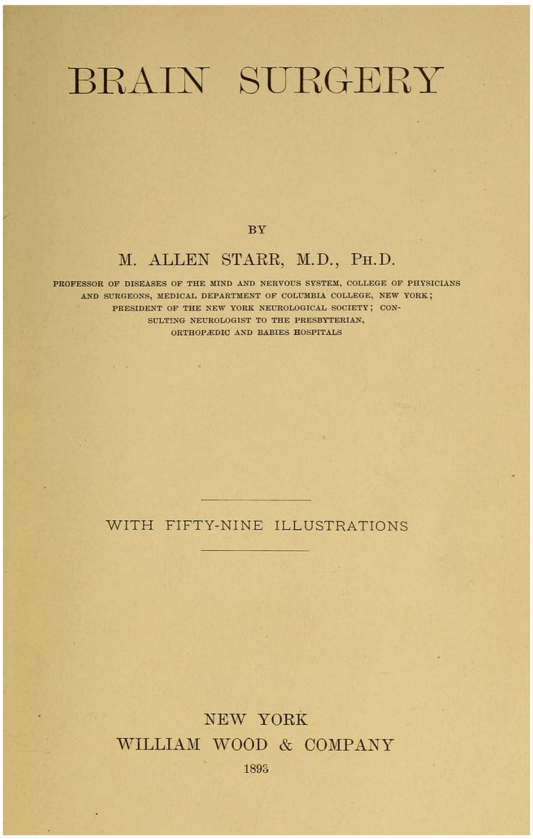
His report, however, presented evidence that a final effort under those circumstances could be lifesaving and, even more, could result in complete recovery. Several articles appeared from the 1950s until well into the 1970s suggesting that a poor neurologic examination before surgical intervention could only lead to a worse examination after surgery.

Questioning Inoperable States

Freedman reported 19 patients with acute neurosurgical intervention (15 subdural or epidural hematomas); 14 of

*Correspondence: wijde@mayo.edu
Neurocritical Care Services, Saint Marys Hospital, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA

Springer



BRAIN SURGERY

BY

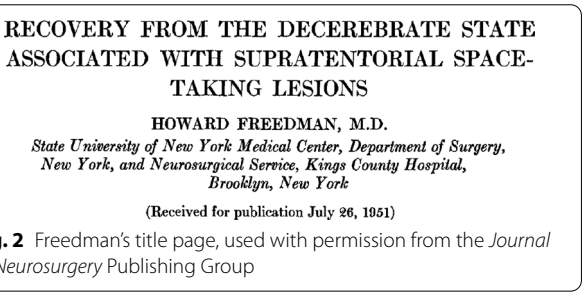
M. ALLEN STARR, M.D., PH.D.

PROFESSOR OF DISEASES OF THE MIND AND NERVOUS SYSTEM, COLLEGE OF PHYSICIANS AND SURGEONS, MEDICAL DEPARTMENT OF COLUMBIA COLLEGE, NEW YORK; PRESIDENT OF THE NEW YORK NEUROLOGICAL SOCIETY; CONSULTING NEUROLOGIST TO THE PRESBYTERIAN, ORTHOPÆDIC AND BABIES HOSPITALS

WITH FIFTY-NINE ILLUSTRATIONS

NEW YORK
WILLIAM WOOD & COMPANY
1895

Fig. 1 Starr's book on brain surgery



RECOVERY FROM THE DECEREBRATE STATE ASSOCIATED WITH SUPRATENTORIAL SPACE-TAKING LESIONS

HOWARD FREEDMAN, M.D.
State University of New York Medical Center, Department of Surgery, New York, and Neurosurgical Service, Kings County Hospital, Brooklyn, New York

(Received for publication July 26, 1951)

Fig. 2 Freedman's title page, used with permission from the *Journal of Neurosurgery* Publishing Group

these had bilateral extensor rigidity [4] (Fig. 2). Moreover, 15 had dilated, fixed pupils, mostly bilaterally. Rigidity was present as long as 20 h from onset. In 13 patients, the outcome was "reasonably satisfactory." Rather than admitting defeat, Freedman concluded, "It is emphasized that any sign indicative of midbrain dysfunction occurring during the course of supratentorial space-taking lesions should be a signal for immediate definitive surgery" [4]. The explanation given for improvement was that herniation of the medial aspect of the temporal lobe through the tentorial opening (the so-called temporal pressure cone) resulted in a change of the blood supply to the brain stem and appearance of the decerebrate signs. Similarly in France, where French neurosurgeons also found a difference in outcome between immediate posturing (frequently good) after trauma and when posturing appeared after an interval (usually bad), outcome was also related to age [5].

In Brendler and Selverstone's series of 16 patients, the midbrain syndrome of fixed pupils and extensor posturing was clearly the result of an expanding supratentorial mass in nine patients. They found no mass in the remaining seven patients and postulated local or regional ischemia as the probable cause of the syndrome [6]. Removal of the space-occupying mass, whether tumor, hemorrhage, abscess, or edematous brain, is the obvious treatment for compressive lesions of the midbrain; in their study, eight patients underwent surgery, with prompt improvement in seven. Recovery from severe midbrain dysfunction was more rapid and more nearly complete in the compressive than in the noncompressive cases [6].

Gutterman and Shenkin evacuated intracranial hematomas in 29 patients, and 14 survived (48%) [7]. Of these survivors, two had no neurological deficit, nine had relatively mild (nonincapacitating) neurological deficits, one had an incapacitating neurological sequela, and two had distinct behavioral disorders. The length of time of the decerebrate state prior to surgical intervention was established in 23 patients [7] (Fig. 3). They demonstrated that evacuation of an intracranial hemorrhage of surgical proportions can result in prompt recovery from a decerebrate state lasting less than 6 h. Survival was greatest with acute epidural hematomas and worst with acute subdural or intracerebral hematomas [7].

Talalla and McKissock's case series of eight patients with acute subdural hematoma described a fatal outcome in most patients with fixed and dilated pupils and extensor posturing. Most notable was the hemiparesis on the site of the acute subdural hematoma in all eight patients (the acute Kernohan's notch), but the surgeon was guided by a diagnostic cerebral angiogram [8].

A Changing Paradigm

Sherrington's classical experiments [9] of decerebrate animals were linked to decerebrate rigidity in humans associated with hemorrhages in the upper brainstem. Therefore, the concept emerged that surgery for acute supratentorial expanding masses could lead to secondary brainstem lesions, and if presumed present, surgery would be futile. In a 1972 article published in the *New England Journal of Medicine*, Zervas and Hedley-White [9] described the survival of patients with cerebral aneurysms and decerebration and concluded that

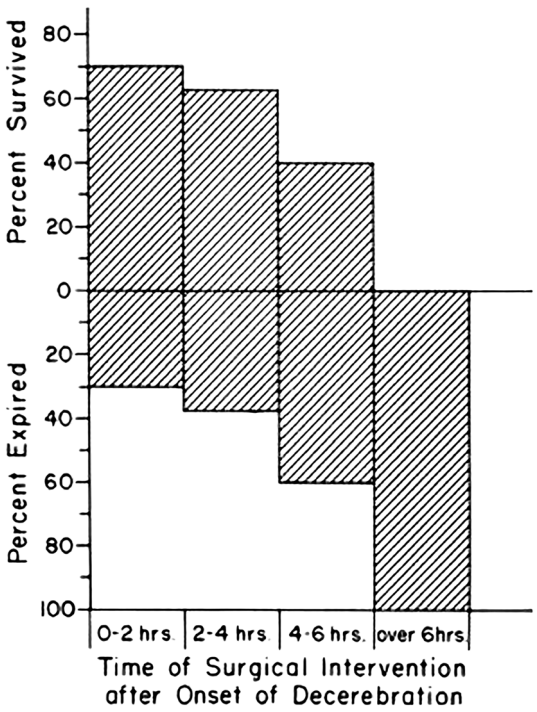


Fig. 3 Relation of time of surgical intervention to survival from traumatic decerebration, used with permission from the *Journal of Neurosurgery* Publishing Group

although previously not reported, it probably occurred sporadically. They encouraged expeditious treatment in such cases. The signs of mesencephalic compression after temporal lobe herniation were "clear and unmistakable with coma, pupillary dilatation and decerebration." After surgical evacuation of the hematoma, decerebrate rigidity was absent, and anisocoria improved. All patients were fully conscious within 2 to 26 h and ultimately regained normal intellectual and psychologic function. Later, reports in the 1980s emphasized that comatose patients with acute subdural hematoma should undergo surgery within 4 h, which would reduce mortality from 90 to 30% [10]. In that series, 45% had bilateral fixed pupils, 60% had absent oculomotor function, and 47% had decerebrate posturing or flaccidity of extremities. In another series of 101 patients [10], half of the patients presented with flaccidity and extensor posturing, and mortality was 78%, and those with bilateral fixed pupils had 88% mortality and a 7% functional recovery. A similar but nonsignificant trend to poor outcome was found toward longer times to surgery and when beyond 4 h, but ability to control postoperative ICP was a stronger factor in outcome.

Fast forward to 2015, the discussion remained: who should perform surgery if no neurosurgeon is available? A group of neurosurgeons adopted the Neurosurgical Society of Australasia guidelines for the management of acute neurotrauma in rural and remote locations [11]. It stated that "If there is a predicted delay of greater than 2 h to reach a neurosurgical center for patients with neurosurgical emergencies, the general surgeon should seek advice from a neurosurgeon and commence surgery." This applied to an expanding intracranial hematoma as the main indication. This surgery will frequently be lifesaving even if secondary surgery is required from the neurosurgeon. And this was far preferable to a delayed transfer without surgery. However, except for war trauma-related neurosurgery, it is unimaginable for US general surgeons to proceed with craniotomy.

Remembering these early days of neurosurgery, we note that decisions in acute situations changed despite a persistent narrative. Extensor posturing and fixed, dilated pupils in acute extracerebral hematomas were not discriminate findings for outcome. Later, a computed tomography scan may have further differentiated decisions, but in the 1950s and into the current century, viewpoints changed so that despite a poor neurologic examination, evacuation of extracerebral hematomas should be offered—not as a final effort but as a genuine attempt to change outcome.

Source of support
No extramural funding supported this effort

Conflict of interest
There are no conflicts of interest.

Publisher's Note

Received: 1 December 2023 Accepted: 7 December 2023
Published online: 24 January 2024

References

1. Starr MA. Brain surgery. New York: William Wood and Company; 1893.
2. Gibson RM, Sumerling MD. Cerebral angiography in neurosurgical emergencies. Postgrad Med J. 1960;36(416):362–9.
3. Rengachary SS, Batnitzky S, Morantz RA, Arjunan K, Jeffries B. Hemicraniectomy for acute massive cerebral infarction. Neurosurgery. 1981;8(3):321–8.
4. Freedman H. Recovery from the decerebrate state associated with supratentorial space-taking lesions. J Neurosurg. 1952;9(1):52–8.
5. Chavany JA, Messimy R, Le Besnerais Y. [Decerebrate rigidity in neurosurgery and more specifically in cranial traumatology]. Presse Med (1893) 1959;67(12):453–6. French.
6. Brendler SJ, Selverstone B. Recovery from decerebration. Brain. 1970;93(2):381–92.
7. Gutterman P, Shenkin HA. Prognostic features in recovery from traumatic decerebration. J Neurosurg. 1970;32(3):330–5.
8. Talalla A, McKissock W. Acute "spontaneous" subdural hemorrhage. An unusual form of cerebrovascular accident. Neurology. 1971;21(1):19–25.
9. Sherrington CS. Decerebrate rigidity, and reflex coordination of movements. J Physiol. 1898;22(4):319–32.

10. Seelig JM, Becker DP, Miller JD, et al. Traumatic acute subdural hematoma: major mortality reduction in comatose patients treated within four hours. N Engl J Med. 1981;304(25):1511–8.

11. Newcombe R, Merry G. The management of acute neurotrauma in rural and remote locations: a set of guidelines for the care of head and spinal injuries. J Clin Neurosci. 1999;6(1):85–93.