LESSONS FROM HISTORY

Two *Lancet* Lightning Articles: Clark and Brigham, 1872; Knaggs, 1894—A Commentary

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Both of these case reports in the *Lancet* of over 100 years ago make for interesting reading and cause one to consider these lightning-related fatalities in light of today's knowledge. The article by Knaggs (article 2) was published in 1894¹; the article by Clark and Brigham (article 1) appeared in 1872.² As I read these 2 articles from over a century ago, I was struck by how differently these cases would have been evaluated and treated today and how differently these articles would be written today. These patients died before Roentgen's discovery of radiographs (1895) and before the era of cardiopulmonary resuscitation (1960).

My comments and analysis are divided into 4 parts. I focus on the articles as viewed from today's perspective and point out observable differences relating to medical approaches and writing styles, then and now. These 4 segments are as follows: 1) there have been extraordinary advancements in the medical technologies and treatments available today compared to those of the 1800s; 2) our understanding of neurologic sequelae of lightning strikes, including the finding of intracranial hemorrhages, has grown enormously in the past century; 3) the language of these older medical reports had a more free-flowing style than the more scripted reports of current articles; and 4) the universal skills and keen physical diagnostic observations of those clinicians of the 1800s are impressive.

1. Advances in medical technology and knowledge

Inevitably, medical technology and the bank of knowledge have grown remarkably since the 1800s. Our ability to diagnose and treat is much improved. Both articles were long on the details of clinical and postmortem examinations but short on effective treatment and, of course, lacking entirely in radiography and imaging

studies that were not yet invented. Their postmortem examinations revealed lesions (skull fractures and intracranial hemorrhages) that, in all probability, would have been diagnosed today by radiographs and imaging studies (computerized tomography [CT] scans and magnetic resonance imaging [MRI]). It is clear to me that with modern treatment, at least 1 patient (article 1) may have had a more positive outcome. The patient (article 1) apparently had a subdural hematoma that would have been evacuated by a neurosurgeon, with the likelihood of a much better prognosis.

Today, emergency CT scans can detect the presence of subdural and epidural hematomas in traumatic brain-injured patients. Neurosurgical evacuation of such hematomas can be lifesaving.

2. Neurologic sequelae of lightning strikes— intracranial hemorrhages and other lesions

A. INTRACRANIAL HEMORRHAGES

Both fatal lightning patients were found to have intracranial hemorrhages and skull fractures on postmortem examinations. Many patients have suffered severe head trauma as a consequence of falling or being thrown to the ground by the enormous blast force of a thunderous lightning strike. Although the authors of both articles excelled in describing the clinical and autopsy findings, they provided few insights regarding the mechanisms of their patients' fatal injuries. Serious, even fatal, head injuries in lightning patients can be divided into 2 groups: 1) head trauma linked to falls, and 2) brain lesions in the absence of falls. Although the authors do not elaborate on these distinctions, it is apparent that both of their patients suffered serious head trauma related to falls. Clarke and Brigham (article 1) do report that "the electric current. . . passed through the old man (throwing him down on his face), and so to the earth." Blunt head trauma patients often present with subarachnoid and intraventricular hemorrhages as well as mass lesions of

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epidural and subdural hematomas.³ It is intriguing that neither paper cited any references pertaining to neurologic sequelae of lightning strikes. As a matter of fact, they cited no references at all.

What about lightning-strike patients who do not suffer head trauma in falls? They, too, can have subarachnoid and intraventricular hemorrhages. However, the intracranial hemorrhages seen in these patients often follow a particular pattern with regard to location.^{4,5} The vulnerable sites are the basal ganglia and brainstem. While small petechial hemorrhages are seen in the brainstem, larger hemorrhages are found in the basal ganglia.^{6,7} By contrast, basal ganglia hemorrhages are uncommon in both blunt trauma and acute hypertension.⁸ Therefore, the pathophysiology of basal ganglia hemorrhages related to lightning is unlikely related to either mechanical trauma or intense peripheral vasoconstriction resulting in acute hypertension. Why do hemorrhages occur consistently in these loci in lightning patients who did not strike their heads in falls? These selective hemorrhage sites may reflect the path of current flow in the brain.

B. OTHER NEUROLOGIC LESIONS

Most lesions in lightning-strike patients are not linked to trauma from falls. Damage to tissues of various organs is triggered thermally or electrically.⁹ The degree of thermal injury is dependent on many factors, including current strength, resistance of the conducting tissue, and, importantly, duration of current flow. Nonthermal mechanisms of tissue damage resulting from lightning or electrical trauma include denaturation of active intracellular proteins and changes in the permeability of cell membranes. Muscle and nerve tissue are particularly susceptible to nonthermal, electrical effects that cause structural changes in cell membranes. Lee et al¹⁰ introduced the term “electroporation” to describe this nonthermal, electrical effect. They have demonstrated that membrane pore defects occur when the transmembrane electrical potential exceeds 500 to 800 mV for periods in excess of 500 microseconds.

These thermal and electrical mechanisms related to lightning are responsible for many neurological lesions of the brain and spinal cord. Tragically, patients with neurologic lesions are often left with permanent disabilities.¹¹ For those interested in more information regarding other possible mechanisms of injury and the entire spectrum of neurologic lesions, I would refer them to 2 issues of *Seminars of Neurology* (1995, Vol 15, No 3 and 4), which are dedicated to many aspects of lightning injuries.

The autopsy on the patient in article 1 revealed “a charred spot. . . on the orbital plate of the frontal bone,

through which the electric fluid seemed to have passed out on to the face, the current apparently having passed down through the antrum into the mouth, lacerating and charring the mucous membrane and causing the haemorrhage from the nose and mouth.” These findings are of interest in light of the recent work of Andrews.¹² He has suggested current may enter via orifices (eyes, nose, and ears) and travel caudalward toward the basal ganglia and brainstem. Two frequent serious central nervous system complications of lightning injury are respiratory arrest caused by depression of the respiratory center and, as mentioned above, basal ganglia hemorrhage.¹³ The same mechanism may account for both of these lesions: preferential conduction of electrical current to these parts of the brain.¹⁴

3. Writing styles—1800 vs 2002

To a large degree, these older medical articles resemble literary prose more than the articles of the 21st century. There are several explanations for this transformation. One obvious difference is the near absence of data such as blood chemical and hormone levels and hematologic values that occupy much of the space of current articles. In the brave new world of this century, articles are filled with molecular genetic analysis, chromosomal mapping, T1- and T2-weighted MRIs, and other such markers of our high-tech age. Both articles earn high marks on physical diagnosis and postmortem findings. Notably absent are long lists of laboratory values. Those articles were written in the same era (end of the 19th century) that a most famous fictional physician, Conan Doyle’s Dr John Watson, wrote his reports. Sherlock Holmes, a man for all times, did not appreciate the enduring insights of Watson’s writings when he criticized him for writing “from the point of view of a story instead of as a scientific exercise.”¹⁵

Another feature that is common to many current journals is the insistence by editors that authors comply with a stereotypical format (eg, articles must follow a definite scheme: Objectives, Methods, Results, Conclusions, etc). In an article on evidence-based medicine, Watine and Borgstein¹⁶ remarked that “medical literature is gradually becoming an oxymoron.”

By contrast, the writing style of the older articles was more colloquial and less structured. From my perspective, there are both positives and negatives to that older literary style. The informal style reveals more about the feelings of the writer and brings the reader closer to the event. In article 1, the authors’ description of the hospital course resembles notes from a hospital chart. Information is often given in nonsentences. For example (article 1): “Passed a restless night, being very violent at times,

and moaning continuously, but dozing at intervals.” In the second article, the author refers to a “fellow labourer” who recovered and “was none the worse for his close shave.”

Some of the conversational tone and non sequiturs of the older articles would not be appropriate in our time and added little to the text of a century ago. For example, the term “coolie” to identify the patient in article 2 carries an unconstructive connotation, and I doubt it would be chosen today.

The language of medicine has changed over the generations. These changes, like much in society, have been both for better and worse. However, the progress in technology and information has clearly been for the better.

4. Clinical skills—1880 vs 2002

The physicians of that period were universalists. In the second article, the physician attended to his patient and then performed the postmortem. I do not know any modern-day physician who performs both of those essential tasks or is even competent to do so. The world of medicine was smaller then. The commitment of the physician was absolute.

The observational skills and attention to detail are apparent in both articles. For example, both physicians commented on torn clothing. These are important forensic observations in the diagnosis of lightning-strike injuries. When witnesses do not see the fatal lightning strike, the cause of death may not be apparent to investigators. The findings of torn clothing can be critical forensic clues in making the correct diagnosis.¹⁷

Today’s physician is far better equipped with new technology and an avalanche of ground-breaking information. Yet, the virtues of the old time medicine persist because they are so important. Recently, Caplan wrote: “The panacea and saviour for medical therapeutics is not, and will not be randomised trials or evidence based reviews or meta-analyses. . . . [A]lso desperately needed is more time spent by specialists at the bedside. . . finding out exactly what is wrong with each patient. . . and getting to know their thoughts, fears, biases, and wishes.”¹⁸

References

1. Knaggs RHE. Unusual injuries caused by lightning stroke. *Lancet*. 1894;2:1216.
2. Clark RO, Brigham JE. Death from lightning. *Lancet*. 1872;2:77.
3. Valadka AB. Injury to the cranium. In: Mattox KL, Feliciano DV, Moore EE, eds. *Trauma*. New York, NY: McGraw-Hill; 2000:377–399.
4. Mann H, Kozic Z, Boulos MI. CT of lightning injury. *AJNR*. 1983;4:976–977.
5. Stanley LD, Suss RA. Intracerebral hematoma secondary to lightning stroke: case report and review of the literature. *Neurosurgery*. 1985;16:686–688.
6. Critchley M. Neurological effects of lightning and of electricity. *Lancet*. 1934;1:68–72.
7. Ozgun B, Castillo M. Basal ganglia hemorrhage related to lightning strike. *AJNR*. 1995;16:1370–1371.
8. Katz DI, Alexander MP, Seliger GM, Bellas DN. Traumatic basal ganglia hemorrhage: clinicopathologic features and outcome. *Neurology*. 1989;39:897–904.
9. Thaventhiran J, O’Leary MJ, Coakley JH, et al. Pathogenesis and recovery of tetraplegia after electrical injury. *J Neurol Neurosurg Psychiatry*. 2001;71:535–537.
10. Lee RC, Aarsvold JN, Chen W, et al. Biophysical mechanisms of cell membrane damage in electrical shock. *Semin Neurol*. 1995;15:367–374.
11. Cherington M, Yarnell PR, London SF. Neurologic complications of lightning injuries. *West J Med*. 1995;162:413.
12. Andrews C. Structural changes after lightning strike, with special emphasis on special sense orifices as portals of entry. *Semin Neurol*. 1995;15:296–303.
13. Jain S, Bandi V. Electrical and lightning injuries. *Environ Emerg*. 1999;15:319–331.
14. Conrad L. Clinical update on lightning injuries. *Wilderness Environ Med*. 1998;9:217–222.
15. Doyle AC. The adventure of the Abbey Grange. In: *Later Adventures of Sherlock Holmes*. Norwalk, CT: The Easton Press; 1980.
16. Watine J, Borgstein J. Evidence-based illiteracy or illiterate evidence. *Lancet*. 2000;356:684.
17. Cherington M, Kurtzman R, Krider EP, Yarnell PR. Mountain medical mystery—unwitnessed death of a healthy young man, caused by lightning. *Am J Forens Med Pathol*. 2001;22:296–298.
18. Caplan LR. Evidence based medicine: concerns of a clinical neurologist. *J Neurol Neurosurg Psychiatry*. 2001;71:569–576.