

## Miscellaneous

# Harvey Cushing, a pioneer of neuroanesthesia

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### Abstract

Harvey Cushing's name is most frequently mentioned in conjunction with Cushing's syndrome, and Cushing's reflex following raised intracranial pressure. The aim of this review is to pay tribute to Cushing's contribution to anesthesia. Besides his own specialty, he used an anesthesia chart for the first time, he introduced blood pressure measurement and precordial auscultation to anesthesiological practice, he employed the first independent neurosurgical anesthetist, and he described the terminology of regional anesthesia.

**Key words** Neuroanesthesia · History of anesthesia

### Introduction

There are numerous associations of the name “Harvey Cushing” in the field of medicine: endocrinologists say he was one of the most important contributors to endocrinology, and neurologists and neurosurgeons link the so-called Cushing's reflex—which describes reflectory changes in systemic blood pressure during elevation of intracranial pressure—to his name [1]. Besides being one of the leading neurosurgeons of his time, he introduced numerous new methods in anesthesiology as well. Therefore he deserves a place among the most important personalities in the history of anesthesia. Although different authors have summarized Cushing's activity in the field of neuroanesthesia [2–6], the most recent work in this field was published more than 12 years ago. Therefore, the aim of the present work is to reconfirm for the readers his contribution to neuroanesthesia.

Harvey Cushing was born in Cleveland in 1869, into the fourth generation of a traditional physician family



**Fig. 1.** Harvey Cushing, the surgical resident, in 1895 (source: www.hico-isd.net)

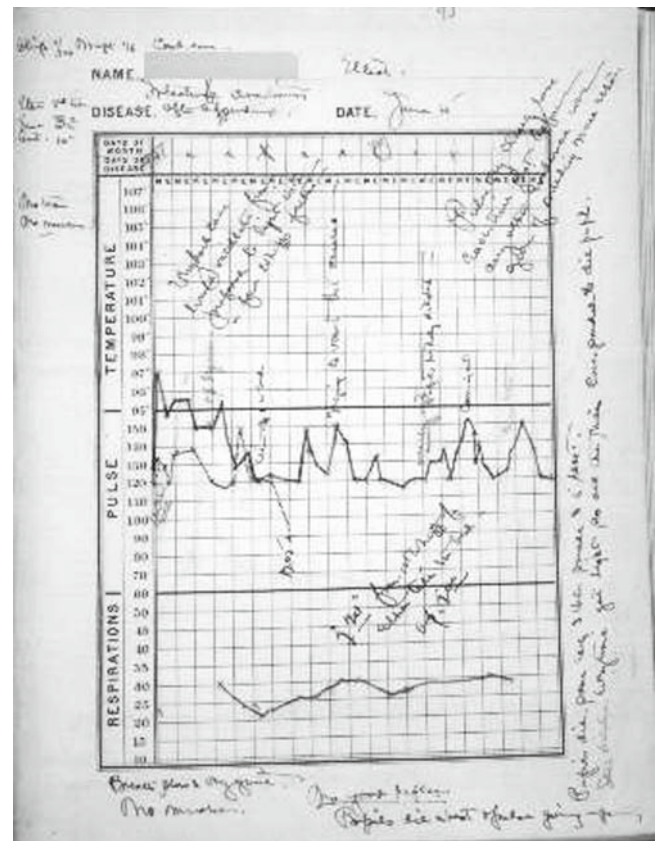
[7]. Of the primary and secondary schools he attended, the Cleveland Manual Training School has to be considered the most important one, as the manual training and the physics-focused thinking at that school probably played a decisive role in a later period of his life. Cushing finished his basic medical studies at Yale, graduated as a medical doctor at Harvard in 1895, and started working at the Massachusetts General Hospital (Fig. 1).

### Introduction of the first anesthesia record

Cushing's first contact with anesthesia happened at Harvard, when he was a third-year medical student: while he was sitting in a surgery lecture, the lecturer asked him, from the audience, to “aetherize” a patient with a strangulated hernia. Unfortunately the patient died shortly after the beginning of the surgery, but the operation was finished in order to demonstrate the surgical technique for the students. Let us see how Cushing described the story in his diary: “My first giving of an

anaesthetic was when, a third-year student, I was called down from the seats and sent into a little side room with a patient and an orderly and told to put the patient to sleep . . . I knew nothing about the patient whatsoever, merely that a nurse came in and gave the patient a hypodermic injection. I proceeded as best I could under the orderly's directions, and in view of the repeated urgent calls for the patient from the amphitheatre it seemed to be an interminable time for the old man, who kept gagging, to go to sleep. We finally wheeled him in. I can vividly recall just how he looked and the feel of his bedraggled whiskers. The operation was started and at this juncture there was a sudden great flush of fluid from the patient's mouth, most of which was inhaled and he died. I stood aside, burning with chagrin and remorse. No one paid the slightest attention to me, although I supposed that I had killed the patient. The operation was completed in spite of the episode, as a demonstration to the class. I slunk out of the hospital, walked the streets of North Boston the rest of the afternoon, and in the evening went to the surgeon's house to ask if there was any possible way I could atone for the calamity to the man's family before I left the Medical School and went into some other business. To my perfect amazement I was told it was nothing at all, that I had nothing to do with the man's death, that he had a strangulated hernia, and had been vomiting all night anyway, and that sort of thing happened frequently and I had better forget about it and go on with Medical School. I went on with Medical School but have never forgotten about it" [7].

What an impressive and dramatic description from a young medical student! In fact, Cushing never forgot this story. When he started working at the Massachusetts General Hospital in 1895 as a resident in surgery, his first task was to provide anesthetics. The history of anesthesia records starts with a bet he made with his friend, Codman ("we made a wager of a dinner as to who could learn to give the best anesthesia") and its goal was to decide who among the two gave better anesthetics for the patients [3]. To make the decision objective, they documented the anesthetics in the form of "ether charts" (Fig. 2). The most important parameters to describe were the pulse rate, breathing, and temperature of the patients. According to the description of Cushing "a perfect anesthesia was supposed to be one in which the patient was sufficiently conscious to respond when left in the ward with the nurse and did not subsequently vomit". Nothing is known about who finally paid the dinner bill, but still in a later description, Cushing noted that he considered this competition very important because it ". . . was undoubtedly a step toward improvement in what had been a very casual administration of a dangerous drug . . . particularly due, I think, to the detailed attention which we had to put



**Fig. 2.** An example of the ether charts made by Cushing (source: [www.asahq.org](http://www.asahq.org))

upon the patient by the careful recording of the pulse rate throughout the operation. We do much better with ether these days, but even so there remains much to learn" [6,7]. When he presented his charts, in 1920, to the Treadwell Library, he wrote the following sentences in the accompanying letter: "Please put this in a corner of the Treadwell Library, where someday some young fellow may brush the dust from it and say, "Who were these fellows anyhow, and what is this ether they are talking about? Do you mean that people used to be put to sleep by the inhalation of drugs in the 19th century?" [4]. Cushing later also paid much attention to intraoperative monitoring and tried to elaborate and introduce new modalities. Among them the most important were the measurement of blood pressure and precordial auscultation.

#### **Introduction of blood pressure measurement during anesthesia**

After finishing his surgical residency, Cushing started working at Johns Hopkins Hospital as a member of the

surgical team. Again, this was a decisive period of his life, because this was the place where he started his neurosurgical career. The leader of the surgical team, Professor Halstead, offered resistance to Cushing's wish to practice in this field, but finally he decided to allow it [5]. In order to improve his neurophysiological knowledge, Cushing visited Europe, between 1900 and 1901. He worked together with Theodor Kocher and Hugo Kronecker, but he also visited Sherrington in Liverpool. What is more important for us than these mainly neurophysiological cooperations was his visit to Pavia (Italy), because that was the place where he learned the Riva-Rocci method of blood pressure measurements. After returning home he took not only the experimental description of the method but also started administering blood pressure measurements in clinical practice. As Cushing gave a lecture in January 19, 1903, with the title "Considerations of blood pressure", the committee of the Harvard Medical School stated that: "the skilled finger was of much greater value clinically for determination of the state of the circulation than any pneumatic instrument, and the work should be put aside as of no significance. It may be that Dr. Cushing takes an enthusiastic view of the matter in his prediction that in appropriate cases the routine observation upon blood-pressure will soon come to occupy the same position that pulse and temperature observations occupy at present, but enthusiasm is necessary to the introduction of any new procedure in medicine, and for this enthusiasm we are duly grateful [8]."

Despite the verdict of the committee, Cushing never lost his enthusiasm for the recording of blood pressure during surgery [9–11]. In his article entitled "Some principles of cerebral surgery", published in the *JAMA* in 1909, a whole paragraph is dedicated to the importance of continuous blood pressure monitoring [8]. Besides intraoperative monitoring, blood pressure recording had additional therapeutic consequences during cerebral surgery: Cushing was aware of the fact that chloroform decreases whereas ether increases systemic blood pressure. Therefore, he preferred the administration of ether during his neurosurgical operations, because his opinion was that the hypotonia evoked by chloroform might be harmful for his patients. Similarly, ether was the first anesthetic of choice in patients with shock because of its effect in elevating blood pressure [6]. Despite his huge efforts, the importance of intraoperative blood pressure monitoring was underestimated by the public opinion of the surgeons. In a letter to Ralph Major in 1930, Cushing said: "I am sure that the general use of blood pressure apparatus in clinical work has done more than harm." As a teacher of medical students he stated: "If the introduction of some method of instrumental estimation of blood pressure changes in clinical cases does nothing other than

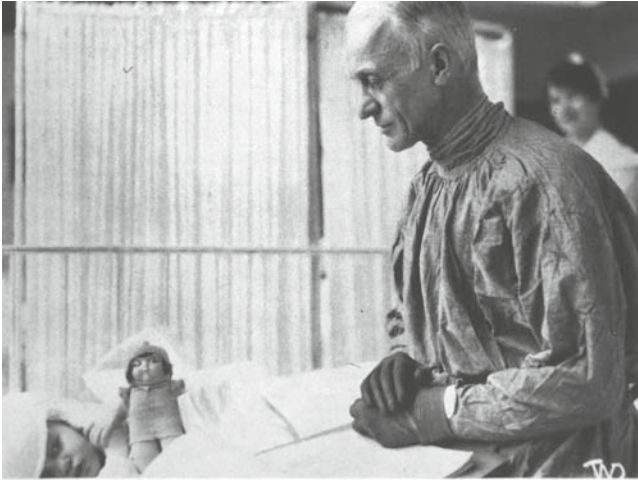
serve to keep the student's mind alive to the physiological principles of the circulation and to make clinical observations on the cardiovascular apparatus more nearly in accord with his earlier experiences in the physiological laboratory, its routine use needs no greater justification" [6].

### **Precordial auscultation**

An additional monitoring technique that was introduced by Cushing during neurosurgical procedures was, precordial auscultation, as described by Cushing: "With a patient in this prone position it is difficult for the anesthetist to gauge fully the variations in cardiac action, and during the past six months Dr. Davis has employed in these, as in all other operations indeed, a simple device, so satisfactory that we wonder why it has not long since come into general use—namely the continuous auscultation of cardiac and respiratory rhythm during the entire course of anesthesia. The transmitter of a phonendoscope is secured by adhesive strips over the precordium and connects by a long tube with the anesthetist's ear, where the receiver is held by a device similar to a telephone operator's headgear" [9]. With this instrumentation, the original form of the presently used precordial auscultation and precordial Doppler sonography came into light.

### **Employment of the first neuroanesthetist**

Such widespread monitoring of patients during surgical procedures could be performed only when a physician took care of the patient full time. Therefore, Cushing asked one of his coworkers to be his constant "etherizer". Let us mention his name, because he was probably the first independent neuroanesthetist: Samuel Griffith Davis. In his article about "some principles of cerebral surgery", Cushing gives an explanation for the employment of a full-time anesthetist: "In cranial operations in particular, not only because of the cramped field and the need of covering for the anesthetist, but also because the cardio-respiratory centers in the medulla are often already embarrassed through pressure, anesthetization by an expert is absolutely essential" [9]. He also described the responsibilities of such an anesthetist, stating: "... one of the most important elements in the giving of an anesthetic is to have the anesthetist keep during its administration a detailed chart of pulse, respiration and blood pressure" [6]. It is exciting to catch the historical moment in anesthesia when the subspeciality "neuroanesthesia" came into the light.



**Fig. 3.** Harvey Cushing with a child after surgery (source: [www.nlm.nih.gov](http://www.nlm.nih.gov))

### Introduction of the term “regional anesthesia”

After starting residency at Halstead’s surgical institute in 1895, one of the first new methods which Cushing had to learn was infiltrational anesthesia. Halstead himself was among the first who used cocaine for this purpose, and Cushing started to introduce it into the field of neurosurgery [12]. From his first work dealing with regional anesthesia, it is known that the purpose of administering it was to avoid side effects in patients with a full stomach and to ensure better cardiovascular stability in elderly patients [13]. One of his patients who had been operated on for an intracerebral cyst appreciated his work with the following statement: “One of the secrets of Dr. Cushing’s success is that he uses nothing except local anesthetic which permits the normal functioning of the heart and other organs during the operation” [14]. The term “regional anesthesia” was also introduced by Cushing, who proposed the term to differentiate it from local anesthesia [15].

In conclusion, in this short overview we have tried to list the anesthesiological inventions and activities of Harvey Cushing in order to demonstrate that not only was he one of the greatest multidisciplinary polyhistorians of his time but that also the concepts of his work do still exist in our daily anesthesiological practice (Fig. 3). Let us finish this report with the words of one of Cushing’s patients about him: “As one lamp lighteth another, so knowledge is diffused throughout the world” [6].

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