

Arthur E. Guedel Memorial Anesthesia Center

Guedel's Anesthetic Depth Chart, Jone J. Wu, and Noel A. Gillespie

By Merlin D. Larson, M.D.

The Guedel Depth of Anesthesia chart was first published in 1920 (Guedel AE. Third stage ether anesthesia. *American Journal of Surgery*, April, 1920, pages 53-57) and had a short evolutionary history until about 1970 when depth charts were considered obsolete. My interest in the most extensive modification to the Guedel chart started during a visit to China in 2001 during an interview with Jone J. Wu, who at that time was one of the last surviving anesthesiologists who had trained under Ralph Waters.

Wu was born in China and received a government-sponsored fellowship to be a resident in anesthesia under Waters from 1947 to 1949 in Madison, Wisconsin. Following his training, he practiced for one year in Utah and then returned to Shanghai after the communist revolution to develop modern anesthetic methods in his native country. He founded the first independent department of anesthesia in China in 1954, wrote the first Chinese anesthesia textbook, and published over 100 articles on clinical aspects of anesthetic practice.

When I visited Jone Wu in Shanghai for an interview in 2001 (Figure 1), he apologized repeatedly for his difficulty with communication because it had been several years since he had conducted a conversation about anesthesia in English. Wu at that time was still coming into the Zhongshan Hospital on Fenglin Road in Shanghai on a daily basis to go over his papers and correspondence.

Figure 1: Jone J. Wu in his office in November 2001. His textbook, written in Chinese, is on the desk, and he is holding one of his many publications. He commented that during the Cultural Revolution from 1965-1975, he was not allowed to administer anesthetics because of his Western education. During this time he worked sometimes as a janitor in the hospital.



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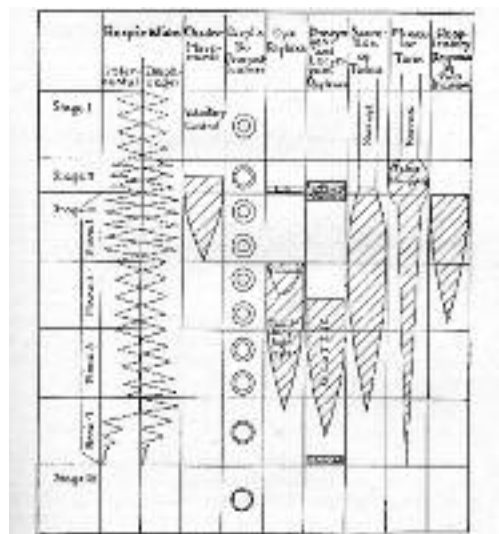
During our interview, Wu's textbook *Clinical Anesthesia* (1959 edition), written in Chinese, was prominently displayed on the desk in the anesthesia work-room. He reluctantly showed me the book and inquired whether I was familiar with the Guedel anesthetic depth chart. He seemed to have great interest in the chart as he opened the page to where the chart was drawn. Wu noted that there were no references to Western authors in the book and stated that the communist government under Chairman Mao would not permit any credits to be given to Western sources.

Close inspection of the clinical signs chart revealed that it was not actually the chart that Guedel had illustrated in his two books or in his famous monograph of 1920. Wu had either added information to Guedel's chart, based upon his own personal experience, or he had extracted information from other sources.

Further research led to the exact source of the anesthesia depth chart published by Jone Wu in 1959. Noel Gillespie's anesthetic depth chart, published in the September-October 1943 issue of *Anesthesia and Analgesia*, shows modifications to the Guedel chart by the deletion of two pupil columns and the addition of nine reflexes (Figure 2). In this paper, Gillespie explained that testing for reflex responses was more important than the respiratory signs or the pupil signs, which he thought could be misleading. A photograph of Wu's chart in Chinese was translated by Patrick Sim of the Wood Library and confirmed that it was redrawn, with only minor differences from the Gillespie original.

Figure 2: Gillespie's hand drawn chart as it first appeared in *Anesthesia and Analgesia*, 1943. The Wu chart was redrawn, but the text is an exact translation of the Gillespie chart. In his letters it becomes apparent that Gillespie added the respiratory patterns and the pupil sizes mostly as a tribute to Guedel.

Noel A. Gillespie had an unusual background prior to his interaction with Jone Wu. Gillespie was raised by his mother, who lived successively in England, Jebail, Syria, and New York. Noel was already a highly educated



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physician prior to his entry into anesthesia training in 1933 at The London Hospital. He had become acquainted with T.E. Lawrence (Lawrence of Arabia), who served him as a mentor in his formative years in Syria, and with Albert Schweitzer, with whom he traveled and worked at Lambarene, in French Equatorial Africa in 1924. Gillespie spoke several languages, was an accomplished pianist, and an expert rifleman. He received a Doctor of Medicine degree from Oxford University and a Diploma in Anaesthesia in 1935.

The interaction of Wu and Gillespie took place at the University of Wisconsin in the Waters anesthesia-training program. Noel Gillespie, already a trained anesthesiologist, left England to receive additional training with Waters in 1939. Initially, his position was as a resident, but he became a part-time member of the faculty in 1945. Wu was a pharmacologist by training and worked under Gillespie during the years 1947-1949.

Gillespie drew his chart with the reflexes as an assignment from Ralph Waters, who had been asked to contribute to a manual for the safe administration of anesthetics by the American Medical Association. In preparation for this task of defining anesthetic depth, Gillespie corresponded extensively with Arthur Guedel. These letters are preserved in the Guedel Library and reveal the thoughts of the two men about the signs of deepening anesthetic levels.

In a letter to Guedel in 1940, Gillespie writes:

... now we tend to interpret your work, in teaching the young, as though the respiratory signs were the only thing of importance. I submit that the exact reverse is true ... that it is alone the reflexes which matter in practice, and that, provided ventilation is adequate, respiration matters not a damn.

In reviewing his letters to Guedel, it becomes clear that Gillespie wanted to politely disagree with the more famous, experienced physician but, at the same time, he truly admired him and sought his approval. Gillespie wanted to name his new chart the “Guedel–Gillespie” guide to anesthesia.

In a 1941 letter from Gillespie to Guedel he writes:

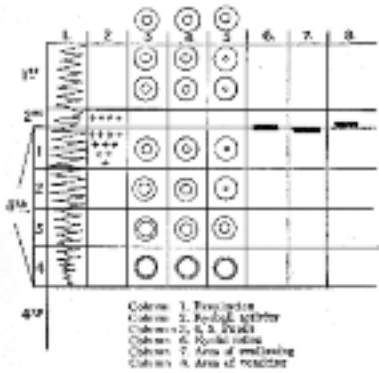
The new guide is currently referred to in our Office as “Guedel-Gillespie”; and whereas I feel highly honored, I would feel that you were dishonored by the association. However, you may remember that Busoni had the temerity to re-write Bach’s organ works for the piano and that when they are played at concerts, they are usually referred to on the program as Bach-Busoni. On this analogy I feel all the guilt, which I usually attribute to Busoni for venturing to

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re-arrange the works of the master. Only he hadn't the satisfaction, which I enjoy, of being able to make his confession directly to the master and ask his forgiveness. This I hereby do.

Guedel wrote back to Gillespie on August 21, 1941:

Your chart is better than mine. ... As for naming this chart—your chart—there is in my opinion only one thing to do. Call it your chart and if you want to give credit to me for mine, you can state that yours is a modification of mine. ... By all means, stick to yours as it is, because it is good, but let it stand as yours and call it the “Gillespie” instead of the “Gillespie-Guedel.” ...



A. Guedel depth of anesthesia chart, 1937

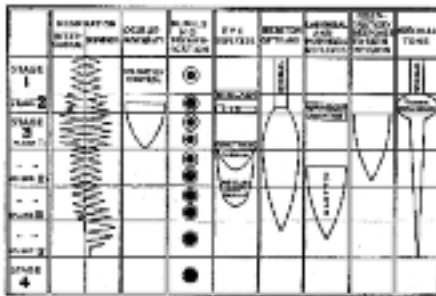


FIG. 24. The limits of deepness of various types of anesthesia.

B: J. Alfred Lee's reproduction of Gillespie's chart, credited to Guedel

Figure 3: Above (A) is the Guedel chart and below (B) is a modified Gillespie chart in J. Alfred Lee's textbook, dated 1968, giving credit to Guedel.

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Ironically, as the textbooks came out in the next two decades, the Gillespie chart was shown repeatedly, but credit was given to Guedel. It is possible that Wu would have referenced his former colleague, but as mentioned, he was not allowed to insert references in his book.

The popular Lee and Atkinson British textbooks show the Gillespie chart but give credit to Guedel (Figure 3). Similarly, Vincent Collins, and Wylie, Churchill Davidson discuss the reflex (Gillespie) chart but credit Guedel. When considering Guedel's praise of Gillespie's insight, it seems odd that when Guedel's second book was published in 1951, it only showed the original Guedel chart that included eyeball activity, pupil sizes, and respiratory patterns and did not reference the Gillespie paper. Guedel did not discuss reflex depression in his original 1920 paper, but both books have a short chapter that mentions the reflexes.

Anesthetics today are largely administered through attention to reflexes: patient movement, abrupt changes in blood pressure or heart rate, coughing, laryngospasm, and changes in BIS or entropy values—these are essentially complex reflex responses that require our attention—and this attention usually takes the form of a change in drug therapy. Although Gillespie did not originate the idea of looking at reflexes, he did promote it and subsequent authors picked up on it. For example, W.C. Wylie and H.C. Churchill Davidson quoted Laycock in their book (*A Practice of Anesthesia*, 1966):

Reflexes are the guiding principles of all we do from the moment we start an anaesthetic until the patient wakes up. We must understand them, look out for them, nurse them, leave them alone, depress or abolish them. (Laycock JD. *Anaesthesia* 8:15-20, 1953).

Jone J. Wu died earlier this year at age 100 and Noel Gillespie died at the age of 51 in Madison, Wisconsin (1955), of an apparent heart attack. Although Gillespie did not receive due credit for his attention to the clinical and practical value of reflex activity during anesthesia, he did achieve fame as the author of *Endotracheal Anaesthesia* (University of Wisconsin Press, 1941), which went through three editions and is considered a classic in the anesthesia literature.

The author thanks Patrick Sim of the Wood Library for translating the figure in Wu's textbook and to Dr. Mark E. Schroeder, from the University of Wisconsin, who provided biographical information on Noel Gillespie.

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