

HOW NITROUS OXIDE WAS INTRODUCED INTO CLINICAL PRACTICE: THE CASE OF CALIFORNIA

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This paper examines the introduction of nitrous oxide into clinical anaesthesia practice in California from 1846-1946. California is a good study site for the history of anaesthesiology because it was relatively isolated geographically for many years and because there were few medical institutions such as medical journals. In 1846 when anaesthesia was first successfully demonstrated in Boston, California was not part of the United States, either geographically or politically. Travel to California was exceedingly difficult, taking six months by land or six to eight months by ship, and the journey was hazardous. Cholera, pellagra, Indians and shipwrecks were among the dangers awaiting travellers to California, many of whom did not survive. Because of the great distance between the States and California and the travel difficulties, it took a long time for news to reach the State. Although the discovery of surgical anaesthesia reached the world's major cities within the next year, California did not learn of it until three years later, when the Gold Rush of 1849 began. The delay is understandable; during those three years, there was little reason for the news of anaesthesia to get to California. In 1846 there were only three doctors, all Army surgeons, in the State and there were no hospitals, no medical schools, no pharmacies, and no medical journals.

Effect of the Gold Rush

The Gold Rush of 1849 changed this isolation. Once gold was discovered, people from around the world rushed in 'to strike it rich'. This group included an estimated 1,200 physicians. Most 'forty-niners' did not strike it rich and many of the physicians practised medicine to survive. We know that some of these doctors brought their medical tools such as stethoscopes and microscopes and, no doubt, also brought ether and chloroform. This is suggested by the office sign of a University of Edinburgh graduate who arrived in 1849. His sign promised 'draws teeth painlessly'. He was probably familiar with chloroform as an Edinburgh graduate and used his ability to relieve pain with it as a way to attract patients to his tent-office in the tiny Gold Rush town of Placerville.

Ten years after the Boston demonstration, California's first medical journal began publication. Anaesthesia was well-established by then. The very first article in the new journal was on the possible additive effects of morphine and chloroform in a patient who died during surgery. Anaesthesia was mentioned in thirteen articles in the first volume, and chloroform was the most common anaesthetic. At this time, ether and chloroform were imported from Europe, but by the 1860s were being manufactured in the State.¹ The question for this study is how N₂O might have been added to anaesthesia practice in the State - how did nitrous oxide get to California, and when?

Arrival of nitrous oxide

It is known that Gardner Q Colton, the itinerant chemist whose 1844 demonstration in Hartford, Connecticut, led dentist Horace Wells to try nitrous oxide for dental work and then

surgery, was in the State for several years during the California Gold Rush. There is no evidence that he administered N₂O while there.²

Sources for my study were primarily medical journals, starting with the State journals. There were nearly continuous State medical journals from 1856 to 1944 and there was only one at a time, making it relatively simple to get information on anaesthesia articles.³ Journals of the earlier years were general, as there were no specialists. Anaesthesia journals began in the US in 1916 and, again, there was only one at a time until after World War II.⁴ The medical journals were reviewed for articles on anaesthesia and the number of articles on N₂O were totalled. Reports of operations, which might mention the anaesthetic, were also checked; none mentioned N₂O. In fact, very few reports of operations noted the anaesthetic, including a report of multiple patients undergoing brain surgery. Once anaesthesia journals began, articles on N₂O written by Californians were totalled. These data were supplemented with information from miscellaneous sources: *The Minutes Book of the Southern California Society of Anesthetists* (the first anaesthesia society in the State) from 1919 to 1921, the transcript of a 1934 trial in which Los Angeles physician anaesthetists sued a nurse anaesthetist for practising medicine without a licence and, finally, any available meeting programmes of anaesthesia societies.⁵

Medical journals of the time often included abstracts from other medical journals. The first mention of N₂O in the State came from such an abstract. The noted anaesthetist, Dr Joseph Clover of London, reported on combining N₂O and ether in another journal; this was abstracted in the *Pacific Medical & Surgical Journal* in February 1877, 33 years after the first use of N₂O for surgical anaesthesia.⁶ Two months later, Henry Gibbons, one of the State's most prestigious physicians, reported on his experience having teeth pulled under N₂O when he was visiting Philadelphia.⁷ It appears Gibbons was familiar with the effects of nitrous oxide: 'I expected to feel its exhilarating effects, which I had many times experienced when inhaling it for amusement' (medical students of his generation in the US sniffed N₂O to get 'high' during N₂O parties). Gibbons became unconscious with this administration, rather than feeling exhilarated. He noted the benefits of N₂O and then stated that it was suitable for brief surgical operations. The major problem was its short duration. If the operation should go on longer than 1-2 minutes, Gibbons noted it could be inhaled again. He also noted that it was difficult to keep a supply in 'perfect condition'. This no doubt was to be a critical reason for the delay in using N₂O in clinical practice. Compared to ether and chloroform it was difficult to produce and transport.

After these reports, 24 years passed without mention of N₂O, except for a single brief 1881 abstract on Paul Bert's 'anaesthesia car', in which operations were done under pressurised N₂O at various Paris hospitals.⁸ In 1897, when our first physician anaesthetist, Dr Mary Botsford of San Francisco, began her practice, few others were interested. The paucity of interest in anaesthesia in general and N₂O in particular continued, with only two more articles describing N₂O in 1901 and 1905.⁹ There was a ten year hiatus, and then an explosion of interest with nine articles and presentations on N₂O in 1915. This increased activity lasted until 1921. In 1925-27, another cluster of articles occurred. In this time period, the 'secondary saturation' technique was common. The hypoxic hazards were known and written about in the articles, but most patients were thought to tolerate them with little problem. Dr Botsford and her numerous trainees wrote many of these articles, demonstrating her leadership in developing professional anaesthesia in the State.¹⁰

From the non-journal sources, it was found that N₂O was more expensive than ether or chloroform. The Fee Schedule of the Southern California Society of Anesthetists listed fees of \$25/hour for nitrous oxide and only \$10/hr for ether.¹¹ (This cost differential was also present in the New York Society of Anesthetists' Fee Bill¹² from about the same time.) This was no doubt due to the need to purchase equipment, such as the new McKesson machine, for efficient delivery and to the higher cost to produce, package and transport N₂O. The 1934 trial transcript extensively described anaesthesia practice in Los Angeles. Physician anaesthetists did only general anesthesia, using N₂O, ether and CO₂. Nurse anaesthetists used ether and chloroform.

In summary, information on N₂O was available in California by 1877, but there is at present no evidence it was used for surgery until 1914. The years 1915 to 1921 were a time of great interest in N₂O anaesthesia, with a second period of lesser interest in 1925-26. In Los Angeles in 1934 N₂O was always supplemented with ether and CO₂, and only physicians gave it.

Decreasing use

Why did interest decrease after that? There was the higher cost of N₂O and the necessary apparatus. New agents such as ethylene, thiopentone and cyclopropane, introduced in the 1920s to 1930s, appeared as alternatives to straight N₂O. Most importantly, the hypoxic hazards of N₂O became clear. Los Angeles' neuropathologist, C B Courville, wrote an article in 1936 which in 1939 was expanded into a book: *Untoward Effects of Nitrous Oxide Anesthesia*. This documented hypoxic brain damage in patients who died during 100% N₂O anaesthesia. The book had a profound influence on the move to other anaesthetics.

Conclusion

Although this study did not find a perfect answer to the question how and when N₂O entered anaesthesia practice in California, it is possible to say it was used at a surprisingly late time and its popularity declined when other agents became available and as the hazards of nitrous oxide became better known.

References

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2. I reviewed all the Colton material available in the U.S.
3. Medical journals were: *California State Medical Journal* 1856-57, *The Pacific Medical and Surgical Journal* 1858-1869, *The Pacific Medical Journal* 1864-1904, and *California and Western Medicine* 1924-1946.
4. Anaesthesia journals were: *The Anesthesia Supplement of the American Journal of Surgery* 1916-1922 and *Current Researches in Anesthesia & Analgesia* 1922-1946.
5. The *Minutes Book* of the Southern California Society of Anesthetists is at the History Division of UCLA School of Medicine's Biomedical Library. The trial (Francis-Chalmers et al and the Anesthesia Section of the Los Angeles County Medical Association vs Nelson and St Vincent's Hospital) transcript is in the archives of the

6. American Association of Nurse Anesthetists, Park Ridge, IL. Meeting programs were published in *California and Western Medicine*. If the presentation was later published (most were), it was not counted twice. Organizations meeting in the State included The Anesthesia Section of the California Medical Association (precursor of the present California Society of Anesthesiologists), the national association: The American Association of Anesthetists and the regional society: the Pacific Coast Association of Anesthetists.
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