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The Ombrédanne inhaler in Japan

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(This article by John W.R. McInyre was originally conceived as part of a book project that ended with his death. John W.R. McIntyre (1925–1998), who was Professor Emeritus at the University of Alberta in Edmonton, Canada, at his death, had special ties to Japanese anesthesiology. He was repeatedly a Visiting Professor at the University of Hirosaki School of Medicine and received its Distinguished Alumni Medal in 1995. In coauthorship with Prof. Akito Matsuki, he published, among other things, a manual for writing scientific medical texts in English (Kokuseido Publishing Co., Tokyo, 1992). He supplied the Japanese facsimile edition of Johann Sigismund Elsholtz's *Clysmatica Nova* (Berlin, 1665) with an access-facilitating commentary and, similarly, a reprint, published first in Japan, of J.Y. Simpson's *Anaesthesia or the Employment of Chloroform and Ether in Surgery, Midwifery, etc.* (Philadelphia, 1849) with an introduction (both books published by Iwanami Book Service, Center, Tokyo, 1995). In the present paper, John W.R. McIntyre elucidates a further aspect of the history of Japanese as well as international anesthesia.)

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In Japan the third Shogun, Iemitsu (1604–51), ordered the closure of the British trading house in Hirado in 1623. However, in 1634, a tiny foreign settlement for the Dutch called Dejima was established in Nagasaki as a required domicile for all foreigners. By 1639 the policy of isolation for Japan was completed, because Japanese people had by then been forbidden to make voyages abroad.

Nevertheless, information about the practice of medicine in Holland inevitably reached scholarly interpreters in Nagasaki and also Edo, where representatives came regularly to pay homage to the Shogun. A landmark event during the evolutionary period was the attendance of Genpaku Sugita, Ryotaku Maeno, and Jun-an Nakagawa at a human dissection in 1771. Their observations coincided with the illustrations in a contemporary Dutch anatomy book but differed from their own national texts. Consequently, after many difficulties they managed to publish in 1774 *Kaitai Shinsho* (*A New Book of Anatomy*), which was their translation of the definitive Dutch anatomy text *Ontleedkundige Tafelen*. This was the first scholarly translation ever made in Japan of a scientific book from the West, and then studies of Dutch culture rapidly developed. Holland remained the basis of Western medical culture until a 1767 translation into Japanese of a section of Heister's *Chirurgie* heralded the introduction of German medical culture. This truly began to flourish when Philipp Franz Balthasar von Siebold, a young German physician in the service of the Netherlands East India Army, arrived in Nagasaki in 1823. He was one of a long line of Siebolds in the medical faculty at Wuerzburg who had helped to bring that school to the forefront of German medical schools. This vigorous intellectual, fascinated by medicine, science, and politics, led a controversial and tumultuous international life and, together with his extensive German professional contacts, must have played a major role in promoting the adoption in Japan of the German system of medicine and medical

education. This persisted well into the 20th century. Very early in his career, the distinguished bacteriologist Hideyo Noguchi, while studying in the United States, stated "but if I have not been to Germany whatever will become of me (in Japan)." Accordingly, Japanese interest in Ombrédanne's inhaler (see Appendix) coincided with its adoption in Germany. Its first use in Japan seems to have been about 1927, and clinical accounts began to appear in Japanese journals in 1930.

Ken-ichiro Kitajima [1] first employed air and ether for induction of anesthesia and then used heated ether, carbon dioxide, and air. His reasons for using that technique were the following: (1) Carbon dioxide promotes spontaneous breathing, and heating the ether saves about 50–100 cc of ether. (2) Induction is rapid and smooth, without excitement. (3) The depth of anesthesia is easily controlled during anesthesia. (4) There is little postanesthetic complication. (5) The closed-circuit anesthesia machine allows beginners to give anesthesia easily.

Kohei Koyano [1] then commented that Ombrédanne's inhaler had been introduced as *Aether-Kohlensaeure-Narkose*, and they had used it for two or three years with excellent results. How CO_2 acted was still unknown, but the stage of excitement was much shorter with inhalation of both ether and CO_2 than with ether inhalation alone, and induction was completed very quickly. The airway mucosa was relatively unstimulated by the inhaled gas. Emergence from anesthesia was rapid. The magnitude of the bowel movement was less depressed than during N_2O anesthesia. Thus the surgical field was not disturbed by distension of the bowel.

In 1931 Hiroshi Shimomura [2] reported experiences with Ombrédanne's inhaler during gynecological surgery and obstetrics from April to October 1930, either as the sole technique or to supplement spinal anesthesia. The salient features of his clinical account were as follows. There were no characteristics of patients that were specific contraindications to the use of Ombrédanne's inhaler. An adequate anesthesia level was obtained 5–8 min after the start of anesthesia. Preparation for surgery was begun about 4 min after the start of anesthesia. Respiration was deep, rapid, and regular during the entire course of anesthesia (95% O_2 and 5% CO_2). No patient developed respiratory depression, cardiovascular collapse, or airway spasm (bronchospasm or laryngospasm), which had been commonly seen with the open-drop method. Cyanosis was observed in a few cases due to careless anesthetic management, i.e., failure to realize that when cyanosis developed, the knob should be switched to level 0, with CO_2 inhalation. The heart rate and blood pressure tended to increase during anesthesia. Frequent hypotension had been observed with the open-drop method, but Ombrédanne's method had little of this problem, and was a rational anesthetic method. A remarkable point was that there was little problem of airway secretion with this method. The postanesthetic condition of patients for whom Ombrédanne's method had been employed was obviously better than that of patients after use of the open-drop method, with rapid and smooth emergence. Most patients could talk 1 h postoperatively. There was a low incidence of postoperative nausea and vomiting (about 30 of 135 patients). CO_2 promotes bowel movement, and postoperative bowel paresis was rare. A remarkable point was that postoperative pulmonary complications were very rare and were not serious if they did occur. This was thought to be due to the use of warm inhaled gases saturated with water vapor. However, during the early period of use of the Ombrédanne inhaler, there was a relatively high incidence of bronchitis and pneumonia, although the symptoms were not serious. Thereafter, inadequate cleaning of the mask was found to be responsible for this complication. After the method of cleaning the mask had been changed, only a few patients developed such complications. Shimomura concluded that Ombrédanne's method with CO_2 inhalation when used as general anesthesia or general anesthesia for supplement of spinal anesthesia, for obstetrical and gynecological procedures, provided a safe and reliable method instead of the open-drop method.

The advantages include the following: (1) Induction was relatively rapid and smooth. (2) After adequate depth of anesthesia has been obtained, maintenance of anesthesia was smooth, without complications during the procedure. (3) Respiratory function could be monitored through the anesthesia bag. The amounts of either ether or inhaled CO_2 were easily controlled. (4) Ether consumption was minimal. (5) Awakening was rapid, and postoperative nausea or vomiting was rare. (6) Postoperative pulmonary complications were rare. (7) Operation was easy, even for beginners.

This combination of inhalation of CO_2 and ether delivered from an Ombrédanne inhaler was also strongly advocated in 1931 by Tatsuo Abe [3]. Hiroshi Shimoura reported further experiences with this inhaler in 1932 [4], and these were similar to his 1930 report. Again he emphasized the low incidence of postoperative pulmonary complications compared with what followed open-drop ether administration. Shiryi Kato [4] commented that when spinal anesthesia was given and supplemental general anesthesia was used with Ombrédanne's inhaler, ether was the most effective of the various anesthesia methods.

Judging by the paucity of subsequent literature in Japanese about Ombrédanne's inhaler, it appears that, except in isolated hospitals or in military circumstances [5], its use was superseded quite rapidly by other methods.

Appendix

In 1908, the Parisian surgeon Louis Ombrédanne presented a new apparatus for applying ether. He criticized existing English inhalers for, among other things, functioning discontinuously due to the intermittent lifting of the mask (to supply fresh gas), for their limited evaporation surface (for liquid ether), and for the clinical problems arising from these flaws (e.g., fluctuating, often insufficient level of anesthesia, agitated patient). His goal was a steadier application of anesthesia, whereby with every inspiration, along with fresh air, rebreathing gas would also be inhaled, which could be more effectively augmented with a narcotic agent. This was to be attained by sending it through a chamber filled with an ether-imbibed sponge. The chamber consisted of a spherical body with a rebreathing bag on one side, and a fresh air inlet and a control knob moving a pointer up a scale on the other side. At the top was a shutable opening for pouring in the ether, and the mask and two rings for the thumbs of the applier were attached below while the other fingers clasped the lower jaw to make sure the mask sat tightly. A regulating mechanism inside the inhaler and activated by the control knob took care of the ether dosage in accordance with the demands of the surgeon. He signaled to the medical assistant, who usually carried out anesthesia, the desired mark on the scale to be reached by the pointer. The apparatus was considered "a remarkably foolproof device" (Barry, 1961 [6]), delivered acceptable results for that time, consolidated the paradigm of the surgeon as solely responsible for both the operation and the anesthesia, and dominated operating theaters in France and South America for decades. It appeared also in Germany (where it competed mainly with the open ether-drop method using the Schimmelbusch mask) and in other continental European countries, including the (former) Soviet Union. Its career reached an end following World War II, when modern anesthesiological standards from the Anglo-American countries (where the Ombrédanne inhaler was unknown) were applied worldwide.

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