

Arthur E. Guedel Memorial Anesthesia Center

Ethyl Chloride and the Rapid Induction

By Merlin Larson, M.D.

A review of anesthetic techniques during the 1920s reveals that operating room efficiency and production pressures were just as much of a concern then as it is now. One example during that era was the widespread use of ethyl chloride, an agent that allowed the surgeon to start the case soon after the patient was brought into the operating room.

Rapid turnover in the operating room was emphasized in the article "*The Guillotine and Ethyl Chloride*" by CR Sandiford and JC Clayton in the July 28, 1928, issue of the *British Medical Journal*. In this article, the authors described their rapid ethyl chloride anesthetic for tonsillectomy. Two operating room tables with separate nurses were set up in the same operating room. As one child was being taken out of the room, another one was brought in and placed on the other clean table. One surgeon and one anesthetist worked a case and then moved to the other setup as the emerging patient was being lifted out of the room.

The ethyl chloride induction consumed approximately 30-40 seconds, and the surgeon was able to perform bilateral tonsillectomies and adenoidectomy in another 30 seconds. The surgeon's tool was the guillotine knife. No attempt was made to cauterize or pack the bleeding tonsillar fossa. The total time for each procedure was estimated to be approximately two minutes so that 30 cases could be performed each hour!

Bleeding that led to airway compromise was treated by lifting the legs and suspending the child upside down until the airway cleared. Apnea or failure to emerge from the anesthetic was treated by splashing a bucket of ice water on the child's face "with care to first close the external auditory meatus." One key to the entire process was a good orderly who knew how to position the patients properly during transport (see **Figure 1 on the following page**).

Figure 1: A well-trained orderly transported the semi-conscious post-tonsillectomy patient to the recovery area. The authors mention that the nurses and orderlies are able to position the patients so the anesthesiologist's hands do not contact blood, thus avoiding the need to wash their hands between cases! The word suction does not appear in the manuscript, so presumably was not available. Image modified from the *British Medical Journal*, July 28, 1928.



Ethyl chloride was one of the many alternatives to ether and chloroform during the early 20th century. It was a failure as an anesthetic, but it took several decades before the dangers of the drug were realized. The highly volatile liquid was sprayed directly into a closed system (see **Figure 2 on the following page**), and a deep and profound anesthetic developed within less than a minute, often accompanied by “stertor” and opisthotonis. For unknown reasons, this type of rapid induction as a prelude to ether maintenance became routine practice, even though it was often described as dangerous by most textbooks of that era. Arthur Guedel was noted to be a master of the rapid ethyl chloride induction but was not immune to the serious complications that followed. In a letter to Ralph Waters dated 1928 he described the following case:

T and A. Girl age 6. Apparently in good health. Ethyl chloride for about half a minute or until the rough edge of consciousness was taken off. Lumbard's stuff. Then ether for two minutes and suddenly a dead child. Post mortem picture of chest (X-ray) showed large thymus. Would say about the size of a twenty-five cent bottle of fountain pen ink. One here before me now. At any rate it was a much-enlarged thymus.

Status lymphaticus (enlarged thymus) was frequently used to explain anesthetic tragedies. There was an all out attack on lymphoid tissues in the first half of the 20th century. By 1950, there were over one million tonsillectomies performed in the United States. Thymus tissue was sometimes treated with radiation to shrink the gland prior to general anesthesia. Guedel was not the only one to fall back on this diagnosis to cover up toxic deaths from uncontrolled delivery of potent agents like ethyl chloride. *Osler's Modern Medicine*, published in 1925, has a section on status lymphaticus that describes the risk of death during anesthesia in subjects with this syndrome. A series of influential papers in the late 1950's eventually debunked the entire concept of status lymphaticus, leaving our specialty without this convenient excuse for intraoperative deaths.

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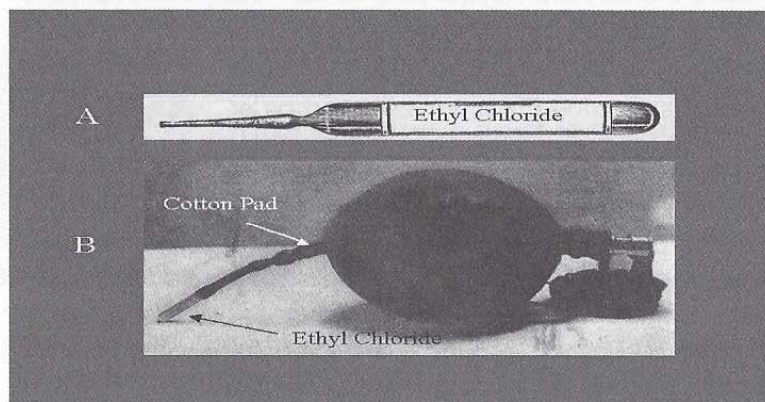


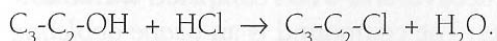
Figure 2: The mask was held over the face with the left hand. After a few breaths, the glass ampoule containing ethyl chloride was snapped open with the right hand. At a vapor pressure of 1064 mm Hg (68 degrees F) the liquid would rapidly vaporize. The glass ampoule is shown in A and positioned into the rubber tube as shown in B. Cotton padding prevented glass from entering the bag. Some air could enter the system around the mask. Image modified from J. W. Gwathmey, *Anesthesia*, 1914, page 274.

When looking back today on the method by which ethyl chloride was delivered, it becomes apparent that these anesthetists would not have been able to manage the many variables that controlled alveolar concentration such as temperature, quantity of ethyl chloride vaporized, minute ventilation, oxygen concentration, carbon dioxide rebreathing, and absorption of gas by the rubber bag. If an anesthetist were fortunate to give the agent without killing the patient, then it would be an early example of the adage: "better to be lucky than good." Imagine coming out of training and entering a practice that condoned these methods to provide rapid turnovers! Ethyl chloride also commonly was used to speed up ether anesthetics, and in this capacity it was also a dangerous agent (see above case report).

Death during ethyl chloride anesthesia was difficult to quantify. Flagg, Gwathmy, Lundy and Clements all considered the drug to be dangerous and to require great clinical skill to deliver. Many anesthetists thought that they had that unique skill, including Guedel and his trainees. George Alexander H. Barton stated in his book "*A Guide to the Administration of Ethyl Chloride*," that it was a dangerous agent but should not be abandoned. His estimates of death from ethyl chloride ranged from 1 in 3,000 to 1 in 200,000. This agent was on the decline even prior to the introduction in the mid 1930s of thiopental, a drug that solved the delayed inductions that accompanied mask ether inductions.

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Guillaume Rouelle, Antoine Lavoisier's chemistry teacher, first synthesized ethyl chloride in the 18th century from hydrochloric acid and ethyl alcohol:



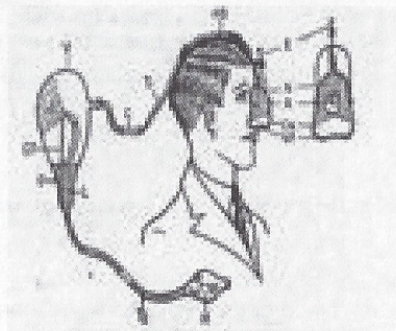
The compound is essentially ethyl alcohol with the OH radical replaced by chloride. It was not used medically until the mid nineteenth century when Marie Flourens discovered its anesthetic properties in dogs. Shortly afterward, J. F. M. Heyfelder used it clinically in humans, but his demonstration reported on its dangerous properties, and its use was initially overshadowed by ether and chloroform.

After the demonstration of ether spray-induced local analgesia by Benjamin Richardson in 1866, the more favorable properties of ethyl chloride spray for this purpose were soon appreciated. Local anesthesia with cocaine was introduced in 1884, but ethyl chloride-induced topical anesthesia was promoted as an alternative to cocaine.

The re-introduction of ethyl chloride general anesthesia was an accident. Although several methods of providing analgesia for dental procedures had been developed by the 1890s, one technique was to spray ethyl chloride onto the gums prior to extractions or restorative work. A dentist named Carlson from Gothenburg, Sweden observed that this maneuver would often induce general anesthesia and reported on his observations in 1894.

Coincidentally Carlson's report came at a time when the safety of chloroform was beginning to be seriously questioned. Several deaths by that time had been attributed to fulminant liver failure following chloroform. Its more rapid decline, however, followed the manuscripts of Levy that reported on its peculiar propensity to induce cardiac arrhythmias. Ethyl chloride filled the gap that chloroform had previously provided. Its rapid onset of action led to its use (together with trichlorethelene) as one of the first patient-controlled analgesics (Figure 3).

Figure 3: Patient Controlled Analgesia. When the patient squeezed the bulb (H), more liquid would vaporize. This apparatus was used for both ethyl chloride and trichloroethylene. Image modified from Scher, *Dental Record*, 1946, p 217, and Forman, *Anesthesia and Analgesia* 1942, Nov, p 318.



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Other disasters with the drug deserve mention. Ethyl chloride spray has been promoted as a topical local anesthetic for well over a hundred years. However, for this purpose it is only marginally effective, and when compared with bicarbonated lidocaine, it has no advantages. The compound is an *ozone depleting* gas and has been used illegally as a “popper” with lethal consequences. The spray has been labeled “The Duster” by the drug sniffing community and “lanca perfume” by celebrants during Carnival in Brazil. Several case reports confirm that these uses can be fatal.

Operating room efficiency is a frequent topic of hospital committees, and time spent during the anesthetic induction often is part of the discussion. Developing a reputation as a quick and efficient worker is one of the few ways that anesthesiologists can distinguish themselves, at least within certain segments of the hospital staff. The chair of a large hospital in New York City recently confided interesting information about how he previously had evaluated the members of his large department. He thought that the surgeons could be called upon to evaluate the anesthesiologists. The reasoning was that the surgeons observe the anesthesiologists every day, so that they should be able judge the care they provide. The evaluations from the surgeons fell neatly into two groups: the anesthesiologist was either fast (good) or slow (bad). Obviously, these evaluations were useless, and this became clear enough when the “fast” workers would pass on inadequately prepared cases to other anesthesiologists, thus improving their averages at the expense of the others. Furthermore, there was always the possibility of severe complications from providers that continually tried to minimize the time between induction and incision time. We might take the historical example of ethyl chloride and use it to bolster our belief that undue pressures to begin a case can have undesirable consequences.

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