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Thunberg's Barospirator, a Fully Encasing Predecessor of the Iron Lung

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ABSTRACT

Used as a ventilator for assisting victims of polio, the barospirator was described by Swedish physician-scientist Torsten Thunberg in 1924. An immediate predecessor of the iron lung of Philip Drinker, the barospirator fully encased the entire body. Cyclic air-pressure changes within the chamber achieved ventilation during equilibrations of intrapulmonary and ambient pressures. Pulmonary medicine innovator Alvan Leroy Barach used a modified barospirator for lung rest as a treatment of tuberculosis in the 1940s. Adverse effects included damage to patients' tympanic membranes. Despite its limited clinical success, the barospirator was successfully used by one of Drinker's competitors, John H. Emerson, to invalidate Drinker's US patent filings.

In 1929, Harvard engineer Philip Drinker (1894-1972) and pediatrician Charles F. McKhann III (1889-1988) reported their mechanical respiratory support of a young victim of polio with a device that became known later as an *iron lung*.[1] They mentioned a preceding ventilator called a *barospirator* (Figure 1),[2–6] which Swedish physician-scientist Torsten Thunberg (1873-1952) of Lund had reported in 1924. Interested in oxygen delivery and in aerobic metabolism, Thunberg was nominated for a Nobel Prize for characterizing enzymatic dehydrogenation.

The Thunberg device was described in detail by his assistant, the physician Sven Axel Henrik Enghoff (1894-1986).[3,5] Whereas the iron lung held the patient's head outside the cylinder, the barospirator required the entire body, including the head and neck, to be enclosed inside. Indeed, the barospirator worked through cyclic pressure changes within a space enclosing the entire patient. The net pressure amplitude was typically a sixth of an atmosphere at a rate of about 20/min. The compression and rarefaction of ambient chamber air achieved intrapulmonary gas movement.[2,3] The Thunberg apparatus assisted ventilation in a patient with poliomyelitis in 1926 and was applied to neonatal resuscitation in 1930.[1,4]

Although the barospirator helped in the conception of the Drinker iron lung, the iron lung in turn prompted a modification of the barospirator. This change happened because, theoretically, no lung movement is necessary for pulmonary ventilation within a barospirator. In practice, there are chest excursions because of airway resistance.[7] Such lung movements were minimized by means of a porous head-chest chamber partition incorporating a neck collar. There are no chest excursions when the resistance of the partition matches that of the airway.

By the 1940s,[8] New York City physician Alvan Leroy Barach (1895-1977) was using a modified barospirator for lung rest as a treatment of tuberculosis. His “equalizing alternating pressure chamber” rested each of five victims of pulmonary tuberculosis for several months. For the purpose of allowing tuberculous cavities to close, the chamber was typically used for 12 hours per day.[8]

In 1956, hypnotist Morey Bernstein (1920-1999) penned a pseudo-scientific bestseller entitled *The Quest for Bridey Murphy* (reissued in 1965 as *The Search* for same). Bernstein describes his experience of suspended chest motion in a modified barospirator as an attempted aid to self-hypnosis (http://ariwatch.com/VS/TheIronLung/RespirationWithoutBreathing.htm). Perhaps, his experiment failed because the pressure oscillation was too painful for his eardrums.[8]

Despite its limited clinical success, the barospirator preceded the Drinker iron lung chronologically. Consequently, a competitor of Drinker's, John H. Emerson (1906-1997), cited the barorespirator as one of several predecessor inventions that invalidated Drinker's US

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Fig. 1. Swedish physiologist Sven Axel Henrik Enghoff (1894-1986) standing in the interior of the Thunberg barospirator in Lund, Sweden. Thunberg's protégé, Enghoff, was prompted by the barospirator to study lung physiology, including dead space, airway resistance, and apneic oxygenation.[5] Physiologists recognize Enghoff's eponymous modification of the Bohr equation for physiological dead space.[5] The photographer was probably physiologist Francis Gano Benedict (1870-1957), who visited Lund in 1926. The image is figure 42 on page 46 of volume 5 of a journal kept by Benedict and entitled "Reports of Visits to Foreign Laboratories [1907-1927]." The full journal is online at http://vlp.mpiwg-berlin.mpg.de/references?id=lit39747. This scan is from the US National Library of Medicine.

patent filings.[9] Ironically, the iron lung on display at the US Smithsonian Institution is an Emerson Respirator … and not a Drinker iron lung.

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