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TRIBUTE

The amazing Minivent ventilator

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In the mid-1960s Dr Anthony Cohen, an anaesthetist in private practice in Johannesburg, developed the Minivent respirator in response to the lack of ventilators that existed at that time in operating theatres in both private and state hospitals. The remarkable, rugged, miniature ventilator had only four components, could fit into an anaesthetist's pocket and required no electrical power source. The pressure generated by the distension of a reservoir bag by the flow of anaesthetic gases to the patient triggered inspiration and the switch from inspiration to expiration was controlled by a pressure-sensitive magnetically operated bobbin. The device operated as a minute volume divider. Respiratory rate was obtained by counting the clicking noise from the bobbin and, provided there was no leak, tidal volume was easily calculated by dividing the gas flow by the respiratory rate. The device was widely used in numerous countries including South Africa, the United Kingdom, Australia and Canada.

Keywords: anaesthesia, history of anaesthesia, medical equipment, ventilators

Introduction

Dr Anthony Cohen was born in Liverpool in England on 10 May 1927 whilst his father was studying medicine in Liverpool. In 1929 the family returned to South Africa and settled in Warmbaths, where his father practised as a general practitioner. After matriculating at Pretoria Boys High School in 1944, Anthony entered the Faculty of Engineering at the University of the Witwatersrand where he qualified with a BSc in Electrical Engineering. In 1948, on the advice of his father, he switched to medicine, graduating with a MB BCh (Rand) in 1955. His younger brother Michael also studied medicine and practised as a urologist in Johannesburg for many years. After completing his intern training at Coronation Hospital in 1956, Dr Cohen returned to the family practice in Warmbaths as a general practitioner. In 1961, he commenced registrar training in anaesthesia at Baragwanath Hospital under Dr Duffield and then Dr Hilda Ginsberg, qualifying with an FFA (SA) in April 1964. After specialising, he joined Drs Michael Kramer and Dennis Glauber in private anaesthetic practice in Johannesburg. Like his partners Dr Cohen was active in the affairs of the South African Society of Anaesthetists (SASA), becoming secretary of the Southern Transvaal branch from 1965 to 1967 and Chairman in 1968. He was appointed as a part-time lecturer to the University of the Witwatersrand Department of Anaesthesia, and after Physics and Clinical Measurement replaced Anatomy on the curriculum for the Part I of the Fellowship of the Faculty of Anaesthetists (FFA) of the Colleges of Medicine and Surgery (CMSA), he was appointed by the College as a primary examiner.

Development of the Minivent

Whilst Dr Cohen was at Baragwanath hospital, there was only one Draeger ventilator in the anaesthetic department. The ventilator was cumbersome to use and was not available to junior staff, who spent many hours manually ventilating their patients by squeezing the black rubber reservoir bag. He realised that instead of manually squeezing the bag he could control the gas flow by pressing the button on a Reuben non-return valve, thereby inflating the reservoir bag that in turn delivered a tidal volume to the patient. On releasing the button the reservoir bag would then refill with anaesthetic gases. At the time that he went into private practice in Johannesburg anaesthetists had to supply all their own equipment, including anaesthetic machine, drugs, endotracheal tubes, nitrous oxide etc. Private hospitals



Figure 1: Dr Anthony D. Cohen BSc, MB BCh, FFA(SA), FANZCA (photographed in Melbourne in 2015)
Source: Dr Christine Ball.



Figure 2: The Minivent ventilator.

supplied only oxygen. Ventilators were not supplied. A few anaesthetists owned their own ventilator and paid an assistant to carry their equipment from hospital to hospital. As a result of the lack of ventilators, various branches of SASA established ventilator funds from which ventilators were purchased for both private and state hospitals. As a result of these problems, Dr Cohen designed the Minivent respirator that functioned like an automatic Reuben valve.[1] The prototypes were built using a lathe with the help of his fitter and turner brother-in-law. The ventilator was developed and tested with the assistance of a simple artificial lung of adjustable compliance designed by Dr Cohen.[2] It was the year of the miniskirt in 1966 and the name Minivent was suggested by his partner Dr Dennis Glauber. The name was well chosen because the device only weighed 115 g and could be held in the palm of a hand (see Figure 2). The final model was patented and manufactured in South Africa by the Acme Instrument Company. In 1969 it was advertised for sale in London for £26.5.0d.[3]

Mechanism of action

The Minivent respirator is a minute volume divider that uses a magnetic shuttle valve (bobbin) coupled to the reservoir bag in the breathing attachment to pressurise the reservoir bag during expiration. Once sufficient pressure had built up in the reservoir bag the bobbin would move away from the magnet and allow inspiratory gas to flow to the patient. The ventilator was usually positioned between the endotracheal tube of the patient and the black corrugated tubing of the Magill circuit (Figure 3). In this position the ventilator acted as a non-return valve for expiratory



Figure 3: The Minivent positioned between the endotracheal tube and the corrugated tubing of a Magill breathing system.



Figure 4: The Minivent positioned at the anaesthetic machine end between the reservoir bag and the corrugated tubing of a Magill breathing system.

gases. If access to the face was difficult (e.g. for head and neck surgery), it could also be positioned at the machine end between the reservoir bag and corrugated tubing of the Magill circuit as shown in Figure 4. In this position it was necessary to insert a non-rebreathing valve at the endotracheal end to avoid the otherwise large dead space caused by the corrugated tubing.

The shuttle valve produced an audible clicking noise that could be used to time the respiratory rate and, provided that there was no leak, the patient's tidal volume could be calculated by dividing the gas flow by the respiratory rate. This simple but rugged device possessed only one moving part, had two screw adjustments, required no external power source and was easily dismantled for cleaning.

Conclusion

The Minivent became the first of three miniature ventilators that were developed at that time.[3] The other two were the Freeman Minivent and the Carden Microvent. All three were prone to sticking.[3] In Australia, the Minivent was coupled to the Adelaide Bag-in-Bottle Circuit,[4] and in England it was used as an anaesthetic and transport ventilator.[5] Miniature ventilators became obsolete with the development of anaesthetic machines with built-in ventilators, increasingly sophisticated alarms and the ability to better ventilate patients with poorly compliant lungs.

Dr Cohen emigrated to Melbourne, Australia in 1979 and worked as a consultant anaesthetist at the Alfred Hospital until 1983 when he went into private practice. On arrival in Melbourne he discovered that the circle system with carbon dioxide absorber was the standard breathing circuit in use. He modified the ventilator to allow coupling with the circle system but in personal

communication stated that this required a fresh gas flow of 7 L/minute thereby nullifying the low-flow advantage of this system. In 1981, he was granted an honorary FANZCA. Dr Cohen has since retired and lives in Melbourne. A YouTube video of the ventilator in action may be seen on https://youtu.be.TYYCVNCi2nM.

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Video link – https://youtu.be.TYYCVNCi2nM

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