

Pioneers in South African Anaesthesia: Professor Arthur Bull and the Taurus Radiofrequency Blood Warmer

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Arthur Barclay Bull graduated MBChB at the University of Cape Town (UCT) in 1943. After internship at the New Somerset Hospital he joined the SA Medical Corps during the 2nd World War where he developed an interest in clinical anaesthesia. From 1948 – 1951 he underwent training as a registrar in anaesthesia at Groote Schuur Hospital. In 1953 he obtained the Diploma in Anaesthesia of the College of Physicians and Surgeons in Ireland and in 1960 became one of the 40 Foundation Fellows of the Anaesthetists of the Royal College of Surgeons in Ireland. From 1954-1955 he was appointed the Nuffield Dominion Clinical Assistant for South Africa in the Department of Anaesthesia at Oxford under Sir Robert Macintosh. In 1956 he was appointed Senior Anaesthetist at the newly opened Red Cross War Memorial Children's Hospital. During that time he, together

with Prof Pat Smythe, pioneered the use of prolonged curarisation and IPPV for treating tetanus. In 1960 he was awarded a WHO Travelling Fellowship and in 1977 an honorary fellowship from the Australian and New Zealand College of Anaesthetists. He succeeded Dr CS Jones as Head of the UCT Department in 1961, was appointed Associate Professor in 1963 and became the first holder of the UCT Chair of Anaesthetics in 1963. He served two terms as President of the SA Society of Anaesthetists and was Chairman of the SASA Committee that drew up the first Guidelines for Practice in 1987. He passed away in 2001 aged 80 years.

The Taurus Blood warmer:

The Taurus blood warmer, named after Professor Bull, was a novel method of warming blood, developed in a collaborative venture between the UCT Departments of Anaesthesia and Electrical Engineering in the 1960's in response to a need to warm blood in order to prevent hypothermia and possible cardiac arrest during massive transfusions. Prior to its development blood warming strategies were largely inefficient and unsafe.^{1,2}

The commonest forms of blood warming at the time were either immersion of the bottles of blood in a warm bath, which was slow, or the use of heat exchangers consisting of a long length of coiled tubing up to 24 feet. The tubing was passed through a water bath, making it ineffective at the high flow rates needed for rapid transfusions due to its high resistance.^{1,2}

Requirements of a new blood warmer for massive transfusions included that the warmer should have no



Figure 1: Taurus blood warmer Mark II in use at Groote Schuur Hospital in 1972. (Note the bottle of 0.5% saline containing a thermometer, used to test the temperature to which blood would be heated)

deleterious effect on whole blood, should be effective at high transfusion rates (>150ml/min), must be rapidly assembled, and be simple to use.²

The research team, led by Dr J Besseling and Associate Prof Bull, chose radio-frequency induction as the means most likely to heat blood contained in a standard Baxter blood bottle rapidly and evenly.¹ To achieve this, a power-oscillator circuit was designed to provide a suitable electro-magnetic field at a frequency of 33 MHz capable of producing the 250W of energy required for this purpose. This circuit could warm 620 ml of blood from 5°C to 35°C within four to five minutes.^{1,2} Electrically blood can be regarded as an inhomogeneous dielectric in which the conductivity increases with increasing temperature, producing a variable load to the radio-frequency circuit.² This phenomenon was used to create an electrical balance, which could act as a relay to terminate the heating process at a desired temperature, eliminating the risk of excessive heat damage. The process was patented in South Africa and the Taurus Mark II blood warmer was manufactured under licence by Plessey. (See Figure 1)

In 1967 the UCT group published an investigation into the efficacy of the new Taurus Blood warmer to heat blood

uniformly, to stop heating at the desired temperature and to preserve red blood cells after transfusion.² This study demonstrated that the relay circuit was reliable in terminating the heating process, initially using bottles of 0.5% saline that has a similar conductivity to blood, and subsequently with blood of varying shelf life. It also demonstrated uniform heating of blood with a temperature gradient difference of less than 0.5°C throughout the bottle. Transfusions of warmed Cr⁵¹ tagged red cells confirmed satisfactory survival in human recipients.²

The change in the containers used for storing donated blood and packed red blood cells from glass to plastic led to the development of the Taurus model 300. It utilized a Volkswagen Beetle windscreen wiper motor to agitate the blood to promote even heating. The move from “transistor” to “integrated circuit” technology (the power oscillator circuit still uses a Triode valve), led to the development of the Taurus 301 model manufactured by Cape Mechanical and Electrical Industries in Lansdowne, Cape Town. The 301 model was widely used throughout South Africa. Unfortunately production of the Taurus blood warmer ceased in 1996 following a fire in the factory that destroyed the dyes.

At a time when massive blood transfusions were increasingly required for resuscitation and for major surgery the Taurus blood warmer using radio-frequency induction provided a revolutionary means of heating blood that was both safe and reliable. Remarkably the Taurus 301 model is still in daily use at Groote Schuur Hospital 47 years after the prototype was developed.

References

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