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IN MEMORIAM

Inge Edler: the Father of Echocardiography

Professor Inge Edler, born 1911, has passed away a few days before his 90th birthday. Following medical studies at the University of Lund, Sweden and general medical training, he was employed at the Department of Medicine, Malmö General Hospital in 1944 and became responsible for its cardiac catheterization laboratory in 1948. From 1950 to 1960 he had the corresponding task at the Lund University Hospital. After a short stay in a small countryside hospital he was appointed head of the Department of Cardiology at Lund University Hospital in 1963, where he stayed until his retirement in 1977.

During the years in Malmö, Edler worked together with Professor Helge Wulff, one of the pioneers within the field of cardiac surgery. Closed mitral commisurotomy had evolved as an important surgical method, and Edler soon identified the need for improved preoperative diagnostic methods. Initiated by the use of the Radar technique during World War II, he considered the possibility of using some kind of echo technology for this purpose. After contacts with Jan Cederlund, a physicist in Lund, he started a co-operation with another physicist, Hellmuth Hertz, who was familiar with the so-called ultrasonic reflectoscope, developed for non-destructive material testing by the Firestone Co, USA. Hertz was aware of an ultrasonic reflectoscope at a shipyard in Malmö and borrowed the device during a weekend in May 1953. When Edler and Hertz placed the transducer of the reflectoscope over the chest they could detect moving echoes, obviously originating from the movements of the heart.

Hertz then managed to arrange a long-term loan of an ultrasonic reflectoscope from the Siemens Co, Germany. This instrument was used for an intense evaluation of the new method *in vitro* and *in vivo*. To be able to analyse the ultrasound recordings, a special device for continuous recording of the movements of echo-producing structures in the heart was developed (M-mode recording). On 29 October 1953 Edler and Hertz recorded the first ''ultrasound cardiogram'', and published their findings the following year[1].

The clinical evaluation of the method in adult cardiology was then performed by Edler and co-workers at the University Hospital in Lund (Arne Gustavsson, Tord Jarlefors, Bo Christensson and Olle Dahlbäck) and in paediatric cardiology by Nils-Rune Lundström at the same hospital. The evaluation was a most difficult task, including anatomical and physiological studies and of course also an enourmous amount of careful, time-consuming examinations of patients. Edler did not exactly know what to look for, he had no two-dimensional (2D) real-time image and he was also forced to use ultrasound transducers made out of quartz with a sensitivity 100 times lower than modern ceramic transducers. The result of these studies was an outstanding scientific contribution, summarized in his PhD thesis in 1961[2].

In the meantime, Hertz and co-workers considered the possibility of creating 2D ultrasound cross-sectional pictures of the heart in ''real time''. With newly developed mechanical mirror systems, for the first time in the world 2D real-time images of the heart were presented at the Lund Institute of Technology during 1967[3]. Development and evaluation of this new instrument took place in close co-operation with Edler at the Department of Cardiology in Lund.

At the same time, Edler and Lindström explored the possible use of the Doppler effect in order to perform ultrasound measurements of intracardiac blood flow. The ultrasonic Doppler technique for vascular applications had been developed in 1956 by Satomura in Japan, and although he also applied the technique to cardiac recordings, the resulting signals were interpreted as being caused by movements of the heart muscle and from the valve leaflets, respectively. No signal could be attributed to blood flow, and therefore the method was initially of negligible cardiological interest. At the beginning of the 1960s the first clinical equipment for estimation of blood flow in superficial arteries became available. Using such Doppler equipment, preliminary blood flow experiments were performed in Lund. At this stage of development Edler's clinical experience in cardiac auscultation and phonocardiography was most useful: out of a very noisy signal, Edler was convinced that he could hear the sound of blood flow. After a period of technical development (simultaneous M-mode echo registration and CW Doppler measurement) the equipment was ready for experiments in an isolated heart model. The results were convincing: it was possible to record ultrasound Doppler signals from the inside of the heart, generated by blood flow. During the first World Conference in Ultrasonic Diagnosis in Vienna 1969, Edler and Lindström presented their ultrasound Doppler studies, including the first 40 clinical intracardiac Doppler recordings for evaluation of aortic and mitral valve incompetence[4]. This method has later developed into today's many advanced colour Doppler techniques and was thus a further major improvement of ultrasound cardiac diagnostics.

It is almost 50 years since Edler and Hertz introduced echocardiography, the first clinical application of

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medical diagnostic ultrasound. Today, this method is the most rapidly growing medical imaging technique and is expected by many experts to become more important than X-ray technology. This development has occurred despite the lack of suitable high speed electronic components, sufficiently fast computers and advanced ultrasonic transducers which could completely utilize the inherent possibilities of the method – the sign of an innovation with high invention standards. As modern information technology develops we will see a number of inventive ultrasound scanners with much improved resolution and even three-dimensional real-time images.

Edler's pioneering work on ultrasonic diagnosis in cardiology has, from an international point of view, given him the honourable nomination "The father of echocardiography". Other national and international appreciations are his memberships of honour of the American, the German, the Swedish and the Yugoslavian national ultrasound societies, together with the Swedish Society of Cardiology and The American College of Cardiology.

Together with Hellmuth Hertz, Edler received the 1977 Lasker Clinical Medical Research Award (often named the American equivalent to the Swedish Nobel Prize in Medicine). In 1983 he received the Rotterdam Echocardiographic Award for his most outstanding and pioneering work applying ultrasound as a diagnostic tool in cardiology, and in 1984 the Royal Physiographic Association in Lund Award for scientific work of extraordinary significance. In 1987 he was honoured with the title of Professor by the Swedish Government.

In 1988 he received The Medical Ultrasound Pioneer Award from the American Institute of Ultrasound in Medicine, the World Federation of Ultrasound in Medicine and Biology and the Medical Sciences Division of the National Museum of American History, the Smithsonian Institution (Washington). He also received the Münchener und Aachener Preis für Angewandte Naturwissenschaft. The Eric K. Fernström's Great Nordic Prize was given to Inge Edler in 1991. His last scientific award was in 2000 when he was designated "The Swedish Cardiologist of the Twentieth Century" after a vote of the members of the Swedish Society of Cardiology.

To create and evaluate a new and revolutionary diagnostic method demands a person with extraordinary qualities: an ardent interest for the patient, interdisciplinary creative thinking, and extreme accuracy coupled with an infinite patience. Edler possessed these qualities, which made his research successful and the daily collaboration easy: the information and data received from Inge Edler were always precise and correct. With this concentration in his work, Edler was sometimes regarded as rather correct in an old-fashioned way but also a very kind person. Beneath his official exterior there was always a great amount of humanity, cordiality and sense of humour, together with a natural curiosity within many different areas. A typical example illustrating this curiosity is his response to a journalist asking him how he would spend the prize money when he received the Eric K. Fernström's Great Nordic Prize in 1991. Edler, who was then 80 years old, responded that he planned to travel the Silk Road from Islamabad to Peking (including the Khunjerab Pass 5000 m above sea level). Of course he performed this trip, although his first attempt was hampered by an avalanche!

From his youth he had always been very interested in technology, and perhaps it was this interest that inspired him to develop the new techincal methods for cardiac diagnosis. After his retirement he spent quite a lot of his time helping young biomedical engineering students at the Lund Institute of Technology with his medical knowledge. However, he was equally interested in discussing technical problems like model railways and trains as well as video techniques and did this in a very initiated way. Those who had the privilege to become more closely acquainted with Inge Edler also found that he even was an almost professional magician.

Inge Edler made a pioneering work in medical diagnosis that is hard to surpass. His contribution is obvious, and can be summarized as the motivation for The 1977 Albert Lasker Clinical Medical Research Award says: "For pioneering the clinical application of ultrasound in the medical diagnosis of abnormalities of the heart – probably the most important *non-invasive* tool for cardiac diagnosis since the electrocardiograph machine".

Colleagues and friends from Lund University, Lund, Sweden

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