Ian Donald (1910–1987) [1]

By: Erjavic, Nicole Keywords: Neonatal Medicine [2]

Ian Donald [3] was an obstetrician who developed ultrasound [4] diagnostics during the twentieth century in Europe. Ultrasound is a medical diagnostic technique that uses sound waves to produce images of the inside of the body. During the early 1900s, physicians had no way to see inside a woman's uterus [5] during pregnancy [6]. Donald developed the first method of scanning human internal anatomy in real time, which enabled doctors to diagnose potentially fatal tumors and cysts. Donald's development of ultrasound [4] imaging enabled doctors and midwives to more accurately track fetal development and prevent potential health problems.

Donald was born on 27 December 1910 in Cornwall, England, to Helen Wilson and John Donald. His mother was a concert pianist, and his father was a medical doctor. Donald was the eldest of four children, with younger siblings Margaret, Alison, and Malcolm. While Donald grew up in rural England, his father emphasized the importance of a broad education, including conversing in French at the dinner table and memorizing the works of Shakespeare. Donald began his formal education at Warriston Preparatory School in Moffat, Scotland, and continued his secondary education at Fettes College in Edinburgh, Scotland.

In 1925, at the age of fourteen, Donald moved with his family to Cape Town, South Africa. He attended Diocesan College in Cape Town, where he studied Greco-Roman literature, music, philosophy, and language. Two years later, Donald, two of his siblings, and their mother contracted diphtheria. Diphtheria is a potentially fatal infection of the nose and throat. Though the children recovered, Donald's mother died of a heart attack and Donald's father died three months later. Maud Grant, the family's housekeeper, was left as the children's guardian, and a trust fund supported them financially.

In 1927, at the age of sixteen, Donald enrolled at the University of Cape Town in Cape Town, where he majored in arts and music. Donald graduated with first class honors in 1930, and shortly thereafter, the Donald siblings moved to London to continue their education. Also in 1930, Donald entered St. Thomas's Hospital Medical School in London, England. In 1937, he received his Bachelors in Medicine from St. Thomas's, becoming the third generation of Donald doctors. Soon after receiving his medical degree, Donald married Alix Mathilde de Chazal Richards and became a general practice physician in the Obstetrics and Gynecology Department at St. Thomas's Hospital in London. In 1939, he began his residency to become an independently practicing physician.

In May 1942, during World War II, Donald was drafted into the Royal Air Force as a general medical officer. During Donald's time in the service he developed a keen interest in sonar, a technique that uses sound waves to navigate, communicate with, or detect objects underwater. In 1943, Donald worked on the anti-submarine campaign to improve detection of German U-Boats from British aircraft using both radar and sonar echolocation technologies. Radar is similar to sonar, except it uses high-frequency electromagnetic waves instead of sound waves.

During the war, Donald was unable to practice obstetrics and gynecology, and had to put his medical career on hold. Instead, he tended to soldiers suffering from stress and fatigue, which developed Donald's interest in psychiatry. After World War II, in 1946 Donald was eligible for civilian employment, and a sizable increase in salary over his military pay, but only if he returned to the specialty in which he had already been trained. Thus, Donald returned to St. Thomas's with a position in obstetrics.

By 1947, Donald was appointed a member of the Royal College of Obstetricians and Gynecologists, a professional association based in the United Kingdom. Two years later, he accepted the newly created position of tutor in Obstetrics and Gynecology at St. Thomas's. In that position, Donald taught early graduate students in the field of obstetrics and gynecology. After the National Health Service incorporated the hospital into its organization [7] in 1948, St. Thomas's Hospital no longer needed to allocate income to patient care. The National Health Service was funded by taxes and provided need-based healthcare for all UK citizens. Thus, the hospital put a new emphasis on research.

Subsequently, Donald and Maureen Young, who specialized in fetal and neonatal physiology, obtained a grant to begin investigating the management of neonatal breathing difficulties. Infants born prematurely sometimes have underdeveloped lungs that require a respirator to assist with their breathing. Donald was concerned with the efficiency of the available neonatal respirators, as they established breathing rhythms independent of the infant's normal breathing pattern, often making it even more difficult for the infant to breathe. Donald developed an improved design for a negative pressure respirator. Negative pressure respirators are only activated once an infant takes a breath, and thus it conforms to the infant's breathing patterns as opposed to operating at a pre-set rhythm. In 1952, Donald and Young successfully built and demonstrated their new respirator at a meeting of the Physiological Society at the Royal Free Hospital in Hampstead, England.

Later in 1952, Donald resigned from St. Thomas's to take up a readership position at the Institute of Obstetrics and Gynecology at the Royal Postgraduate Medical School, based primarily in Hammersmith Hospital in London, England. A readership is an academic position at British universities, ranked above senior lecturer but below professor. In contrast to St. Thomas's, where research was new and uncommon, every staff member at the Royal Postgraduate Medical School had their own research project. There, Donald continued his research to refine technology to aid neonatal respiratory conditions. He developed a positive-pressure respirator, known within the Hammersmith Hospital as the Puffer, which delivered an oxygen mixture to the infant's face and could be applied to the patient in under a minute. Donald's negative-pressure respirator was best suited for long term treatment, whereas positive-pressure ventilation was preferable in immediate crisis scenarios, such as when an infant was not breathing at all and required the machine to start breathing for them.

In 1953, as part of his continued research, Donald collaborated with Albert Claireaux, who performed postmortem examinations of all of Donald's respiratory patients. Donald attended nearly every autopsy, where he learned how difficult it was to diagnose the cause of neonatal respiratory distress solely through a physical examination. Donald suggested to physician Robert Steiner of the Department of Radiology at Hammersmith the possibility of using radiography as a method of more thorough postmortem examination. Donald and Steiner worked together on how to determine the cause of neonatal respiratory distress via X-rays. In 1953, Donald and Steiner published a study of twenty-eight cases of hyaline membrane disease, also known as infant respiratory distress syndrome [8]. Infant respiratory distress syndrome [8] is a breathing disorder in infants caused by immature lungs. In their study, the two physicians took several X-rays of infants with the syndrome at different times and recorded their observations. Donald and Steiner's study concluded that radiographic imaging could help explain causes of the affliction.

In May 1954, Donald was invited to give the Blair-Bell Lecture to the Royal College of Obstetricians and Gynecologists. He spoke about atelectasis neonatorum, or the collapse of a lung in neonatal patients, and he highlighted the potential his respirators had for improving the management of that condition. Also in 1954, Donald met with the biologist John Wild, who had successfully used pulse-echo ultrasounds to visualize abnormal tissue in the human breast. Ultrasound is a general diagnostic technique in which a device projects inaudible sound at a target and then measures how fast the sound reflects off the target, which creates an image of the target. In many ways, ultrasound [4] is similar to radar- or sonar-based echolocation. The frequency range and energy level used in ultrasound [4] are low enough so as to not be harmful to human tissue, yet high enough to provide considerable image detail. Donald sought Wild's opinion on potentially applying ultrasonic imaging to obstetrics in order to gain insight on fetal development. Wild suggested the use of ultrasonic industrial flaw detectors, which were used for analyzing industrial materials, as a source of ultrasound [4] imaging.

In September 1954, at forty-four years old, Donald left the Royal Postgraduate Medical School to become the Regius Chair of Midwifery at the Glasgow Maternity Hospital in Glasgow, Scotland. In the spring of 1955, one of Donald's patients introduced him to her husband, the director of Babcock and Wilcox, an industrial fabrication company. Babcock and Wilcox was a major user of industrial ultrasound [4], and it utilized flaw detectors to check for cracks in welds and steel plates. Donald was invited to tour the factory in Renfrew, Scotland. Bernard Donnelly, a technician at Babcock and Wilcox, demonstrated the ultrasonic flaw detector for Donald. The technician tested his equipment by bouncing the ultrasonic beam off the bone in his thumb, which demonstrated to Donald that flaw detectors could effectively be applied to biological material.

In late 1956, Donald became acquainted with Thomas Brown, a twenty-three-year-old engineer at Kelvin and Hughes Ltd. in Glasgow, Scotland. Brown had a broad background in working with instruments, and was familiar with nearly all aspects of industrial ultrasound [4] technology. Brown had already been working in medical imaging with John MacVicar at the Western Infirmary in Glasgow, Scotland. Donald, as well, had been working with McVicar to assist with his research in the Department of Midwifery. Over the next years, Brown's engineering background along with Donald's and McVicar's medical knowledge enabled them to understand and improve the various technologies and processes of ultrasound [4] as a diagnostic technique. Their work resulted in an ultrasound [4] scanner mounted to the ceiling that could image a fixed area underneath it. In 1957, the group used their technology to examine a woman who was previously diagnosed with inoperable gastric cancer. However, according to the ultrasound [4] images, she did not have cancer, but rather an ovarian cyst. Surgical intervention confirmed that diagnosis and a large ovarian cyst was successfully removed. In June of 1958, Donald, Brown and McVicar published the first ultrasound [4] images of a fetus [9] at fourteen weeks' gestation [10], in *The Lancet*. According to Malcolm Nicolson, that exposure brought global attention to the three men.

Over the next years, Donald expanded his understanding of medical ultrasound [4] imaging with funding from a number of commercial medical equipment companies and Glasgow University. That led to the development of the Automatic Scanner, which could be moved in three dimensions using a joystick, which enabled the scanner to easily rotate around a stationary patient. Donald, McVicar, and Brown developed key technologies such as refinement of the angle and movement of the joystick, and direct capture and viewing of images on the screen that advanced the application of ultrasound [4] imaging. By 1960, Donald, MacVicar, and Brown demonstrated their scanner at a medical exhibition in London, England. During the subsequent decade, with his contacts at Western Infirmary and the Royal Maternity Hospital and bolstered by younger colleagues, Donald continued to advance the technology and application of ultrasound [4]. In 1963, Donald and his team further refined their machinery into what was called the Diasonograph. The Diasonograph was a smaller box attached to a hinged wall mount that could be swung over a patient and manually controlled with one hand. In 1964, Donald was able, using the Diasonograph, to identify fetal echoes within the uterus [5], and monitor fetal development throughout the pregnancy [6] term.

By 1970, Donald was able to document fetal developments during pregnancy [6] with the Diasonograph, leading to new criteria for diagnosing early pregnancy [6] failure. His techniques were widely adopted as a standard clinical practice in the late 1970s. The fetus [9] was no longer invisible to medical clinicians.

Donald died in 1987 in Essex, England, of complications from heart failure.

Sources

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Ian Donald was an obstetrician who developed the technology and therapy of ultrasound diagnostics during the twentieth century in Europe. Ultrasound is a medical diagnostic technique that uses sound waves to produce images of the inside of the body. During the early 1900s, physicians had no way to see inside a woman's uterus during pregnancy. Donald developed the first method of scanning human internal anatomy in real time, which enabled doctors to diagnose potentially fatal tumors and cysts. Donald's development of ultrasound imaging enabled doctors and midwives to more accurately track fetal development and prevent potential health problems.

Subject

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