It was in 1968 that South African–born surgeon Dr Donald Ross led the team of doctors and nurses at the National Heart Hospital in London for the United Kingdom’s first heart transplantation. The operation, on a 45-year-old man, lasted 7 hours. The patient survived for another 46 days before dying from what was described at the time as an “overwhelming infection.”

Looking back, Dr Ross, who in South Africa had been a fellow student of Christiaan Barnard, MD, PhD, the man who carried out the world’s first heart transplantation at the Groote Schuur Hospital, felt that it was almost logical that he should lead the team for the United Kingdom’s first transplantation. He says, “Despite the surge of publicity, we did not consider this to be unique. Operations on the open heart introduced the need to be able to deal with a quiescent heart action, so like most cardiac surgeons, I was involved in operating on an arrested heart and, as an extension of that, a quiescent transplanted heart.”

Dr Ross, who retired 10 years ago, recalls no particular surgical challenges. The greatest issue faced was overcoming rejection of the newly transplanted heart. “We felt that transplantation was a natural evolution,” he says. “But while Dr Barnard gave up surgery in favour of film stars and publicity, we carried on with our research and teaching.”

But, he adds, “We did not feel we had achieved any particular advances in transplantation at that time, and we stopped after the third transplantation because the problem of rejection had not been overcome.”

Born of Scottish parents in 1922 in Kimberly, South Africa (known as “the city of diamonds”), Dr Ross undertook his medical training at the University of Cape Town, first as a dedicated scientist and subsequently as a doctor. He graduated in 1946 with first-class honours and the university gold medal.

He recalls, “I was awarded a 2-year overseas scholarship, which I accepted eagerly, although it was for a short period. Nevertheless, once in England I took up a career in surgery and became a Fellow of the Royal College of Surgeons within 2 years instead of the usual 3. I worked first in Bristol in chest and oesophageal surgery, and then I began to include early cardiac surgery, such as on the ductus arteriosus.”

He cites 2 key figures who helped shape his career: Ronald Belsey, MD, and Russell Claude Brock, FRCS, FRCP (later Lord Brock). Dr Ross recalls, “Dr Belsey was the oesophageal surgeon in Bristol with whom I was working, and he took me with him to Guy’s Hospital in London to see Sir Russell Brock attempt to split open a calcified aortic valve. There was no open-heart surgery in those days, and the operation was a dramatic failure. But the drama involved convinced me that I had to study new developments in cardiac surgery.”

Dr Brock was in charge of surgery at Guy’s Hospital, and he took Dr Ross on as a cardiovascular research fellow and later as senior thoracic registrar. Four years later, in 1958, he was appointed consultant cardiothoracic surgeon.

“This launched my career, and I ended up as senior surgeon at the National Heart Hospital, London. In 1970, I became director of the Department of Surgery at the Institute of Cardiology, also in London,” says Dr Ross.

Throughout his early training, Dr Ross felt a lure toward chest surgery and cardiology because they seemed to be the most active specialties in an era when very little could be done for a patient with heart disease of any type, up to the early 1950s.

He remembers, “My interest lay particularly with the valves—especially the aortic valve—but, in general, anything that was related to the function of the heart. Initially, I was involved in the development of a bypass machine and the use of hypothermia to enable us to operate on the open heart.”

The Ross procedure (see Figure), or pulmonary autograft for aortic valve disease, was developed in 1967. It replaces a
patient’s damaged aortic valve with his or her own pulmonary valve. Dr Ross explains, “The pulmonary autograft was the logical development of the homograft,” which he first used in 1962.

“The use of homografts allowed us to regularly replace diseased aortic valves, but, despite our early hopes, they all had a limited life span—generally around 8 years.” He continues, “But, I believed that, with care, the patient’s own living pulmonary valve could be transplanted to replace the diseased aortic valve in that critical and vulnerable position and that it could persist there permanently. The benefits of the procedure were that it did not require lifelong anticoagulation with its attendant risks, and it could grow proportionately with the patient, making it suitable for use in children. The pulmonary autograft has probably been my proudest achievement.” But, Dr Ross adds that it would be better “if we could create our own living tissue valves and living cells to replace not only valves but any other vulnerable section of the heart and related tissues.”

Dr Ross believes there is a bright future in cardiac surgery, with radiology having a huge impact on heart disease, both in diagnosis and in treatment. But he remains concerned at the worldwide shortage of human organs and tissues for transplantation procedures. He says, “Tissue engineering may eventually provide the answer to the worldwide shortage of tissue. A national policy of ‘opting out,’ or presumed consent, rather than ‘opting in’ to organ donation, also may address the shortage, but such a policy has wide ramifications and requires strict safeguards.”

No longer an active surgeon, Dr Ross is an observer and lecturer, visiting cardiac centres worldwide, giving advice wherever he can. At one time, outside of his medical pursuits, he was actively involved in breeding Arabian horses, a pastime he now misses, but he still enjoys the theatre, opera, and, particularly, chamber music at the Wigmore Hall, London. Dr Ross still lives in the heart of the city, by Regent’s Park, with his wife Barbara.

Mark Nicholls is a freelance medical journalist.

Viewpoint: Kate Brown, MRCP

Few centres in Europe offer paediatric extracorporeal membrane oxygenation. Dr Kate Brown, consultant in cardiac intensive care at Great Ormond Street Hospital, London, United Kingdom, talks to Emma Baines, MSc, about the role of this treatment and the problem of extending its availability.

Extracorporeal membrane oxygenation (ECMO) is a life-support system for oxygenating the blood that has been used for the past 20 years to help patients recovering from severe reversible heart or lung trauma. The technique also has been found to have some success in resuscitating patients with cardiac arrest, although its use for this purpose in adults is rare because success rates are only around 30%. But in paediatric patients, where the overall success rates are better, its use is increasing, according to Dr Kate Brown.

Dr Brown joined the ECMO team at Great Ormond Street in 1999, where ECMOs had been carried out regularly since 1992. It is 1 of only 4 ECMO units in the United Kingdom, and it has provided support for more than 400 neonates and children.

Dr Brown explains, “Although ECMO was used occasionally to resuscitate infants in cardiac arrest at Great Ormond Street throughout the early 1990s, it wasn’t until 1998 that the first report on using ECMO for this indication was published.” The report was authored by a team at the Boston Children’s Hospital in Boston, Mass. Further studies were published in 2004 and 2005 using data from the Children’s Hospital of Philadelphia in Philadelphia, Pa. These studies showed that paediatric patients put on ECMO within 30 to 45 minutes of a primary cardiac arrest stood a good chance of recovery, although patients have survived after as long as 90 minutes of cardiac arrest.

“If you can put them on ECMO within 30 minutes, the children seem to come through it quite well. In some cases, if you met them, you would never know what they’d been through!” says Dr Brown. “However,” she adds, “it’s not a miracle treatment. The survival rate is around 40%.”

She warns that great care is needed in extending the use of ECMO to cardiac arrest in children. “We’re just at the moment starting to follow up with the children who have been treated with ECMO for cardiac arrest,” she says. “We need to do more research to look at the long-term progress of children who have been treated, particularly in terms of their neurological development.”

In particular, children whose cardiac arrest is the result of respiratory problems leading to low oxygen levels are likely to have severe neurological problems. “In my view,”
she says, “even if you run in and put them on ECMO right away, these patients will very seldom come out of it in good shape, because the low oxygen levels will have already led to brain damage.” Dr Brown continues, “We really need more information about the development and quality of life of these children, and we need to look further at what we’re doing to make sure that the ones who get through do so with a really good quality of life and with good long-term neurodevelopment. It’s important that we learn more about the long-term outcomes and case selection and that we only use the procedure for the right patients.”

Her team is currently taking part in a randomised controlled trial that is being run from Toronto, looking into cooling techniques that might minimise the risk of injury to the brain caused by delays in initiating ECMO.

Although the use of ECMO for cardiac arrest is increasing, it is still rare. According to Dr Brown, most cardiac ECMO patients at Great Ormond Street have been put on the machine because they developed complications following open heart surgery (see Figure). In her opinion, this is likely to remain the main cardiac reason for using ECMO.

“We’re constantly taking on tougher cases in the operating room,” she says, “as well as trying to do heart transplantations on higher-risk cases. Because we’re trying to do more aggressive things, ECMO will continue to be needed.”

A recent investigation carried out by the ECMO team at Great Ormond Street showed that the sorts of cardiac procedures that resulted in patients being given ECMO have changed as surgical techniques have advanced. “Ten years ago, we would sometimes use ECMO after surgery for biventricular patients, which was, at that time, pushing the boundary. But the techniques, surgery, and intensive care unit treatments for these patients have improved so much that they rarely require ECMO these days. Now, we’re more likely to use it for patients who have undergone surgery for hypoplastic left-heart syndrome.” She adds that this is partly why the paediatric cardiac ECMO survival outcomes remain low, at 40% to 45%. “It’s because we’re using it for tougher and tougher cases,” she says.

She believes that mobilising ECMO for cardiac patients undergoing new and experimental interventions would facilitate the development of new surgical techniques, and that ECMO should be considered essential in any cardiac centre undertaking high-risk cases. “In my opinion, if you have a big cardiac programme where you are doing high-risk cases, and certainly if you are doing transplantation, you really need an ECMO programme to support the rest of the programme. There are big centres that might disagree with me, but I believe that is the case.”

However, there are only a small number of ECMO centres in Europe, and it would be prohibitively expensive for most hospitals to offer a 24-hour ECMO on-call service because of the large team of trained specialists that would be required.

Dr Brown explains that to put a patient on ECMO in the middle of the night requires a minimum of 6 people, including at least 1 surgeon, 1 physician, 1 perfusionist to run the pump, at least 1 specialist nurse, and 2 runners—all available at very short notice. “If you are running a full ECMO programme, you need the infrastructure to provide that level of staffing constantly, so it’s quite an undertaking in terms of resources, training, and expertise,” she says. “There are safety issues, and you have to keep people’s skills up. If every centre did just 1 or 2 cases a year, you might not be able to maintain their skills.” She concludes, “Centres that are not taking on high-risk cases don’t necessarily need it. But, if you are going to offer the best possible care for the very high-risk patient, ECMO is a good backup to help you out when things go wrong. It’s not always successful, but it is there if you need it for those really tough cases.”

Emma Baines is a freelance medical writer.

References


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History of Cardiology: Defibrillation

The history of defibrillators goes back to the 18th century when a Danish veterinarian and physician studied the effects of electrical shock on chickens. Diana Berry explores the development of the technique.

Nearly 25% of deaths in humans are attributable to events that result in sudden disorders of ventricular rhythm. Here at the beginning of the 21st century, an external defibrillator is a readily available and fairly affordable home accessory for those who may need one. Defibrillators are recommended as part of the essential first-aid kit for many public places such as shops and gyms and are even sophisticated enough to inform the care provider whether use is appropriate.

This situation is a far cry from 1775 when the Danish veterinarian and physician Peter Christian Abildgaard, MD, studied the effects of giving electric shocks to animals. Dr Abildgaard “studied animals killed by lightning and rarely noted internal injuries sufficient to account for death.” He tried unsuccessfully to duplicate the effects of lightning on a young horse using a primitive type of battery constructed of glass jars and strips of tin and decided to try again with chickens. “A shock to the chicken’s head resulted in death, and repeated countershocks to the head were without effect. Countershocks to the spine, however, resulted in complete recovery.”

Dr. Charles Kite, MD, of Gravesend, Kent, United Kingdom, who was a keen member of the London Humane Society and much involved with the resuscitation of the drowned, also described a portable resuscitation kit (see Figure) and one of the first successful defibrillators, which had basic components that were similar to those of today. That is, it had a capacitor, a charge adjustor, and 2 electrodes for delivery of the charge. Some 8 years later, 2 Danish advocates of life-saving procedures, John Daniel Herholdt, MD, and Carl Gottlob Rafn, MD, wrote a seminal work covering both historical surveys and contemporary advice on resuscitation. They were passionate believers in the use of electricity and wrote that “Among all means of resuscitation, nature has none which can be applied so directly to the heart or produce such a rapid and potant effect as electricity.”

Physiological studies of the heart that included ventricular fibrillation were carried out in the Leipzig, Germany, laboratory of the renowned physiologist Carl Ludwig, MD. Dr Ludwig became professor of anatomy and physiology in Zurich, Switzerland; Vienna, Austria; and ultimately Leipzig, where he founded the Physiological Institute. It was here in 1849 that the first electrically-induced ventricular fibrillation was observed and documented. John A. MacWilliam, MD, who was professor of medicine at Aberdeen University, Scotland, referred to work at the Physiological Institute when he described how “Faradic currents when applied to the ventricles of a dog’s heart caused an abolition of the normal beat. The ventricular muscle is thrown into a state of irregular arrhythmic contraction whilst there is a great fall in the arterial blood pressure.”

The Swiss physiologist Edme Felix Alfred Vulpian, MD, found that ventricular and atrial fibrillation are different phenomena that can be induced by stimulation of either ventricles or atria, respectively. He was the first to suggest a myogenic theory of fibrillation.

Further experimentation in the field of ‘faradisation’ of the heart was continued at the turn of the century by the Swiss physicians Jean-Louis Prevost, MD, and Frederic Batelli, MD. They discovered that whilst fibrillation could be produced by a weak stimulus, one of a higher strength when applied to the heart could arrest ventricular fibrillation and promote restoration of a normal sinus rhythm. Sadly, their findings were neglected for several years and not promoted or applied clinically.

Fortunately, Dr Prevost and Dr Batelli’s work was continued independently some 30 years later by the Russian physician Naum Lazerevich Gurvich, MD, who in 1932 enrolled as a graduate at the Institute of Physiology in Moscow. His PhD advisor was L.S. Schtern, MD, who had previously been an associate of Dr Prevost. Dr Schtern’s research laboratory concentrated on electrical stimulus-induced arrhythmogenesis and defibrillation, providing the necessary impetus for Dr Gurvich’s further researches. In 1940, Dr Gurvich advocated the use of biphasic waveforms for defibrillation, and in 1948, the main focus of his research career became the initiation and maintenance of fibrillation and defibrillation.

Early in the 1950s, Dr Gurvich designed one of the first worldwide commercially available transthoracic defibrillators, and the biphasic “Gurvich waveform” has been used in Russian-designed transthoracic defibrillators since the 1970s. The first defibrillators were clumsy machines weighing up to 60 lb (27 kg), and today’s tiny lightweight implantable devices are the result of a long and arduous journey.

Diana Berry is a medical historian and freelance writer.

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