

# Alexis Carrel (1873-1944)

*Nobel Laureate, 1912*

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**A**lexis Carrel, recipient of the 1912 Nobel Prize in Medicine, was born in a small town near Lyon, France, on June 28, 1873. His father, a wealthy textile manufacturer, died when he was 5 years old. He was educated in Jesuit schools and entered medical school in 1890, at the age of 17. During the 1890s, Carrel interned at several hospitals near Lyon and was described as a “good but not brilliant student.”<sup>1</sup> He decided early to pursue a career in surgery and his research interest was peaked by an assassination in 1894. Sadi Carnot, the president of the French Republic, was stabbed in the abdomen while visiting Lyon and exsanguinated with a severed portal vein. The general opinion of the time was that major vascular injuries were beyond the surgeon’s capability to repair. Carrel, however, felt that anastomosis of blood vessels, as with any other organ, should be possible with the correct technique.

He began to work in the laboratory of one of his surgical professors, Mathieu Jaboulay, who had developed a technique of blood vessel repair using interrupted U-shaped mattress sutures to evert the edges of the vessels and allow intimal contact without suture material in the lumen. Between 1896 and 1902, Carrel spent long hours in the laboratory perfecting his own suture technique and published 25 papers on a variety of topics, including varicella infection, Cheyne-Stokes respiration, abdominal aneurysms, and uterine fibroid disease.<sup>2</sup> He received a doctorate in medicine from the University of Lyon in 1900. He worked at this university until 1902, while continuing to refine his vascular anastomotic technique. Carrel’s first paper describing this technique was published in French literature that same year.

In 1903, he cared for a young woman dying of tuberculous peritonitis on a “sick train” that made a yearly trip to the miraculous “grotto at Lourdes.” After reporting on this case, he was ridiculed by the medical community in France and, soon thereafter, he twice failed the very competitive exams for a full faculty position at his university. Frustrated by his lack of acceptance, he left for America in 1904. These early setbacks may have shaped his future social and professional interactions; he has been described



Alexis Carrel

by different authors as being bitter,<sup>3</sup> moody to the point of sullenness,<sup>1</sup> as well as overly serious and socially withdrawn.<sup>2</sup>

Carrel accepted a position in the Hull Laboratory of Physiology at the University of Chicago in 1904. It was there that he met Charles Guthrie and together perfected their vascular anastomotic technique. Carrel and Guthrie are credited with the vascular technique of triangulation, in which 3 equidistant stay sutures are placed and a fine suture is run along the relatively flat surface between each of the stay sutures. Carrel is also credited with the “Carrel” patch technique used in replantation of major vascular structures during organ transplantation. Unlike most techniques of their time, their method stressed surgical asepsis, careful handling of vessel ends, the use of fine silk suture coated with vaseline, and the in-

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corporation of the intima with the suture line. They conducted numerous experiments together and Carrel is credited with 29 publications. Only 21 of these articles, however, appear on Guthrie's curriculum vitae. The two scientists parted ways in 1906 with Guthrie claiming that Carrel had published several joint experiments solely under his own name.

Carrel's work, however, was becoming nationally known. Carrel hosted Harvey Cushing and George Crile in his laboratory during the annual meeting of the Society for Clinical Surgery which was held in Chicago in 1905. After witnessing Carrel's vascular anastomotic techniques, Cushing, then the director of the Hunterian Laboratory at Johns Hopkins University, invited Carrel to give a guest lectureship at the university in 1906. This visit to Baltimore led to his decade-long correspondence with William Halsted.<sup>2</sup>

While Cushing was very interested in bringing Carrel to Baltimore, he also was responsible for introducing his work to Simon Flexner, the director of the newly founded Rockefeller Institute for Medical Research in New York. Carrel was offered a position at the Rockefeller Institute and immediately accepted, moving to New York in September of 1906. Over the next 8 years, Carrel continued his investigations, not only in vascular technique, but also in several related topics including cardiac surgery and organ transplantation. During this time, he kept up a steady correspondence with Halsted who was working on related experiments in Baltimore. Halsted became one of his strongest supporters, and the two men developed a strong relationship of mutual respect, if not friendship.<sup>2</sup> With the support of Halsted, Cushing, and Flexner, Carrel's work on vascular anastomoses and organ transplantation became nationally recognized and in 1912, he was awarded the Nobel Prize in Medicine and \$39 000.

Despite this accomplishment, Carrel's vigorous research career continued without pause. Between 1910 and 1914, he worked extensively with tissue culture techniques and his tissue culture of a chicken heart embryo is said to have survived 34 years.<sup>1</sup> His work also explored the topics of cold storage of tissues, skin grafting, and wound healing.

He married a young, widowed nurse named Anne Marie de la Meyrie in 1913. While vacationing in France in 1914, Carrel, still a French citizen, was drafted into the army as the country became embroiled in World War I. He noted that many soldiers were losing limbs to infection and felt that the care of these wounds by the French surgeons was archaic. Carrel attempted to study new techniques of wound care but had difficulties obtaining funds from the government of France. Thus, he turned to Flexner and the Rockefeller Institute who were able to supply funds and an American chemist named Henry Dakin. Together, Dakin and Carrel created a system of wound management that involved mechanical cleansing, surgical debridement, and copious irrigation with a solution of sodium hypochlorite buffered with sodium bicarbonate. This solution, then termed Carrel-Dakin's solution, is still in use today and now carries only the latter's name. After some time, this method was accepted as the preferred method of wound management by both military and civilian surgeons. In 1917, Carrel wrote a textbook titled *The Treatment of Infected Wounds*, with his wife co-authoring a companion text for nurses. After the war, Carrel returned to the Rockefeller Institute where he remained until his retirement in 1939.

In the 1920s, Carrel concentrated his research activities on tissue culture and perfusion techniques. He spent many years attempting to create an apparatus to perfuse ex-vivo organs. After many failed experiments, he was visited by Charles Lindbergh, the famous aviator. Lindbergh's sister-in-law had recently died from mitral stenosis after her physicians had informed him that operations on the mitral valve were not possible because there was no means of temporary heart bypass. Carrel and Lindbergh spent 5 years creating a pump oxygenator for long-term perfusion of individual organs and by 1935, they were able to keep organs alive for several weeks with this apparatus.

During the later stages of his career in 1935, Carrel wrote a book, *Man the Unknown*, summarizing his views of science and philosophy.<sup>1</sup> The book became tremendously popular; it was translated into 19 languages and more than 900 000 copies of it were eventually sold. While it was an excellent summary of his scientific discoveries, couched in simple language for the lay person, it also espoused ultra-conservative philosophies on education, women's place in society, and criminal punishment.<sup>1</sup> In the book, Carrel also praised the virtues of authoritarian governments, which would haunt him in his later years.

In 1939, Carrel turned 65 years old, the mandatory retirement age for the Rockefeller Institute. Angry at being forced into retirement, he returned to France where he hoped to establish a "Foundation for the Study of Human Problems." However, while preliminary plans for the institution were being made, France was captured by the Germans in 1940. Carrel continued with his plans for the Institute, with the consent of the German government, and was thus accused of collaborating with them. The authoritarian philosophies he espoused in *Man the Unknown* were cited as evidence. When the American army liberated France, Carrel was relieved of his position as regent of the Institute. With his health already failing, this devastating blow led to a precipitous physical and emotional collapse. Carrel died in disgrace in France on November 5, 1944.

Carrel's long and sometimes contentious career is full of ground breaking innovations in surgical technique and philosophy, including his Nobel Prize-winning work on vascular anastomoses, his pioneering of surgical asepsis and wound management, as well as his extensive work with tissue culture. His career was also populated with relationships with other pioneers in American surgery, including Harvey Cushing and William Halsted. His work taught us not only that innovation can be created with perseverance and that research is a collaborative effort, but also that brilliant men are often tragically flawed.

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